THE ROLE OF DESIGN IN HUMAN-WORLD ENGAGEMENTS: BOUNDARIES OF SELF IN TECHNOLOGICALLY MEDIATED IN-CAR NAVIGATION

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submitted by **ELİF BÜYÜKKEÇECİ** in partial fulfillment of the requirements for the degree of **Doctor of Philosophy** i**n Industrial Design, Middle East Technical University** by,

Prof. Dr. Naci Emre Altun
Dean, Graduate School of **Natural and Applied Sciences** ________________

Prof. Dr. Gülay Hasdoğan
Head of the Department, **Industrial Design** ________________

Prof. Dr. Gülay Hasdoğan
Supervisor, **Industrial Design, METU** ________________

Examining Committee Members:

Assoc. Prof. Dr. Fatma Korkut
Industrial Design, METU ________________

Prof. Dr. Gülay Hasdoğan
Industrial Design, METU ________________

Assist. Prof. Dr. Damla Tönük
Industrial Design, METU ________________

Assist. Prof. Dr. Berke Atasoy
Visual Communication Design, TEDU ________________

Assist. Prof. Dr. Aren Emre Kurtgözü
Industrial Design, TEDU ________________

Date: 22.05.2024

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name Last name : Elif Büyükkeçeci

Signature :

ABSTRACT

THE ROLE OF DESIGN IN HUMAN-WORLD ENGAGEMENTS: BOUNDARIES OF SELF IN TECHNOLOGICALLY MEDIATED IN-CAR NAVIGATION

Büyükkeçeci, Elif
Doctor of Philosophy, Industrial Design
Supervisor: Prof. Dr. Gülay Hasdoğan

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The study aims to identify varying relations occurring between the driver, environment, and navigation technology during in-car navigation, guided by phenomenology, postphenomenology, and related approaches. In the field research employing autoethnography and participant observation, 26 driving sessions conducted with the assistance of navigation technologies. The drives were performed by a total of 15 drivers, involving the researcher. Participants were chosen from 83 respondents to a user survey. Each session was followed by an interview focusing on their navigation experiences. The results illustrate embodiment relations where the boundaries between the driver and environment partially dissolve, resulting in the unity of the two. Based on the results, the study examines embodiment from two perspectives. The first aspect concerns the driver synchronizing with the surroundings and moving accordingly without noticing. The second entails applying tacit knowledge, which was acquired from previous navigation practices, during the drive. Notably, no instances of embodiment relations were observed between the driver and navigation technology throughout the study. The study found no evidence suggesting that navigation technology disrupts the unity of the driver and environment. Instead, it offers alternative connections between the two. The context-specific and customized information it provides may enhance the diversity of those connections. Such information may also lead to a reduction in shared environmental experiences. Repeated navigation practices on specific routes may allow the driver to acquire skill in navigating those routes. The study concluded that consistent use of navigation technologies does not impede such skill acquisition.

Keywords: Navigation Technologies, Phenomenology, Postphenomenology, In-car Navigation

ÖZ

İNSAN-DÜNYA İLİŞKİLERİNDE TASARIMIN ROLÜ: ARAÇ İÇİ NAVİGASYONUN TEKNOLOJİK DOLAYIMINDA BENLİĞİN SINIRLARI

Büyükkeçeci, Elif
Doktora, Endüstri Ürünleri Tasarımı
Tez Yöneticisi: Prof. Dr. Gülay Hasdoğan

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Bu çalışmanın amacı, araç-içi navigasyon pratiği boyunca sürücü, çevre ve navigasyon teknolojisi arasında gerçekleşen çeşitli ilişkilerin tanımlanmasıdır. Çalışmaya temel olan teorik çerçeve fenomenoloji, postfenomenoloji ve ilgili yaklaşımlar etrafında yapılandırılmıştır. Saha çalışmasında kullanılan yöntemler ana hatlarıyla otoetnografi ve gözlemdir. Otoetnografi ve gözlemler kapsamında araştırmacının kendisi ve katılımcılar tarafından, toplam 15 sürücü ile navigasyon teknolojisi asistanlığında 26 sürüş gerçekleştirilmiştir. Katılımcılar navigasyon etkinlikleri üzerine 83 kişinin katıldığı anketin sonuçlarına göre belirlenmiştir. Katılımcılarla yürütülen her bir sürüş seansının sonunda ilgili katılımcı ile, kendisinin navigasyon deneyimleri üzerine bir röportaj gerçekleştirilmiştir. Araştırma sonuçları sürücü ve çevre arasındaki sınırların kısmen kaybolduğu ve bu ikisinin bütünleştiği bedenleşme ilişkilerini örneklemektedir. Sonuçlara dayanarak, çalışmada bedenleşme iki açıdan ele alınır. Bunlardan birincisi sürücünün belli bir anda farkında olmadan çevresiyle uyumlanarak hareket etmesi, ikincisi ise daha önceki navigasyon pratiklerinde edindiği örtük bilgiyi sürüş sırasında uygulamasıdır.

Araştırma sırasında sürücü ve navigasyon teknolojisi arasındaki sınırların kaybolduğu bir bedenleşme ilişkisine rastlanmamıştır. Araştırmanın, navigasyon teknolojisinin sürücü ve çevre arasındaki kısmi bütünlüğe zarar verdiğine dair bir bulgusu yoktur. Bunun yerine, teknoloji, sürücü ve çevre arasında, alternatif bağlantılar sunar. Teknolojinin sunduğu bağlama özel ve kişiselleştirilmiş bilgi, bu bağlantıların çeşitliliğini artırır. Bilginin bağlama özel ve kişiselleştirilmiş olması, aynı zamanda ortak çevresel deneyimlerin azalmasına neden olabilir. Belli bir rotada tekrar eden navigasyon pratikleri yapmak, bu deneyimlerin bedenleşmesini ve sürücünün o rotada navigasyon becerisi kazanmasını sağlayabilir. Çalışma sonucunda, navigasyon teknolojisinin düzenli kullanımının böyle bir kazanımı engellemediği görülmüştür.

Anahtar Kelimeler: Araç-içi Navigasyon Teknolojileri, Fenomenoloji, Postfenomenoloji

To my family

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ABBREVIATIONS

Actor-Network-Theory (ANT)

Global Positioning System (GPS)

Graphical User Interface (GUI)

Material Engagement Theory (MET)

Participant observation of naturalistic driving (POND)

Route selection before the drive (RSBD)

Route selection during the drive (RSDD)

Universal Serial Bus (USB)

CHAPTER 1

INTRODUCTION

This chapter will begin by providing a summary of the contextual background of the study. Subsequently, it will delineate the study's aims, objectives, and research questions, which are derived from this background. Additionally, it will detail the scope and methods used to achieve the objectives and address the research questions. An overview of the study's structure will also be presented in this chapter.

1.1 Background

Phenomenology is a philosophical area which focuses on daily experiences of human with the environment which cannot be separated from human life (Stienstra, 2015). Considered technological expansion, Sokolowski (2000) advocates that phenomenology is an area that provides a theoretical background about humans' experiences with technology. Postphenomenology is another area which provides insight about humans' relations with technology (Ihde, 2003; Ihde & Malafouris, 2019). Based on the phenomenological approach to definition of human, what postphenomenology focuses on are our relations to technological artifacts and the ways they mediate our relations to the world. The technological mediation is generally explained in postphenomenology as variations of *I-technology-world relations*.

As regards to how "I" is dealt with in these philosophical fields, it is necessary to mention the definition of self. As defined in phenomenology, it is the entity being able to say "I" (Sokolowski, 2000) and the subject of experience (Strawson, 1997; Zahavi, 2000). On this basis, it can be said that "I" in the I-technology-world relationship can be addressed as self-technology-world. Also, human is considered in phenomenology, postphenomenology and related fields as a combination of mind and body (Ihde, 2002; Malafouris, 2008; Moran, 2010). This means that self can be accepted as the unity of mind and body in self-technology-world relations.

Concerning self-technology-world relations, it is suggested that body is intertwined with its environment and therefore it is considered to *extend* towards it (Moran, 2002; Verbeek, 2005). There are also approaches, related to these fields, supporting that body and its environment inseparably interact with each other in human experiences. As suggested in these views, human mind benefits from its bodily interaction with the environment (Ingold, 2002) and this interaction even reshapes it (Dreyfus, 2002; Ihde & Malafouris, 2019).

As studies on self-technology-world relations suggest, the boundaries between them are not sharp and definite in every case. *Extendibility of mind and body* towards the environment and *transparency of technology* are concepts posing questions about, for example, if the technology is indeed a separated part of the environment from the human body, or an extension of it. Examples of the intertwinement in technologically mediated human experiences is not limited to this. In Ihde's (1990) studies, the difference between, for instance, (I-technology)-world, I-(technology-world), refers to changing boundaries between these three. As understood from such discussions, the boundaries between self, technology and world are changeable.

Considering the interests of phenomenology, postphenomenology and related approaches, they have a potential to support design research and design practice as a field including development of technology. These fields provide a ground to frame the approach to *user* as *human* in design studies. The theories they propose in relation to humans' engagement with the technology and world, can be associated to *users' relations to design outputs*. Taken all together, research on technological mediations of human engagement with the world, as discussed in these domains, yields insights into users' experiences with design outputs. Specifically, discussions on boundaries enables an exploration of how the role and status of users in their engagement with products and information systems, as determined by design, can be examined with reference to these domains. Furthermore, this approach, rooted in the user's human existence, paves the way for fruitful discussions regarding whether these engagements are congruent with human existence and whether they support the human-world relationships inherent in the respective practices. These discussions can assist in establishing existential criteria for the design of targeted mediations throughout the development of any technology.

This study approaching engagement and experience from the perspective outlined above differs from existing design studies that focus on users' experiences with technological artifacts in that it examines the practice not from a standpoint of usage, but from a standpoint of being human. Furthermore, such a study goes beyond the commonly explored user-technology relationship in design research by investigating how technology shapes the human-world relationship. In this context, it does not scrutinize technology itself, but looks at the trio of the human, technology, and world to understand how its presence shapes human experience.

On the other hand, focusing on in-car navigation technologies offers valuable insights into the mediation of human experiences by design outputs. This is because, firstly, human-world relations are prominently observable during navigation. This allows for interpretations within the domain of design studies concerning user-technology-environment relations by framing navigation practice as human-technology-world relations. Furthermore, the technologies discussed within the philosophical framework underpinning this study differ from the navigation technologies within the scope of this study, as will be delineated in Chapter 4. Therefore, the findings of such research could contribute to the literature on human-world relations as well.

The significance of focusing on in-car applications of navigation technologies can also be explained by two reasons. Firstly, in-car navigation, by increasing mobility, leads to rapid changes in the user's environment, providing a rich context for discussions on user-technology-environment relations due to the diversity of environments. Hence, it provides a conducive ground to observe the diversity of relationships within this trio. Secondly, a more indirect reason is that in-car navigation practice necessitates serious consideration in terms of driving safety. As an activity requiring a correct and uninterrupted relations with the surroundings regarding driving safety, during driving, the human-environment relationships are also noteworthy. Examining the potential impact of navigation technologies on human-environment relationships can shed light on discussions as regards to their effects on driving safety.

1.2 Aim, Research Questions, Methods, and Scope

Given this background, this research aims at exploring diverse forms of engagement among the users, navigation technologies and the environment, and how the boundaries between these three change in their various relations. This aim primarily necessitates identifying how each of these three participates in the practice, comprehending their interactions with each other during these participations, and providing interpretations regarding how the boundaries between them change based on these interactions. Hence, these are the initial goal of the study. Another goal is to examine the role of navigation technologies in such changes. Research inquiries pertaining to the aim and goals are as follows:

Q1. How do the driver, environment and navigation technology participate in in-car navigation?

Q2. What type of engagements does the driver establish with the environment and navigation technology during in-car navigation?

Q3. How do the boundaries between the driver, environment and navigation technology vary during in-car navigation?

Q4. How do navigation technologies interfere in the boundaries between the driver and environment during in-car navigation?

Following these questions, the study investigates how the boundaries between the user, navigation technology, and environment change during in-car navigation. These boundaries, frame the scope of each of these three, determining *what they are*. As will be noted in the conclusion of Chapter 2, this study approaches the discussion of what the user, navigation technology, and environment *are* by considering *what is done* by this trio, and *what is known* from the user's perspective, during practice.

At this juncture, it is imperative to clarify that navigation technologies encompassed by the scope of this dissertation Global Positioning System (GPS) based technologies that provide users with turn-by-turn instructions concurrently with their journey. The most characteristic feature of these technologies is their provision of a dynamic map and other visual information displayed on a screen along with voice notifications. These consist of navigation devices integrated within cars, mobile navigation devices, and navigation applications specifically designed for mobile phones.

The study focuses on navigation technologies while excluding other technologies engaged during driving. It particularly agrees with the notion that driving practice cannot be thought of independently of the relations between the driver and var; however, it refrains from referencing these relations. Therefore, for instance, when discussing relationships between the driver and environment during moving in the environment, these will be expressed as environment-driver relationships, without mentioning the car.

As to how navigation practice is approached here, it is defined in this study as a process of information exchange among the driver, navigation device and environment participating in it. The study similarly defines these three as information providers. The reason for this is that engaging with a phenomenon, i.e., experiencing it, depends on engaging with information related to it. In other words, what determines how a phenomenon appears is how the information it presents is engaged with. Therefore, examining how a phenomenon is engaged with first requires defining the information provides.

Since the study considers information as what makes a phenomenon experienceable, the word information here as *everything a phenomenon presents*, has a very broad meaning. For example, a vision of a building or air temperature presented by the environment, a map displayed by the navigation technology or a voice message it gives are example of information. When experienced, all these examples constitute the appearances of the related information providers.

According to this perspective, each piece of information is also a source of information that can be broken down into smaller units of information. For instance, in the context of a navigation practice, the view of the road, flowers lined up along the roadside, a single flower among them, its form and color are all within the scope of the concept of information. Similarly, a song playing at that time, the lyrics it presents, the meaning the lyrics present, or the melody and each note it presents all are considered as information in this study. These, together with other environmental elements experienced simultaneously, shape how the environment appears to the driver at that moment.

Although only aesthetic information and meaning are mentioned above, the scope of the concept of information addressed in the study is not limited to these. Besides aesthetic information and meaning, information about memories and anecdotes, information about the relations between things, tacit knowledge, kineasthetic knowledge and so on are included in navigation practice. To put it in different way, this study defines navigation as a practice open to the experience of all these, and deals with how all these types of information participate in the practice.

In accordance with the aforementioned aim, the theoretical framework of the research has been structured around phenomenology, postphenomenology, and related approaches. Additionally, the study relies on a literature review concerning cognitive, behavioral, and affective studies on navigation, as it necessitates understanding the experiences occurring during navigation practices. To address the research questions, the methods employed within the scope of field research primarily encompass autoethnography and observation focusing on navigation practices. During the observation phase, both navigation processes of drivers observed and interviews regarding these processes were conducted with them. Furthermore, participants of this stage of the study were selected based on their responses to a previously conducted.

1.3 Structure

This section presents the structure adopted to organize the content of the dissertation. Below, each chapter will be described in terms of its purpose and content, providing the reader with a comprehensive overview.

Chapter 1 initially provides a summary of the background of the study. Subsequently, it presents the aims and research questions derived from this background. It introduces the scope and research methods adopted to fulfill the objectives and address the research questions. Additionally, it outlines the structure of the study.

Chapter 2 serves as the foundation for establishing the theoretical framework of the study. It will introduce the concept self and how self relates to both the world and technology. The discussions surrounding boundaries of self will be given in this chapter. These discussions will compile and present the approaches to extendibility of mind and body and shared agency, as conceptualized by this study. Meanwhile, the subject and materials involved in a practice will all be defined as agents of that practice. The chapter will also explore various types of technological mediations in the context of human-technology-world relations. Based on these discussions, it will be determined that the boundaries between agents in a practice are variable and ambiguous.

Followingly, Chapter 3 aims to delve into the nature of navigation through a comprehensive review of literature. This chapter will elucidate how individuals establish connections with both the environment and navigation technology during navigation practice. It will compile variables influencing navigation practice and consider the participation of navigation technology as one of the variables that reshape this practice. Lastly, Chapter 3 will define the agents involved in technologically mediated navigation, which are the human, navigation technology and environment, based on insights gathered from relevant literature it reviewed and the theoretical framework outlined in Chapter 2. It will describe the three agents in navigation practice as information providers, and the practice, as a process of information exchange between these three. It will also articulate its perspective on the boundaries between these agents.

Chapter 4 will leverage the information gathered in Chapters 2 and Chapter 3 to identify the gap in studies on human-technology-world relations in terms of the mediation by navigation technologies. Additionally, Chapter 4 will outline the aim, goals and research questions of this study, along with the design and implementation of field research aligned with the aim and goals.

The findings from the field research introduced in Chapter 4 will be divided into two subsequent chapters. Chapter 5 will explore how the three information providers collaborate during in-car navigation practice, drawing from observations. It will delve into the roles of the driver, navigation technology, and environment in deriving navigational information during the practice. As the basis for these discussions, it will first outline the study's approach to the concept of information and reveal the information provided by each information provider in practice. Subsequently, it will define the concept of navigational information to elucidate the nature of the practice, specifically focusing on the derivation of navigational information through the convergence of the three information providers. Additionally, it will offer insights into situations where support from any of these agents may diminish. Based on the findings of this chapter, this study will define navigation practice as *a chain of matches* between the three agents.

Chapter 6 will deal with how the convergence of information providers is experienced and how the boundaries between them change during these occurrences. From this perspective, it will present scenarios where the information participated in the practice can be stated to be experienced, transparent or absent. It will additionally suggest that the practice defined as a *chain of matches* between information providers in the previous chapter could also be considered *a chain of experience periods*. Various ways in which information providers participate in the practice and how their boundaries change in different forms of participation will be discussed in this chapter as well. The chapter will be concluded with the discussion on the inference of the navigation technology in the boundaries between the driver and environment, reflecting on the results drawn throughout the study. The chapter will define the manner in which humans establish their relationship with the environment during driving from their own perspective. It will ground its approach to this issue in human's way of being and their experience of the world.

Within this discussion, Chapter 6 will refer to viewpoints suggesting that in-car navigation technologies weaken the driver-environment relationship and argue against the intervention of navigation technologies in this relationship. It will interpret these concerns as stemming from two ideas: first, from an epistemological perspective, that the non-physical model of the environment provided by these technologies disrupts the engagement between the driver and the physical environment; second, from a practical standpoint, that they compromise driving safety. It will present its own views on how these technologies influence the driver-environment relationship from these two perspectives. It will argue that these technologies individualize the information users acquire about the environment by providing a unique instruction set in each context of use, thus it may diminish shared experiences of the environment among the public. Additionally, based on the driver's way of being which dictates how they connect with the environment, the chapter will contend that these technologies are designed to mediate human-environment interactions in a manner that does not compromise driving safety. After this discussion, Chapter 7 will conclude the study.

Finally, it is important to address details regarding the usage of certain expressions throughout the text. First, during the presentation of the theoretical framework, phenomenology, postphenomenology, and related approaches will be specifically introduced. However, to maintain the fluidity of the text and streamline referencing, these foundational areas of the theoretical framework will be generally referred to as *(post)phenomenology* throughout the remainder of the text. Second, throughout the text, the study's focus on navigation technologies is referenced as *navigation technologies* or *navigation technology* when specific subsets of these technologies are not explicitly mentioned. However, in the sections where research conduct findings are presented, the term *navigation device* is used to refer to the relevant navigation technologies. This is because these sections directly mention the navigation devices used by participants during observation sessions.

As mentioned before, the study examines the shifts in boundaries between the user, navigation technology, and environment during in-car navigation. The next chapter will introduce the theoretical framework of the study and substantiate how it approaches to the concept of boundaries.

CHAPTER 2

HUMAN’S ENGAGEMENT WITH THE WORLD AND TECHNOLOGY

This chapter will primarily explore how humans experience the world and technology. To achieve this goal, it will begin with an introduction to the concepts of self and world. Subsequently, it will delve into the mode of being of technology from a human perspective in cases where the world experience is mediated by technology. Following this, the concept of boundary will be introduced based on the mode of being of technologies, and then various technological mediations will be presented to illustrate how human-technology-world relations vary, and how the boundaries between these three entities change. The information provided in this section will lay a theoretical foundation for discussions in subsequent chapters on the roles of agents involved in navigation practice, what bounds them, and under what circumstances and how the boundaries between them change.

2.1 Self

Phenomenology whose father is Edmund Husserl is a philosophical tradition (Zahavi, 2003) dealing with consciousness (Gallagher, 2012). It seeks for an answer to, in the broadest sense, how we experience things. Sokolowski (2000, p. 2) defines it as “the study of human experience and of the ways things present themselves to us in and through such experience”.

Phenomenology explains our conscious relationship with things and others through the term intentionality, which means “every act of consciousness is directed toward an object of some kind.” (Sokolowski, 2000, p. 9). Hall (2003) defines it as *off-ness* or *directedness toward* an object. More simply, it means that consciousness is consciousness of things as Smith (2003) explains. Gallagher (n.d.) similarly specifies that this structure is directedness *toward*, consciousness *of* or *about*, something.

Considering that intentionality requires the *existence* of something, Sokolowski (2000) suggests that mind is a *public* entity to which things appear. This means, as he clarifies, the things and *the world* are there and manifest themselves to us. In short, intentionality and the world appearing to us are the concepts that seem to outline phenomenology in general terms. Having acknowledged these, it is possible to describe *self*.

Sokolowski (2000) explains what self is by referring that the way we experience ourselves is different from the way we experience the world. As he defines, self is the conscious being that can say *I*. Zahavi (2003) calls phenomenological self as *experiential self* or *core self*. As Zahavi (2000) summarizes our ability to distinguish our experiences from others' experiences, experience is first-personal given. Therefore, self is the dative element (Sokolowski, 2000), that is accepted as the subject of experience (Strawson, 1997; Zahavi, 2000).

As phenomenology accepts, conscious experience is based on perception (Moran, 2010). According to the review by Zahavi (1994), perception requires an object to be perceived and a perceiver both of which exist in space. Hence, perception necessarily occurs in space between a spatial object and the body of perceiver as his spatial substance. That is, as Zahavi adds, body serves as the *here* of perceiver. In other words, our body is the central point of the area in which the space presents itself to us. Briefly, perception is corporeal (Carman, 1999) and it is our body what makes our engagement with the world possible (Meloncon, 2013).

The role of body in perception is also explained with movement and kinesthesis by Husserl. Zahavi (1994) proposes a useful introduction to this issue. As he explains, perception of an object presupposes continuity in experiences of different appearances of an object. Continuity in experiences of different appearances here is understood as appearances linked, by the perceiver, to each other as belonging to one single object. So, it can be concluded that, first, movement of the body or the object is needed to be able to experience an object's different appearances. Secondly, it is by kinesthesis that the continuity is realized.

Considering above accounts, as Zahavi (1994, p. 69) also indicates, only an embodied subject can perceive its environment. It is understood from the study by Zahavi that Husserl takes body as the subject of experience rather than as something experienced as an ordinary object. Thus, subjectivity and body are not separated. That is, according to Zahavi (1994) body is not something that contains subjectivity. Rather, it is where the feelings, as feelings of the subject, are localized as Carman (1999) points out. Carman similarly indicates that neither it is experienced internally, nor do we have it as an external entity. Instead, as Zahavi (1994, p. 69) calls it, it is "the organ of volition". Accordingly, consciousness of self is directly correlated to awareness of body (Carman, 1999; Zahavi, 1994).

2.2 Introduction to Modes of Being

According to Heidegger, as summarized by Gallagher (n.d.), our relation to the world is established dependently on our actions. Cerbone (2000) points out that it is not through contemplation or beholding that we engage with the world, instead, it is through practical engagement. Harman (2009) additionally indicates that, our relations to entities in the world are not explained relying completely on consciousness by Heidegger. In short, Heidegger takes humans as *embodied* agents (Cerbone, 2000), like the above-mentioned approach that perceiving the environment requires being an embodied subject.

As Cerbone (2000) suggests, our being in a practical context means *being-in-the-world* for Heidegger. He also notes that being *in* the world does not refer to being in it spatially, rather, it addresses to being *involved* in, instead of being *detached* from, this context of practical engagements. Nielsen (2007) defines how a subject engages with an object as *involved activities*.

Briefly, we come to know about our environment by dealing with it, that is, by using equipment, not by intellectualizing it. To give an example, Nielsen (2007) quotes from Heidegger (1988) that it is exactly the act of hammering that makes us have an understanding about hammer, not our contemplation about it. As Domańska (2006) suggests it is through handiness that hammer discloses itself. Nielsen indicates that it is not even necessary to be aware of a product consciously for this to happen.

Heidegger differentiates human existence from the existence of things. For him, human being is different from being of, for instance, of "rocks and trees" (Moran, 2002, p. 238). In relation to existence of things, Heidegger proposes two ways of being, in addition to human being, as *presence-at-hand* which refers to occurrence, and *readiness-to hand* which refers to being available as noted by Dreyfus (1993). Since what is implied here is being occurrent and available for human, Cerbone (2000) states that presence-at-hand and readiness-to hand are dealings of human being as it will be given below.

Tool analysis by Heidegger is necessary to be dealt with to explain what being present-at-hand and ready-to-hand are. Harman (2009) mentions *hammer-at- work*, which is called *hammer-in-use* by Gallagher (n.d.), to explain the difference between these two. As Harman (p. 12) claims, just being used by the carpenter without being thought refers to readiness-to-hand of the hammer as an "experientially transparent" entity. Those are the situations where the tool withdraws (Heidegger, 1962), and it is now, in Harman's words, "an instrument, tool, or piece of equipment" just used for a purpose. Only if it breaks it becomes present-to-hand, that is, only then it presents us what it is, Harman (2011) explains. He (p. 45) puts this discrimination into words by "tool in disrepair" and "tool in action".

Harman (2011) emphasizes that although this theory seems to simply refer to the way of being of *broken tool*, it comprehends beings generally. He puts it in detail that the entity present-to-hand does not need to be a tool, or something broken despite the fact that the theory is explained in reference to broken tool. Similarly, readiness-to-hand is described in more general terms by Nielsen (2007) as everyday actions done without being thought. Accordingly, some of the examples given by Nielsen are the ones which have nothing to do with tool being, such as moving around in one's house, having a conversation with neighbors and so on. Thus, it can be concluded more generally from Nielsen's accounts, not referring tools only, that being present-at-hand of an entity means its presence to us, in other words, our directedness towards it.

As highlighted by Harman (2011), presence-at-hand and readiness-to-hand do not refer to ontologically different types of entities. He points out (2009) that these two are modes in which entities go between as it can be inferred from that a hammer present-to-hand becomes ready-to-hand when the carpenter brings it into play.

In Heidegger's philosophy, the difference between thing and object is another issue that refers to the ways in which we engage with the world. Domańska (2006) simply suggests that if a material entity is ready-to hand, it is a thing. Followingly, if it is present-at-hand, it is an object. She comments that being an object means being "objectively present" (p. 173). These statements by her can be interpreted considering accounts about intentionality and consciousness given before: When something is present-to-hand, that is, present to consciousness, it is the *object of* our intentionality, the object *of* our consciousness. In other words, as well as consciousness requires an object, and as well as it is consciousness *of* an object, being an object requires someone to be conscious of that entity. That is why an entity cannot be taken as an object if it is ready-to-hand, if we are not aware *of* it.

The discrimination above is also found in the philosophy of Heidegger on *nearness* and *farness*. Harman (2009) first reminds that the general use of the words nearness and farness refers to the distance in space. But Heidegger reverses the meanings of these two. Considering Harman's study, if we are not aware of the equipment that we use while using it, this means that we and the equipment are distanced to each other even if there physically is a small distance between them. According to the example he gives, it is a *true distance* that is between the subject and the eyeglasses while using eyeglasses without being aware of them. As briefly stated by Harman, what Heidegger means by distance is not spatial distance, but distance from human concern. It can be inferred from this that when something is ready-to-hand, it is distanced. Harman also states, accepting an entity near only physically as truly near is a mistake for Heidegger because it is reduction of it to presence-at-hand.

In essence, humans' engagement with the world is not achieved through contemplation or observation; rather, it is accomplished through active engagement. This means that humans are embodied beings. Further exploration of this issue will be conducted below.

2.3 Basics of Boundaries of Self

2.3.1 Extendibility of the body

Merleau-Ponty known as "The Philosopher of the Body" (Hass, 2008, p. 75) is said by Moran (2002) that his greatest contribution to phenomenology literature on being-in-the-world is the concept "embodied existence" he proposes. As Moran (2010) states, body, as well as being an object in the world, is a medium by which the contact between the world and subject is established for Merleau-Ponty. According to this philosophy, we relate to the world in an embodied way (Gallagher, n.d.).

Before introducing embodiment that tells us about the relations between self and the world, to explain how body and body for self, is taken by Merleau-Ponty is also helpful. Despite not rejecting that body is an object to some extent as our substance that enables us to be-in-the-world (Marshall, 2008), it is claimed by Hass (2008) that our experience with our body is, for Merleau-Ponty, different from as it is with other things. As Hass presents, whereas things are open to be surveyed and explored by one, and they may not be always right there to be physically experienced, this is not the case for one's body. Another discrimination between body and things is that the way things appear to us depends on the spatial relationships with them and our body, while there is no such perspective in our experience of our body. In short, Hass (p. 78) asserts that body is not perceived as “a thing among things”.

Merleau-Ponty does not handle *I* and *body* separately (Morris, 2014). As Morris indicates about this view, body is one’s conscious opening to the world. Gallagher (n.d.) states in a similar vein that Merleau-Ponty considers body as the knower. This is how the connection between body and mind is established by Merleau-Ponty (Hass, 2008). Gallagher (n.d.) comments that this discourse also underlies the discrimination between *body-as-subject,* or *as-agent,* and *body-as-object* in Merleau-Ponty’s philosophy. Gallagher states, we, as embodied agents, are active bodies in our engagement with the world, not objects.

After body-as-subject, embodiment in Merleau-Pontian philosophy can be introduced. As Meloncon (2013) adds, Merleau-Ponty explains embodiment with the example of a blind man using a cane. As told in this example, it is what the cane touches about that the blind man comes to know, not the cane itself. Hence, the cane is not something perceived, it is a part, an extension (Meloncon), “an extended sense organ” (Feenberg, 2003, p. 104) of the blind man’s body. Like in this example, for Merleau-Ponty, the ways a woman feel where the feather in her hat is and where her hand is are just the same (Ihde, 1990). As Ihde summarizes, the body we experience can *extend through* artifacts. Just as the example of feather, the experience a driver has when being sure the car can get through a narrow opening without measuring the widths, as another situation Ihde cites from Merleau-Ponty, means that our bodies are *extendible*.

As Ihde (1990) clarifies relying on the examples above, the surface of body is not the limit for its perceptual engagement with the world according to Merleau-Ponty, and this is how Merleau-Ponty explains embodiment. Ihde also points out the resemblance between Heidegger’s hammer and Merleau-Ponty’s cane. He reminds what Heidegger means by withdrawal of hammer-at-hand to explain its complementary relationship between the cane used without being aware of in Merleau-Ponty’s example.

Although phenomenological discourses above were first put forward in the first half of twentieth century, they are still relevant to the current ideas about human's engagement with technology. To illustrate, like the cane which has become a part of the blind man, Meloncon (2013) exemplifies that our phones can be taken as our extensions, what we are not aware of while using them, and which we connect to the world through. Similarly, as Meloncon adds, assisting technologies that people with disabilities use are their bodies' extensions as tools enabling them to engage with the world in a way impossible in their absence.

As Ihde (1990) emphasizes, what lies behind embodiment is the transparency of medium, which brings about a kind of union of self and medium in the engagement of self with the world. He also provides an illustration by describing the act of looking at an urban skyline through a recently cleaned plate-glass window. According to him, an observer who doesn't critically examine might be inclined to assert that the view is identical through both the plate glass-embodied vision and the unaided vision, primarily due to the apparent transparency of the medium. Nevertheless, as he emphasizes, in most situations of this nature, there is typically some level of back-glare and perhaps a scarcely noticeable residual translucency in even the finest plate glass. This means that the complete withdrawal of the window is never absolute for Ihde. He additionally states that there is a minor but perceptible reduction in the panoramic depth. Based on these, Ihde proposes a continuum of various degrees of translucency, from pure transparency towards opacity.

In the level of pure transparency in users' experiences of technology, it becomes "an unnoticeable part of their bodies", and what arises is a "human-technology symbiosis" (Flavián et al., 2019, p. 4). Similar to what they mean by symbiosis, Dant (2004) introduces the assemblage of the driver and car, which he calls *the driver-car*. As Dant explains, it is not the driver itself, or the car itself, or a couple of these two, but a new entity arising as a result of embodiment of car by driver. This entity is not an offspring of the driver and car, but rather an assemblage disbanding when the driver departs from the vehicle and can be infinitely reformed or reassembled as long as the cars and drivers are available.

2.3.2 Extendibility of the mind

Material Engagement Theory (MET) developed by Malafouris focuses on engagement between humans and artifacts (Garofoli, 2013). It is a discourse that corresponds to postphenomenology to a large extent (Chakrabarty, 2019; Ihde & Malafouris, 2019). As to what it advocates, Ihde and Malafouris (2019) claim that our minds are shaped, and our bodies are extended by technologies we develop and use. They suggest, human is named in MET as *Homo faber* which means, as they explain, human beings both making and being made by technologies. As they suggest in relation to MET, creation of new materials used in the production of artifacts, development of new forms and invention of new skilled practices play an important role in human evolution. The evolution they mention is also an ongoing process which never ends.

The extended mind hypothesis is one of the views that MET is based on (Garofoli, 2013; Malafouris, 2003). It is proposed by Clark and Chalmers (1998, p. 7) to reply to the question "Where does the mind stop and the rest of the world begin?". Clark and Chalmers, before introducing their theory as the third answer to this question, mention two conflicting views. First, our minds are within our bodily boundaries. Second, our minds are external since what we refer to with our words exists outside the body. The answer of Clark and Chalmers to this question is *active externalism* in their words. According to this view, human mind benefits from external supports to a large extent. Moreover, it is a two-way relationship between mind and its environment, from which the environmental component cannot be removed. Briefly, mind is not something restricted with the skin and skull in their approach.

As defined above, phenomenology explicates our conscious relationship with things through the concept of intentionality, which denotes the directedness of consciousness towards entities that appear to it. This approach is based on the perspective that conscious experience is not solely an internal process within the mind; rather, the mind directs its focus towards entities that exist outside. Accordingly, the extended mind hypothesis seems to align with this view.

2.3.3 Shared agency

During a practice, it can be asserted that the human and materials participating in the practice collaborate in the fulfilling of the tasks required by the practice. The fulfilling of the tasks in a practice involves the sharing of agency between the human and materials. In essence, this can be viewed as *shared agency* (Gondomar et al., 2021; Cornelio et al., 2022). The scope of agency, as cited from the relevant literature below, encompasses engaging in actions, thoughts, or decisions during the practice.

Gallagher (2007) clarifies what agency is by introducing its discrimination from ownership of an action that is subjectivity. As he explains, when one moves, they are aware that the movement is theirs. As the subject, they are the owner of the movement. Agency, as different from ownership, comes into question when the subject is aware that they are not the cause or author of their action. According to this account by Gallagher, while ownership refers to the kinesthetic experience only, agency requires having control of the action. For that reason, agency is an issue that is prevalently approached with an anthropocentric view as stated by Knappett and Malafouris (2008). They associate our human centered approach in agency to the fact that we design products to be "secondary", as being nothing but objects being there to serve us (p. ix). Also, as long as agency is explained with consciousness and human intentionality, we cannot attribute agency to nothing but humans, they advocate. Hypothesis of material agency challenges the accepted assumptions related to human agency as Malafouris (2008) claims.

To explain human agency, Malafouris (2008) reminds *I did it-stance* mentioned in Bateson's (1972) example of a man who cuts a tree down. Although the experience includes a system consisting of "trees-eyes-brain-muscles-axe-stroke-tree", the man believes that he carries out the task himself as the "delimited agent" (Bateson, 1972, p.230). However, an attempt to limit the agent to self is mistakenly cutting of a part of the system according to Bateson. Besides the attempt to delimit the agent, he claims that looking for boundaries of self in the body of human or in the object is a mistake. In the matter of who the agent is, he reminds Merleau-Ponty's example, the blind man's stick, and asks the questions that he later says misleading: "Where does the blind man's self begin? At the tip of the stick? At the handle of the stick? Or at some point halfway up the stick?" (p. 231). From the viewpoint of Bateson, in such experiences, the unit that "thinks", "acts" and "decides" is a system that cannot be reduced to the human body, or self.

Bateson's accounts above are similar to the way material agency is defined by Malafouris (2008). Malafouris gives the example of a potter, and he starts with the question how the potter's hands come to know how to behave to a lump of clay. When potters are asked this, they have not much to say, Malafouris says. Instead of making a verbal explanation they prefer more to *show* how. Malafouris attributes this to the fact that they do not know how to make a pot or are not able to put their tacit knowledge into words. He points out that this practice in which even potters' minds are not aware of how to make a pot is an example of embodied skill. It is, not a one-sided activity that is thoughtfully controlled by the crafter, but a reciprocal practice between the crafter and the crafted. In other words, crafter does not make decisions, but receive information from the crafted, about what to do in the making process. Then, considered the definition of agency by Gallagher (2007), he cannot be accepted as the agent but the owner.

In Malafouris's (2013, p. 119; 2008, p. 22) words, "If there is such a thing as human agency, then there is material agency; there is no way human and material agency can be disentangled.". Agency, he asserts, a property that belongs neither to things, nor to humans. Rather, it is a relational output of material engagement, as a statement that evokes the two-way link between mind and its environment.

In essence, the sharing of agency between humans and materials implies that they all have a capacity to influence each other and the experience. The idea of mutual influence between the human and technology, as indicated in the definition of Homo Faber in the previous section (Ihde & Malafouris, 2019), aligns with the idea presented in this section that agency is shared among them. Matthews (2021) emphasizes that postphenomenology also suggests such a symmetrical relationship between humans and technological artifacts, where both sides mutually influence each other.[1]

In this section, the capacity for the body and mind to extend towards outside world during a practice, and agency shared among the human and materials involved in the practice, have been elucidated. The extension of the body and mind can be interpreted as an extension of the self. Such extension implies a variation at the boundaries of the self and the entities to which they extend. The sharing of agency between the human and materials participating in a practice also signifies that they may substitute each other in performing the tasks, akin to the example of the blind man's cane. In this regard, their mutual interchangeability implies a change and blurring of boundaries, as evident in the question, "Where does the blind man's self begin?"

Consequently, extendibility of the body and mind of the human participating in a practice, along with the agency shared among human and materials in that practice, point to their boundaries. These boundaries are variable due to the extendibility of the body and mind, and the potential for agency to be shared among human and materials in various ways. Additionally, defining boundaries may appear challenging in certain situations, reminiscent of the ambiguity observed in the example of the blind man's cane. Hence, it is plausible to assert that boundaries can also be ambiguous.

[1] Agency is a term that Actor-Network-Theory (ANT) also focuses on. Indeed, the definition of the term here evokes ANT's understanding of agency. However, ANT considers not only human and material objects but also history, values, ideas, and the like as interconnected elements that mutually influence each other within a network (Latour, 2007). In this regard, ANT differs from the theories mentioned above, which is why it has not been included in this study.

2.4 Boundaries of Self in Various Types of Technological Mediation

On the basis of the previous section, it can be briefly said that boundaries of self have a tendency to change constantly. Also, especially in the cases in which self is said to extend towards the world, it does not seem to be definite as understood from the studies by Meloncon (2013) and (Bateson, 1972). From this viewpoint, various types of relations of self to the World are defined in the field of postphenomnology. In this section, the models and definitions related to self's engagement to the world, developed by postphenomenologists, will be given. Since what postphenomenology mainly deals with are relations "through" technologies (Ihde, 1990, p. 74), that is engagements mediated by technology (Ihde, 1990; Green, 2002; Rosenberger, 2014; Kiran, 2015), the relations given here will be three components: self, technology which is the mediation, and the world.

As accepted the founder of postphenomenology, it is useful to introduce types of technological mediations through Ihde's theoretical approach. Ihde (1990) mentions four types of relations, which are embodiment relations, hermeneutic relations, alterity relations and background relations. His study provides a methodological ground on the relations between human, technologies and the world (Kiran, 2015). It can also be said from the viewpoint of this study that Ihde suggests a categorization to discuss the boundaries between these three. Thus, Ihde's approaches to the issue will be discussed in this study within the respect of boundaries.

To begin with *embodiment relations*, it is the medium's transparency that brings about a kind of union of the self and the medium in the engagement of the self with the world. In such relations, there is a human-technology symbiosis in which technology is *withdrawn,* as told by Heidegger as transparency and Merleau-Ponty as embodiment. Ihde also mentions, as an example, the "magnification/reduction structure" of embodiment relations in the words: "Embodiment relations simultaneously magnify or amplify and reduce or place aside what is experienced through them" (p. 76). He gives the example of the change in the perceived appearance of the moon with the use of a telescope as an optical instrument. As a result of this change in how the moon is perceived, the position of the observer in relation to the perceived appearance moon is perceived differently, as Ihde states. Thus, he concludes, such embodiment relations end up with an alteration in Gestalt. As he states, transparency in embodiment relations turns the relationship which is I-window-world into (I-window)-world. Ihde emphasizes that this is a case of perceptual transparency, as in embodiment situations, technology is perceptually transparent for humans. It can be inferred from these instances that there are no distinct boundaries between self and technology in such relations.

Hermeneutic relations in Ihde's (1990) study refers to the cases in which one comes to know about the world by interpreting the data provided by technology. As he exemplifies, while feeling the cold weather is a direct experience of it, coming to know about the weather through the numbers related to temperature on a thermometer is a hermeneutic relation. Ihde defines this situation as hermeneutic transparency. Unlike perceptual transparency, the technology is perceptually present in the case of hermeneutic transparency. But what is experienced in a hermeneutic relation is what is read through this physical engagement. Ihde visualizes this type of relation as I- (technology-world). This means that the three distinct entities of human, technology, and world are not considered as three separate entities in hermeneutic relations. Instead, according to Ihde, in such relations, technology and the world are experienced like a single entity. Consequently, it can be asserted that the boundaries between technology and the world become indistinct in hermeneutic relations, and the self is separated from them.

Alterity relations, which Ihde (1990) says that he defines it regarding the concept of otherness by Levinas. This type of relations is another type of mediated engagement of human to the world. Alterity relations are engagements where the technology becomes the *quasi-other* for the human when it seems to have its own life. To elucidate the concept of quasi-otherness, Ihde first explains his approach to the concept of otherness. In doing so, he provides an example that involves the relationship established between the human and the horse during riding. In this example, Ihde compares a horse and a car. The possibility of the horse displaying, for instance, disobedience during riding causes it to be experienced by the human as an entity which has its own life, in contrast to a car. While a car can be transparent in the driver-car relationship, in the rider-horse relationship, the horse's lesser controllability compared to a car prevents it from becoming transparent but, on the contrary, results in it being experienced as other. In summary, Ihde’s approach to this matter can be summarized as follows: during driving, a transparent car is not an object of the human's experience but a thing, whereas a horse experienced as other during riding becomes an object for the human. To put it more simply, while the car withdraws, the horse, on the other hand, stands out. Moreover, as the horse comes to the forefront, the world can be said it remains behind the horse. Based on this, it can be argued that in alterity relations involving humans, medium (in this case, the horse, not the technology), and the world, these entities emerge at different levels of prominence as separated entities.

According to Ihde, a technological otherness can occupy a position between objectness and otherness. This is what Ihde refers to as quasi-otherness. For instance, the unpredictable path taken by a spinning top during its motion signifies that it moves independently of the human as other. Another example provided by Ihde in this context is the motion of an automaton. When an automaton has human-like properties, it behaves as the other or quasi-other according to Ihde. It can be inferred from this explanation that our relationship with an automaton is contingent upon how it executes the practice in question.

Ihde (1990) contends that the human-technology relations outlined above form a continuum. On one end of the continuum are embodiment relations that liken technologies to a *quasi-me*. Embodied technologies, by virtue of their *semi-transparency*, thereby entering into the existential relationship that shapes the human’s self. On the opposite end are alterity relations, where the technology assumes a quasi-otherness or serves as other.

The last type of technologically mediated engagements of human to the world by Ihde (1990) is *background relations*. Machines working automatically and semiautomatically are examples of these. Although they require the involvement of human to be operated, only at first or at intervals, they run at the background without requiring constant engagement of human. Ihde gives the example of the background noise of a heating technology. When functioning, this technology assumes a nearly imperceptible background presence. However, during its operation, it does not require focused attention.

Ihde also points out two aspects of background relations. Firstly, the machine's engagement as a background presence does not exhibit transparency which is referred to by him. Ihde asserts that in such an engagement, the technology being in the background is not transparent but kind of absent for human, although it is included in the perceptual field.

Aside from the examples by Ihde (1990), other types of technological mediations have been defined in postphenomenology. Besmer (2015) defines, for example, robotic re-embodiment and virtual re-embodiment. *Virtual re-embodiment* is the relation that occurs in the use of video games or other similar digital platforms in which a moving body represents the user’s body. What users must do in virtual re-embodiment is to act by following representation of their movements in the digital platform. *Robotic re-embodiment* occurs in the use of remote operation of vehicles. Similar to virtual re-embodiment, in robotic re-embodiment, users must follow how their movements are resulted by looking at the vehicle. Since the body is like both here and there in these relations, it is possible to state that body extends towards the virtual environment or robotic vehicles during engagement with them as Besmer states.

As understood in this part, how boundaries of self is altered by technology is associated to extendibility of self and the way the action is executed. These concepts evoke the extendibility of the body and mind, and shared agency, discussed in the preceding section. Another concept that can be approached with respect to boundaries in technological mediations, is *field of awareness* coined by Rosenberger (2014). Rosenberger introduces the term *field composition* in his discussion about how one's field of awareness is shaped by technologies. In his words, "The use of a technology may, for example, greatly reconstruct and otherwise transform a user's field of vision." (p. 26). According to his example, in the experience of watching a film in a theatre, the immediate surrounding becomes transparent in a while after the film starts whereas it is more possible to be aware of the crowd, furniture and the like at the beginning. This is how our field of awareness can be composed in the experience of watching a film. Briefly, Rosenberger's study suggests that some technological mediations shape one's experience entirely by shaping how the world appears to them. From the viewpoint of the current study, field composition refers to how technologies shape the boundaries of the world that appears to us. The decrease in the elements that human is cognizant of during the experience signifies a contraction of the world, whereas an increase in these elements implies its expansion. In short, the extent to which one's mind extends towards surrounding elements delineates the extent to which the world appears to them, which means it specifies the boundaries of the world for them.

2.5 Dimensions of Technological Mediation

In this part, information about the ways in which our engagement with the world through mediation of technology will be given. This part mainly based on the study in which Kiran (2015) categorizes the dimensions of technological mediations. Why his study is reviewed here is that he offers a holistic approach to various respects in which technological mediations can be dealt with. According to Kiran's study, there are four dimensions of technological mediations: ontological, epistemological, practical, and ethical dimension. However, since ethical dimension is irrelevant to the scope of the current study, it will not be mentioned here.

In the first category, *ontological dimensions,* Kiran (2015) mentions concealing/revealing structure of technological mediations. He states, the concepts readiness-to-hand and presence-at-hand address to what we perceive and what is withdrawn in our experiences related to the world. Based on this ontological perspective of Heidegger, Kiran reminds that it is through our practical engagement with the world that it manifests itself to us. Simply, what is revealed by technology is what constitutes the world. In other words, Kiran proposes that our connection to the world is related to what is revealed and what is concealed in the use of technology, evoking the concept of field composition by Rosenberger (2014). Therefore, by revealing and concealing structure, technology shapes what appears to us, thus the way our world is. It is the manifold, of the world, brought about by the mediation of technology what we are in. So, as being in the world, the way we are is shaped by technology that shapes the being of the world.

The second type of dimension Kiran (2015) proposes is *epistemological dimension*. As well as the way of being of the world, our knowledge related to the world is shaped by technology according to her study. She, in reference to magnification/reduction structure of technological mediations associated to this dimension, suggests that our capabilities to perceive the world are enhanced and weakened by technology. At this point, Kiran highlights that it is not the case that technology is claimed to change the reality in epistemological dimension. To support this, she cites from Verbeek (2005) that, technology, rather, offers new manifolds of reality. This means that technology, not changes the world, but determines what kind of a manifold of the world we perceive.

The third dimension indicated by Kiran (2015) is the *practical dimension* which is based on enabling/constraining structure, which comes from what they afford, of technological mediations. In as much as technology enables and constrains humans about what to do and how to do, it effects how they act. To exemplify, Kiran points out *taken-for-grantedness* that enabling/constraining structure offers. Our activities are shaped according to what technology enables us to do, for example in the case of buying without considering how much we can carry by our own when our car enables us to carry more.

2.6 Summary

The discussions this chapter has outlined will be condensed below.

- Human is an embodied entity, and their connection to the world is established through practical involvement. This implies that our understanding of the environment is acquired through direct interaction, specifically by utilizing tools, rather than through intellectualization.
- Human existence differs from the existence of things. Heidegger, in his tool analysis, introduces presence-at-hand and readiness-to-hand as the two modes of being in addition to human being. Presence-at-hand describes situations where a tool is consciously perceived by a human, while readiness-to-hand implies the tool's availability for use without being explicitly noticed. When a tool is present-at-hand, it is the object, which is directed towards by the human of the experience. On the other hand, in the mode of readiness-to-hand, the tool withdraws, is not an object experienced by the human. The withdrawal of a tool renders it transparent to human consciousness.
- Regarding human-technology-world relations, the full transparency of a technology is a state of embodiment in which a human-technology symbiosis arises. On the other hand, in the situations where the technology is experienced as another entity, it is experienced as other to a certain extent. This represents the quasi-otherness of the technology.
- Technologies we create and utilize may be extended towards by our bodies. Mind can also be said that it extends towards entities in conscious engagements. The extension of body and mind can be seen as an extension of self. This extension suggests a variation and blurring in the boundaries between the self and the entities to which it is extended. Besides, shared agency among humans and materials engaged in a practice implies the potential for them to interchangeably fulfill tasks, analogous to the example of a blind man's cane. This mutual substitutability indicates a shift and

> blurring of boundaries as well, exemplified in the question, "Where does the blind man's self begin?"

This chapter focuses on the role of technological mediation in the relationship between human and the world. Approaches to delineating boundaries between self, technology, and the world have been examined within the context of a practical process. Discussions have been presented on how the boundaries among these three vary among various mediation processes. According to the results of this chapter, the discussions related to boundaries primarily revolve around the concepts of extendibility of body and mind, and shared agency.

The debate concerning the determination of the boundaries of agents participating in a practice aims to outline *what they are* during that specific period as a discussion that falls within the realm of ontology. The concepts of extendibility of body and mind, on the other hand, fundamentally address what the human *knows* in that practical context. Within this respect, engaging in boundary related discussions through these concepts implies establishing a connection between *what is done* and *what is known* which entails practical and epistemological approaches. Similarly, considering that the concept of shared agency addresses what agents participating in the practice *do*, engaging in boundary related discussions through this concept is a matter of addressing *what they are* in terms of *what is done*.

This methodological approach is based on the premise that conducting an epistemological and practical discussion is necessary to make an ontological inference, and that, first, examining the practice in question is essential for this purpose. The foundation of the idea that the method of this study should involve observation of the practice lies in this understanding. To elaborate further, this research is rooted in the notion that answering the question of how the boundaries between the agents change during the use of in-car navigation technologies requires observing the practice and discussing what agents do and know during this process. Supporting this understanding, the next chapter will examine navigation and its technological mediation. In line with the thought that observing navigation practices is necessary to serve the main purpose of the research, it will shed light on how samples and observed cases should be determined in such research.

CHAPTER 3

HUMAN'S ENGAGEMENT WITH THE ENVIRONMENT AND NAVIGATION TECHNOLOGIES DURING NAVIGATION

This chapter aims to explore the essence of navigation based on a literature review. Considering navigation as a practice that occurs between the human and environment, the focus will be on examining how individuals establish a relationship with the environment during this practice at the beginning. Subsequently, situations where technology is involved in the practice will be introduced, as one of the variables influencing navigation practice. Finally, by synthesizing information gathered from relevant literature and the theoretical framework provided in the previous chapter, this chapter will define the agents of technologically mediated navigation from its own perspective. It will also articulate its approach to the boundaries between agents during this practice.

3.1 Basics of Navigation and Wayfinding

Upon reviewing the relevant literature, it becomes evident that the terms *navigation* and *wayfinding* are employed interchangeably. Montello and Sas (2006) also acknowledge that some researchers consider these two terms somewhat synonymous. Consequently, before delving into the intricacies of navigation and wayfinding, it is imperative to grasp the precise meanings attributed to these terms. Hence, this section will commence with a definition of navigation and wayfinding.

Since investigation of human spatial cognition is pivotal in the examination of human wayfinding (Dalton et al., 2019), this section will broadly address cognitive approaches to this issue. In this context, after delineating the scope of the terms navigation and wayfinding, the section will present perspectives on the use and acquisition of spatial knowledge during navigation.

Arthur and Passini (1992) defines wayfinding as a problem-solving process one experiences while going one place to another and it includes decision making, decision executing and information processing. This definition highlights the practices receiving and using information, making decisions, and physically performing them.

According to Lynch (1960), who coined the term wayfinding (Wiener et al., 2009), wayfinding is consistent application and arrangement of sensory information received from the outside. In comparison to what Arthur and Passini (1992) says about wayfinding, Lynch concentrates more on receiving information and using it, does not refer to bodily practice explicitly in his definition of wayfinding. Golledge (1995, p. 208) makes a description related to navigation and he associates navigation to visual processing of environmental information to a large extent as understood from his words: “The processes involved includes cue or landmark recognition, turn angle estimation and reproduction, route link sequencing, network comprehension, frame of reference identification, route plotting strategies (e.g., dead reckoning, path integration, environmental simplification and ed-route choice, shortcutting).”. Here, it is also important to introduce that finding one’s way is not just a visual practice in contrast to what these arguments accepts. Golledge cites from Loomis et al. (1992) that it may also include an auditory, tactile or olfactive processes as in the case of blind people.

Montello and Sas (2006) approaches to wayfinding, together with locomotion, as a component of navigation. Within this scope, wayfinding, which is the mental (Mark et al., 1999), cognitive element of navigation (Darken & Peterson, 2002), is the spatial problem solving (Passini, 1977) process of navigation. It is basically, the goal-directed (Miller, 1992; Montello & Sas) component associated to knowing “where to go” and “how to get there” (Montello & Sas, p. 2). In the cases that where to go is not perceptively available in the immediate surrounding, engaging with a "distal" environment is necessary for wayfinding (Montello & Sas, p. 2). As to locomotion, it requires to engage with the "proximal" environment (Dalton et al., 2019, p. 1) as the component of navigation referring to moving to performing wayfinding decisions (Montello & Sas). Locomotion also refers to being aware of obstacles and barriers in the immediate surroundings, as well as perceiving landmarks to go towards, while moving in accordance with the wayfinding plan. While wayfinding is an attentional, controlled, and effortful process, locomotion occurs more automatically as stated by Montello and Sas. They compare how one acts in familiar and unfamiliar environments within this respect. In familiar environments where wayfinding is relatively not needed, one may act automatically enough to pay attention to activities other than wayfinding. Though, unfamiliar environments require more attention to go from one place to another.

Although the processes included in wayfinding (and navigation) are described separately, they are neither extricable from overall wayfinding/navigation process nor disassociated from each other. Arthur and Passini (1992) considers information processing, decision making and decision execution, which are included in wayfinding according to them, as interdependent processes. Similarly, as to the relation between wayfinding and locomotion, although it seems like the former is the one preceding the other separately, Darken and Peterson (2002) highlight that these two are intertwined processes.

Still, among the processes that are said to be included in wayfinding/navigation practices, any of them adopted by a definition may be neglected by another one. It goes for, for example, Lynch's definition which does not refer to bodily practice while Arthur and Passini (1992) accepts it as included in wayfinding. Moreover, which processes are combined in wayfinding/navigation practices is also questionable in some cases. That is because sometimes it is not possible to understand the logic of the author at first glance. For example, it can be inferred from Golledge's (1995, p. 208) words that he associates navigation with visual perception and cognition. But his exemplification related to navigational processes seem to focus on cognitive stages much more than perceptional ones. Even so, it is still difficult to clarify whether he overlooks the role of perception in navigation, since why he does not indicate sensing information (or receiving it other ways) in navigational practices might be because he takes it for granted in the cognitive processes rather than overlooking it.

Table 3.1 shows how navigation and wayfinding are considered to include related processes by the authors above. In the table, how they relate navigation and wayfinding to each other is presented.

Table 3.1 Navigation and wayfinding as defined by various researchers

	Perception	**+ Cognition**	**+ Bodily practice**	
Arthur and Passini, 1992	Receiving information	Using information, Making decisions	Execution of decisions physically	**=Wayfinding**
Lynch, 1960	Sensation of information	Organizing sensational information		**=Wayfinding**
Golledge, 1995		Recognition, information estimation and reproduction, comprehension, identification etc.		**=Navigation**
Montello and Sas, 2006		Wayfinding as decision-making	Locomotion as moving through wayfinding decisions	**=Navigation**

This study focuses on both finding solutions to problems of finding one’s way and executing the solutions by moving. Based on the arguments above, the former is called as wayfinding, and the latter, locomotion. As a combination of these two, the whole practice is called as navigation. In Table 3.2, the relation between wayfinding, locomotion and navigation are shown. Processes which are accepted to consist of wayfinding and locomotion in this study are also given in the table.

Table 3.2 Processes navigation and wayfinding include as this study accepts

<table>
<tr><th></th><th>Perception</th><th>+Cognition</th><th>+Bodily practice</th><th></th></tr>
<tr><td rowspan="2">The current study</td><td>Receiving information with senses</td><td>Recognition, information estimation and reproduction, comprehension, identification etc.</td><td rowspan="2">Locomotion as executing wayfinding solutions by moving</td><td rowspan="2">=Navigation</td></tr>
<tr><td colspan="2">Wayfinding as finding solutions to problems of finding one’s way</td></tr>
</table>

Ishikawa et al. (2008) suggest that stored knowledge of the environment is processed during entire navigation processes. It is understood from the study by Willis et al. (2009) that this goes for even in the case of navigation in unfamiliar and semi-familiar environments. As they exemplify, when one must navigate from the center of an unfamiliar city to somewhere, they retrieve information related to their experience from the cities they had been in before to make assumptions about the current city and develop a wayfinding plan.

Apart from the usage of stored knowledge during navigation, it should also be noted that navigation is a process in which knowledge about the environment is acquired and stored. As Piccardi et al. (2019) explain, during wayfinding, one encodes environmental characteristics, develops and stores spatial representations, and uses them. The mental representation, which is like “a picture in the head” but mainly has a symbolic basis rather than being a picture, of the environment is called as cognitive map (Darken & Peterson, 2002, p. 1). According to Wu et al. (2008, September, p. 501), “A cognitive map is an internal representation of outside environment.”. For more detailed explanation, “Cognitive mapping is a process composed of a series of psychological transformations by which an individual acquires, codes, stores, recalls, and decodes information about the relative locations and attributes of phenomena in his everyday spatial environment” (Downs & Stea,1973, p. 9). In short, development of cognitive map requires acquisition and processing of spatial knowledge (Qiu et al., 2020). As a representation of one’s environment, spatial knowledge contains environmental characteristics, the relative position between objects, and properties of spatial relationships (Lynch, 1960). As for spatial knowledge acquisition, it is the outcome of the spatial learning process which is defined by Ishikawa (2018) as storing and maintaining spatial information.

Like above accounts, what wayfinding refers to for Golledge (2003, p. 25) is “the ability to determine a route, learn it, and retrace or reverse it from memory”. Supporting these, Ahmadpoor and Heath (2018) proposes navigational tasks as memorizing landmarks, conducting route knowledge and cognitive mapping. Based on these, navigation is a practice in which both spatial knowledge is used, and spatial learning occurs (Golledge, 2003).

Within the respect of the cognitive process of spatial exploration, Montello (1998) introduces types of spatial knowledge that vary but support each other. Types of spatial knowledge included in the process of environmental learning are landmark knowledge, route knowledge, and survey knowledge as Montello suggests. Landmark knowledge is the knowledge of the “discrete objects and scenes”, which one recognizes and stores in their memory, in the environment (p. 144). According to Montello, the spatial information landmarks provide is the pattern that their sequence constitutes. This pattern of landmarks and the experience of the action taken at landmarks are what help one develop route knowledge. As understood, route knowledge is the knowledge related to the path, not containing the information related to distances, one experience during engagement with the environment. As to survey knowledge, it is “a map-like, at least configurational” representation that the knowledge of the spatial relations of routes, together with those of other environmental elements such as landmarks, districts etc., constitutes (p. 145). In brief, it is the type of knowledge containing the “layout” of the environment (Ahmadpoor & Heath, 2018, p. 132).

How we come to know where we are and how to go somewhere else is a question to which Ingold (2002) seeks an answer as well. He questions if we achieve these with a cognitive map which a person who is cognizant of the geography in question comes to know his current location and how to go to another location by relying on. Ingold opposes that we have such spatial representations as cognitive maps in our heads. As asserted by Ingold, we know our current and future locations in a geography that we are inhabitant of due to our experiences of previous journeys, instead of spatial representations. He expresses this in the words “places do not have locations but histories”, and “places exist not in space but as nodes in a matrix of movement” (p. 219). This matrix is called region by Ingold. The knowledge of the region obtained from the experiences of journeys in a territory is what distinguishes an inhabitant from a stranger in his view.

Another notion that refers to the representation of the view of the environment in human mind is schema, which is internal to the perceiver, subject to alteration through experiences, and specific to the perceived context as defined by Niesser (1977). According to Neisser, it receives and adapts to information, guiding actions and exploratory endeavors that expose it to additional data, subsequently influencing its modification.

In relation to how the view of the environment is represented in human mind, Lynch (1960) mentions environmental image which is developed as an outcome of the interaction between the environment and the observer. According to Lynch, environment displays distinctions and relations, and environmental image is built as a result of observer’s selection, organization and endowment of what environment displays. The environmental image developed this way also effects what observer see in a constant interactive relation. Hence, Lynch emphasizes that the image of a particular reality may considerably differ amongst observers.

Lynch (1960) states that components of environmental image are identity, structure and meaning all of which are about relations. It is necessary for an environmental image, first, identification which refers to recognizing an object as a separate entity from the other things. Second, having an understanding about the structure, which is the pattern or spatial relations between both the observer and object, and the object and other objects around, is needed. Third, as meaning, the object must make sense for the observer practically or emotionally.

To refer to the probability of an object to evocate a "strong" image, Lynch (1960, p. 9) coined the term imageability which can also be called, as he states, as apparency, legibility or visibility. According to his explanation, "It is that shape, color, or arrangement which facilitates the making of vividly identified, powerfully structured, highly useful mental images of the environment". Lynch also makes it clear that "The concept of imageability does not necessarily connote something fixed, limited, precise, unified, or regularly ordered, although it may sometimes have these qualities. Nor does it mean apparent at a glance, obvious, patent or plain." (p. 10).

A built environment's image is constituted by paths, edges, districts, nodes, and landmarks as Lynch (1960) proposes. Paths are the channels that serve as roads. Edges are the boundaries that seem to separate adjacent areas from each other. Districts are parts of the city. They are places not having to have strong thematic identities to be considered as districts. Nodes can be squares, junctions and the like that are more memorable. As different from districts, have distinctive thematic characters. Landmarks are the particular points used by people as spatial references. Both structures that can be seen from a distance and objects more local can be landmarks. "Districts are structured with notes, defined by edges, penetrated by paths, and sprinkled with landmarks. Elements regularly overlap and pierce one another." (pp. 48-49).

In addition to the positions of elements in the environment, during navigation, human must also be aware of their own location. According to Hutchins (1995, p. 12), the question “Where am I?” maybe the central question of navigation. Similarly, Ishikawa et al. (2008) state that orientation, which is knowing one’s location and direction, is primarily necessary for successful navigation. Following this, according to Ishikawa et al., one must relate their location to the location of arrival point in a route plan and implement it during navigation. Montello and Sas (2006) defines being oriented this way as geographic orientation. They state that uncertainty about one’s location or the way they must take is geographical disorientation, which is getting lost. As understood from their study, geographical disorientation can be either long-lasting and severe or temporary and mild.

The fundamental aspects of navigation have been given broadly in this section. The section has introduced how humans interact with their environment during navigation, regardless of whether the practice is assisted. Here, the processes inherent in navigation practice were addressed in general terms. In the next section, the factors that shape a navigation practice, thereby distinguishing these practices from one another, will be examined.

3.2 Variables Affecting Human-Environment Relations During Navigation

To comprehensively understand navigation practice and conduct research in this area, it appears to be essential to grasp the variables that influence it. This section categorizes these variables into four groups based on relevant literature. These are environmental variables, case-related variables, the presence of navigation technologies, and individual variables. Below, these variables will be addressed in this order. Environmental variables and case-related variables will be discussed irrespective of whether the practice is supported by the technology. Subsequently, studies concerning how navigation practice changes when navigation technology is present will be examined. Having addressed the details of technologically mediated navigation, individual variables influencing the practice will be explored by considering mediated navigation as well.

3.2.1 Environmental variables

Wayfinding signs in the environment are elements designed to support wayfinding process. Landmarks, although not inherently designed to support wayfinding, are utilized as references in this process. Based on these, it is evident that the presence of wayfinding signs and landmarks in the environment has an impact on navigation practices. However, beyond presenting these elements, the environment also has characteristics that have an influence on the way human perceive it, thus, wayfinding and navigation. This section will elaborate on the environmental factors that make a difference in navigation practice.

Environments differ in terms of their spatial characteristics structurally and visually (Montello & Sas, 2006). Environmental characteristics may have an influence on environmental image. Development of the image may be resisted to or facilitated by environments variously (Lynch, 1960). Al-Alwan and Al-Azzawi (2014) cite from Sanoff (1991) that there are two types of attributes, which have a role in the development of environmental image, of the environments. These are appearance attributes that include size, shape, color, sign, light, contour and age, and location attributes that include "concepts of prominence and visual scope" (p. 5). Lynch (1960, p. 3) exemplifies the cues to identifying the environment as "the visual sensations of color, shape, motion, or polarization of light, as well as other senses such as smell, sound, touch, kinesthesia, sense of gravity, and perhaps of electric or magnetic fields.".

As Montello and Sas (2006) cite, Weisman (1979) asserts that the ease of orientation and wayfinding is related to differentiation, visual access, and layout complexity. Differentiation refers to the extent to which visual characteristics of different parts of the surrounding, such as sizes, shapes, colors, style, and the like, vary in the visual field. It generally eases wayfinding since it increases distinctness and memorability of elements. Still, it is possible it could cause disorientation. Visual access means the extent of possibility to see various parts of the surrounding during wayfinding. As visual access gets better, orientation becomes easier according to Weisman.

As to layout complexity, wayfinding appears to be harder in complex environments, as cited in Montello and Sas (2006) from Weisman (1979). However, the criteria for complexity are not clear or generalizable as understood from this study. When oblique angles and orthogonal angles on a path are compared, the former one can be said to be more disorienting according to Weisman (1979). But this issue of complexity cannot be confined to this generalization. As Montello and Sas maintain, a grid path network not running in the north-south direction might be disorienting even if it has right angles whereas a curved path might not cause disorientation if it is included in a radial network and the network is comprehended well. These examples about layout complexity shows that whether a specific element in the environment is disorienting or not depends on the degree to which it fits into the layout it is in.

Ahmadpoor and Heath (2018) lay emphasis on the influence of GPS-based navigation technologies on the way people engage with urban environments. From this viewpoint, they find it important for urban professionals to know comprehensively about what users of such technologies understand from their environments. They examine what makes buildings, as landmarks, more memorable for those people. Considering the results of the study, they claim that memorability of buildings highly depends on variations in three features of buildings which are “style”, “significance of building” and “contour/contrast” (p. 147). As they suggest, buildings with differentiative styles, or significance historically and culturally, are more likely to be remembered by GPS users in comparison to other buildings. Also, GPS users remember better different looking buildings with features contrasting the other ones. Ahmadpoor and Heath additionally suggest that memorability of buildings has nothing to do with their location and geographical position in the case of a GPS user since, according to the researchers' assumption, the use of GPS-based maps eliminates the necessity to be aware of the environment.

All the explanations above evoke environmental legibility, which is, as Lynch (1960) describes, the simplicity with which the constituent elements of an environment are identified and arranged into an overall pattern. According to Golledge (2003) interprets this approach as defining legibility as the extent of distinctiveness that allows observers to grasp their surroundings. He summarizes this by stating that a legible environment is characterized by a spatial structure that is relatively evident. Golledge also introduces an alternative understanding of environmental legibility that centers on behavior, specifically related to travel. He cites from Weisman (1981) that legibility fundamentally involves the ease with which travelers navigate through an environment. While still rooted in the characteristics and intricacies of the spatial layout, as Golledge explains, this interpretation emphasizes the simplicity with which individuals can utilize spatial information to facilitate movement between specific points of origin and destinations. In such a context, a legible environment is one where destinations are readily observable or estimable, and travel can be guided by directly perceiving elements in the surrounding space.

Carpman and Grant (2002), as cited in Montello and Sas (2006), mention the discrimination between built and natural environments in terms of environmental characteristics. While built environments provide a respectively definable view with, for instance, straight lines and right angles, natural environments seem to be more irregular and complex. Montello and Sas also consider these visual characteristics of natural environments as more homogenous.

Ingold (2015) draws the difference between two kinds of environmental characteristics, through the perspective of the disparity between a maze and a labyrinth. He considers cities for walkers as mazes of which paths are set by the buildings. In this structure, the walls block the vision of paths other than the one that lies ahead of the walker. As Ingold explains, at any point on a path other than its end points, the only thing to do for the walker is to go ahead since the maze makes it impossible to turn to left or right or pass to another path. But what is also meant here by Ingold is that a maze offers choices at each end point. Walker proceeds on their way dependently on decisions he made. They, as isolated from, and in the absence of, the real outside, makes decisions randomly by their own. Moreover, Ingold cites from Kern (1982) that not only more than one way to choose are offered by a maze, but also some of them have dead ends. As to labyrinth, what it provides to a walker are not decisions but signs that lead them exactly to a certain direction. It is true that having an insight about what the signs say may be hard, but they are there to direct walker to the correct way. Ingold remarks that the view of the environment in labyrinth is not blocked and possible movements of a walker are not hindered by barriers. In this aspect, he likens labyrinth to non-built environments. In case of a mistake in labyrinth, there are no dead ends from which a walker cannot proceed the way anymore, but only deviations.

Considering the comparison above, how to go from one point to another one in a maze is completely depends on walker's purposes, expectations, decisions, in short, their mind. The only single information source to move for a walker in a maze is his mind. As established by Ingold, (2015, p. 132), "Thus the mind intends and the body extends". On the other hand, in a labyrinth reveals signs to be followed. The relegation of the mind to the background in such a practice has been noted by Wiener et al. (2009) (without referencing the concepts of maze and labyrinth). According to Wiener et al., the path has already been predetermined by the designer in sign-following, and as long as signs are consistently placed at each decision point, the agent encounters minimal need for spatial reasoning. In its most extreme form, as they state, sign following can be simplified to merely a task of locomotion. In accordance with the distinction of maze and labyrinth by Ingold, briefly, the maze scenario entails an active decision-making process by the wayfarer whenever encountering a fork. In contrast, the wayfarer in the labyrinth is solely guided by the surrounding environment.

Inference can be drawn from the above information given so far that the features discussed in these arguments dictate the characteristic attributes of the environment.

These characteristics, in turn, determine how the environment appears and, consequently, how it is perceived by humans. It can be deduced from this that the characteristics of the environment shape the nature of the wayfinding process during navigation. This section will continue with individual case-related that affect this practice.

3.2.2 Case-related variables

According to the pertinent literature, there are a group of variables, which can delineate the framework of navigation practice, associated with environmental familiarity and the purpose or motivation for travel. This study considers them as case-related variables. The subsequent classifications of wayfinding processes express the influence of these variables on navigation.

Environmental familiarity is one of the determinatives of the composition of primitives of spatial knowledge one acquires in a specific environment (Golledge, 2003). According to Lynch (1960), it increases the coherence of the environmental image one builds. In relation to the quality of wayfinding performance, it gets better as environmental experience is gathered. As Lynch exemplifies, even on a table that looks completely disorganized, finding objects may not be difficult for one who is familiar with it. It can be deduced from the study by Lynch that it is possible to engage with unfamiliar elements more easily, if they seem like familiar ones, in comparison to other unfamiliar elements. He claims that one may identify and relate an object, even if they have not seen it before if it evokes a stereotype.

Besides wayfinding performance, Wiener et al. (2009), in their study on taxonomy of wayfinding tasks, advocate that what kind of a wayfinding task one carries out is associated with the level of spatial knowledge they have about the environment in which they do environmental search. As they establish, environmental familiarity and familiarity to the route are among the variables that determine the type of the wayfinding task to carry out in a navigation practice. Yet, the taxonomy of wayfinding tasks they suggest is also related to the goal of the travel as it will be delineated below. Raubal (2001) as well states that functional goals of wayfinding tasks can be considered to classify them. As cited in Raubal, Allen (1999) makes a distinction among different types of travel objectives, which include traveling to reach a familiar destination, exploratory travel aiming to return to a known starting point, and traveling with the aim of reaching an unfamiliar destination.

Wiener et al. (2009) propose a classification that resembles the above categorization but provides a more detailed analysis. They primarily divide wayfinding into aided and unaided wayfinding. Subsequently, a classification of various unaided wayfinding processes is also made by Wiener et al. (2009). The initial subdivision is made according to the existence of a target arrival point. The process of navigating with specific destinations in mind is called *directed wayfinding* by Wiener et al.. Examples include walking or driving from home to work or searching for a particular restaurant in an unfamiliar area of town. Directed wayfinding involves a clear endpoint, typically defined as reaching the desired destination. If there is no determined destination to set out for, it is *undirected wayfinding*. It is possible to be practiced in both familiar and unfamiliar environments. As Wiener et al. remark, a pleasure trip or window shopping without a determined destination in familiar environments, or an explorative travel in an unknown city are examples of undirected wayfinding. Below, classification of directed wayfinding related tasks will be given as they are proposed by Wiener et al. Since the cases that interest the current study are travels in which drivers have specific targets to arrive, only directed wayfinding will be mentioned here.

Wiener et al. (2009) state that types of directed wayfinding can be classified according to either *search task* carried out or *target approximation*. Within the perspective of search tasks, there are two types of tasks carried out in wayfinding processes: *informed search* and *uninformed search*. Informed search refers to what one does while going somewhere in familiar environments. Travelling between home and work as a journey on an already memorized path, or looking for someone in a well-known area are examples of informed search. Uninformed search, which is made in unfamiliar environments, is exemplified as what a firefighter searching for a person in a burning house. It is such a case in which the wayfinder does not have survey knowledge and the information about the location of the target in that area.

Classification based on target approximation is related to two situations according to Wiener et al. (2009): Being and not being acknowledged of the path. If the human is in a familiar environment and knows how to go to the arrival point, Wiener et al. name the task they carry out is *path following.* Wiener et al. delineate by relying on Cohen and Schuepfer (1980) that path following is a process in which the human must align sensory input from the surroundings with the route information they have stored in memory, and they must execute and oversee the correct sequence of actions. If human's knowledge about the path is not adequate, which is possible in either familiar or unfamiliar environments, two types of tasks are in question. These are the situations in which the human knows where to go but does not know how. If the human knows the location of the arrival point in a familiar environment but does not exactly know about the path between it and themselves, what they do is planning which way to choose. If they are in an unfamiliar environment in which they know (maybe able to directly see) where the arrival point is, they, as not able to make a route plan, search how to go there. Wiener et al. call the former as *path planning*, and the latter as *path search*.

Schwering et al. (2017) extend the taxonomy suggested by Wiener et al. (2009). They, first of all, call path following that Wiener et al. introduce as passive path following. In passive path following, as they assert by relying on the study by Wiener et al., the navigator possesses route knowledge and carries out the necessary sequence of actions. This activity does not demand significant attention or spatial reasoning and operates almost automatically, like the routine commute to work. In addition to passive path following, they propose a new term which is *oriented path following*. They claim that this type of wayfinding task addresses the situations in which the human both knows the destination and has route and survey knowledge. To picture this type of task, Schwering et al. give the example of going to a known shop in the center of a city in which alternative routes are also known.

Considering the classifications provided above regarding wayfinding tasks, the most comprehensive presentation of wayfinding tasks arising from the categorization of directed wayfinding, which falls within the scope of this study, is given below. As Figure 3.1 shows, directed wayfinding takes on various forms depending on the context.

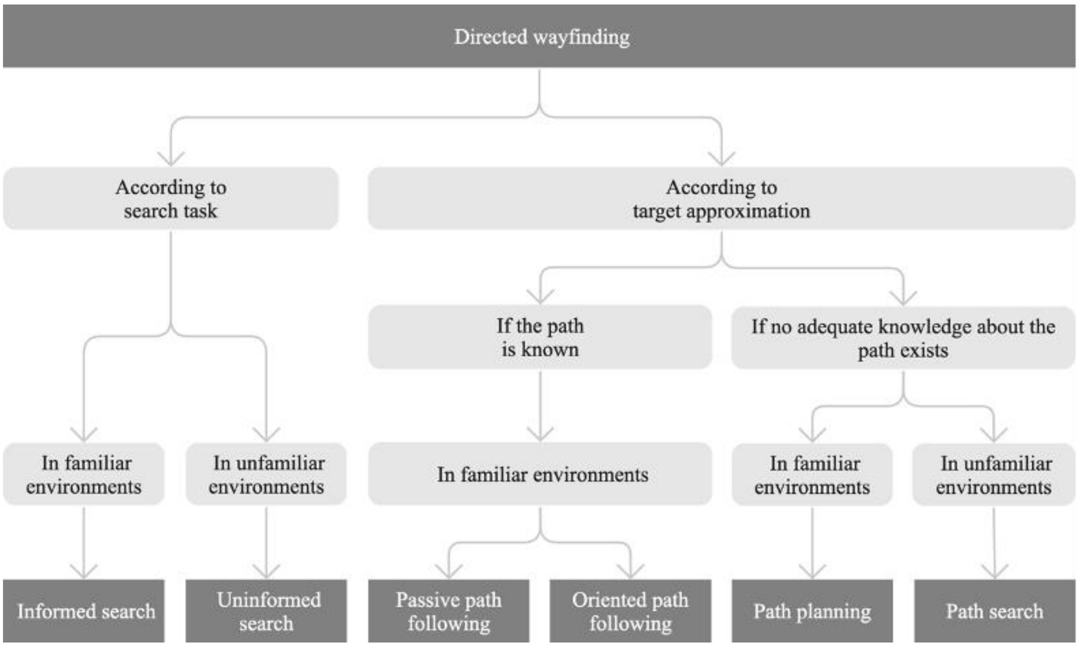

Figure 3.1 The variety of wayfinding tasks and related occasions in directed wayfinding

3.2.3 The presence of navigation technologies in navigation

Before the widespread adoption of GPS-based navigation applications, natural references such as the sun and stars, along with human artifacts like compasses and paper maps, were commonly used for navigation. The integration of GPS into navigation technologies began several decades ago. During the 1970s and 1980s, the system was primarily utilized in the military sector with large and expensive GPS receivers (Spilker et al., 1996). Portable GPS devices became available for civilian use in the 1990s (Hofmann-Wellenhof et al., 2001), and automobile manufacturers began developing integrated GPS navigation systems for vehicles. After 2000, handheld GPS devices gained popularity, and GPS applications on smartphones became widespread (Djuknic & Richton, 2001). By the 2020s, autonomous vehicles capable of self-navigation using GPS technology were being developed. Currently, commonly used navigation technologies include in-vehicle embedded navigation systems, standalone navigation devices, and smartphone applications.

Various GPS-based digital applications used for navigation today include Google Maps, Apple Maps, Waze, HERE WeGo, MapQuest, Sygic etc.. The prominent features of these applications are as follows. Google Maps, offers features such as route guidance, traffic conditions, public transit routes, and local business information. Apple Maps provides route guidance, traffic information, and details about local businesses and restaurants. Waze is a community-based application where users share real-time information on traffic, accidents, and road conditions, enabling the determination of the most current and accurate routes. HERE WeGo offers downloadable maps for offline use and features like traffic conditions, public transit routes, and bicycle paths. MapQuest provides route guidance, traffic information, and local business search capabilities. Sygic offers maps for offline use, route guidance, speed limit warnings, and lane assistance.

The most prominent common feature of these applications, which will be examined in detail later, is their ability to provide route guidance on a map. However, some navigation applications offer additional features. For instance, Google Maps and Sygic allow users, especially pedestrians, to use their phone cameras to view real-world road signs and directions on the screen. Additionally, HUD (head-up display) implementations project information onto the windshield, overlaying visual instructions on the real view of the road (Gabbard et al., 2014). Therefore, such applications are also considered part of a see-through experience (Bark et al., 2014).

Although these uses are beyond the scope of this study, they are worth mentioning here to illustrate the diversity of navigation applications.

This subsection investigates how users of navigation technologies establish relationships with these technologies and the environment during their navigation practices. As stated earlier, a range of navigation technologies fall within the scope of this study as navigation technologies. These encompass navigational systems integrated into vehicles, mobile navigation devices, and applications accessed via mobile phones. However, while the technologies covered in this study may differ in terms of their material existence, the information they provide to users and their modes of use are largely similar. Consequently, the features outlined below are common across the navigation technologies examined in this study. Therefore, unless necessary, specific mention of this has not been made even if the cited studies focus on a particular type of these technologies.

3.2.3.1 Human-technology relations during mediated navigation

Mobile navigation tools are created to assist in overcoming limitations in human perceptual or cognitive capacities during wayfinding tasks (Wu et al., 2008, September). Such technologies give the user incremental (Willis et al., 2009), turn-by-turn instructions by guiding them on what to do at decision points on the route (Schwering et al. 2017) considering the location of the user moment to moment. Chen and Stanney (1999) point out the functions of these technologies in more detail. As they introduce, these technologies assist navigation practice by representing the user's current position, orientation, and movements, and guiding the user. During the assistance, even if the user takes the wrong path, these technologies re-determine the route according to their new location and suggest a new path from the new location to the destination. The absence of stored environmental knowledge is compensated by environmental representation made by these technologies, as an external support, during navigation in an unfamiliar environment (Field et al., 2011, July).

The most prominent feature that these technologies offer can be said to be a dynamic map view. They provide alternatives for map views, which are cartographic images of the world abstracted in various types. Before a travel, it displays the overview of alternative routes to the arrival point on the map. Distance and travel duration for each route alternative are also written on the screen. Some applications give information about the route which is most efficient in terms of fuel saving as well. As Wu et al. (2008, September) picture, the user obtains general information about the routes, thus, they can make strategic decisions, for instance, when to rest during the journey. The system enables the user to choose one of the alternative routes according to their own preferences. At this stage, the system displays congested roads along the routes it suggests so that the user can take traffic congestion into consideration while determining their route. The user can also be search for gas stations, restaurants etc. on the routes.

During travel, the map view is updated constantly according to the location of the user. The user's location is represented on the route as they move. Also, at each turn, the direction of rotation is expressed with arrows. As another feature of this technology, it is possible for the user to see their representation on the screen in the egocentric or allocentric view at their will. In addition, when the user prefers the allocentric view, they can adjust the direction of the movement on the map in two ways. First, they can choose their own perspective so that the part of the real environment which is in front of the user is represented in front of the representation of the user on the map. Second, they can choose the traditional distribution of cardinal directions, so that north is represented on the top of the map. Aside from the map as abstracted environmental views, texts are displayed on the screen during travel as well. The distance to the next turn is written and updated as the user comes closer to the turn. In addition, as the user moves, the system updates remaining travel time and the distance, and notifies the user about these through textual information. As another function related to visual features, both before and during travel, the user can zoom in and out the map view if they will.

Visual instructions, which are abstracted view of the environment and texts, are supported by audial information by the system while using navigation technologies. Especially before a turn, the system gives voice instructions related to the direction and angle of, and the remaining distance to the turn. As another voice notification, if a route more advantageous in terms of time is detected, the system can notify the user about it and let the user to take it or resume. Another audial message the technology gives is not verbal information but sound effects such as the sound when the system is re-routing. The system also allows the user to mute voice notifications.

Briefly, while the system offers instructions and seems to be the one who makes navigational decisions in navigation process, it gives the user the opportunity to make choices. In many versions of such technologies, the system allows the user to choose the route, representation on the screen, abstraction level of the environmental view, viewpoint (as egocentric or allocentric view) and direction of the movement. They can also change the scale of the map view by zooming in and out. The user is also able to mute the system as previously stated. It is also important to emphasize here that no information given by the technology is completely missed when it is muted since voice instructions are just the ones supporting some of the visual information displayed on the screen. This means, even if the user ignores voice instructions, they can still access the related information on the screen. The functions that the user can be involved into are given below in Table 3.3.

Table 3.3 Information given by navigation technology during in-car navigation

	Visual	Auditory
Verbal	- Distance to the point of arrival - Estimated time of arrival - Distance to the next turn These details cannot be deactivated or changed by the user.	- Distance to the next turn - Turning angle - Location of the point of arrival when arrived Voice instructions can be deactivated by the user.
Non-verbal	- Map - Direction of the rotation on the map - Traffic juncture The user can change some of the details of the map view which are: . Modes of abstraction . Viewpoint (egocentric-allocentric views) . Direction of the movement . Scale (by zooming in-out)	-Sound effects Voice instructions can be deactivated by the user.

Karlsson et al. (2015) points out that digital navigation tools are most used in unfamiliar environments for turn-by-turn instructions. Although they concentrate on navigational purposes, they can be used for other purposes as well. As Karlsson et al. exemplify, having access to the arrival time, and overviewing the routes are other purposes of using this technology. The computation of fuel efficiency and determination of the remaining fuel level (Speake & Axon, 2012) represent some of the additional purposes for the utilization of these technologies. In addition to the purposes of using such technologies, the relationships that users establish with them are also a subject of investigation. Following this introduction of what these technologies offer to the users above, below, the relationships users form with them will be delved into.

The research by Speake and Axon (2012) is one of the studies leading the application of engagement theories to user engagements with navigation tools, which are wayfinding artifacts in their terms. In the research conducted with the participation of geography students, Speake and Axon investigated how geography students engage with paper maps and satellite navigation tools behaviorally, cognitively, and affectively.

Among the geography students participated in the study by Speake and Axon (2012), there were both ones who were willing to use a paper map and ones who prefer to use a satellite navigation tool. As Speake and Axon report, with respect to behavioral engagements with paper maps and satellite navigation tools, users may refrain from using the navigation tool even if there is someone available to provide directions to them. Speake and Axon characterize technology as the "last resort" for such users (p. 332). When this finding is interpreted, it is understandable that there are still people not using digital navigation technologies as long as there are alternative ways like using traditional tools or asking for help from others. However, it should be remembered that it is not the case that such technologies provide wayfinding instructions only. Speake and Axon quoted for what reasons the participants said such technologies were used: Calculation of fuel efficiency and the amount of remaining full, estimation of arrival time. Hence, there are people using these technologies even in the environments they are familiar with as the study shows.

Studies on cognitive engagements indicates the ease technology offers to the user during navigation. For instance, such technologies give the user spatial information step-by-step without encouraging them to do spatial tasks as Willis et al. (2009) point out. Concordantly, Wu et al. (2008, September) suggest that mental orientation effort is reduced by this technology. Indeed, Speake and Axon's (2012) research, there were participants who articulated that these technologies weaken awareness of the environment whereas paper maps require users to think. This convenience is also correlated to the reliance on technology by Speake and Axon. One of the participants reflected the extent to which users rely on the information given by the technology during navigation with the words "They've given up their own sovereign brain" (p.

332). On this basis, Speake and Axon point out that these technologies have the potential to carry out navigational tasks in place of users.

Affective engagements between the user and technology during navigation is another issue that Speake and Axon (2012) concentrated on. They unveiled affective engagements of geography students to satellite navigational technologies by comparing them with the way they engage with traditional maps affectively. According to their findings, while some of the participants perceive conventional maps and satellite navigation devices as similar tools in terms of providing map-based information mainly, some of them consider these two media as different entities. The study discovered some positive feelings related to positive experiences with traditional maps, and the emotional attachment participants have with the technology was not that strong. Yet, there are still users who feel dependent on the technology as the study shows. Speake and Axon also found that participants appeared not to be concerned the decline of paper maps. As the researchers highlighted, paper maps had even lost its significance for geography already according to one of the participants.

Speake's (2015) study on how users engage with such systems affectively highlights the emotions users of these technologies experienced. It shows that users of this technology have such feelings as confidence, happiness, and control while they are navigating. For example, the egocentric view makes users "feel at the center of things: in control and in tandem (or even at one) with the technology" (p. 353). Speake reports other positive feelings that the participants experience while using this technology as well, which are safety, relaxation, trust, independence, reassurance, please and ease. For instance, according to Karlsson et al. (2015), having access to the arrival time decreases stress and increases comfort felt by the users. Girardin and Blat (2010) conducted research with the participation of taxi drivers. They report that one of the drivers participated in their study calm down and relax, and one of them is relieved of their fear of getting lost, while travelling with technological assistance. Among the positive feelings, Speake also emphasize the importance of feeling/taking/having control during navigation without considering the type of navigational support tool used.

When users are unable to use the technology, as the study by Speake (2015) shows, they may feel fear, anger, aggression, annoyance, stress, confusion, lack of confidence, frustration, perturbation, wariness, unhappiness, vulnerability, regret, confusion, unsureness, independence, isolation, impatience, lostness and being screwed up. The results of the research conducted by Göktürk and Pakkan's (2013) on affective experiences of navigation technology users are partially similar. They found, for example, that there are users who think that the assistance of a navigation technology increases comfort and enjoyment they feel during a travel since they do not need to ask others or use a map to find their way in its presence. As indicated before, there were participants in their study who preferred to use a navigation system even in the environments they were familiar with finding the system itself enjoying as well. Trust is another issue Göktürk and Pakkan touched upon as like confidence that Speake mentions. Göktürk and Pakkan observed that trust was a feeling users of these technologies felt, and the more technology aptitude the drivers had, the more did they tend to trust the system.

Based on the above arguments, it could be inferred that the presence of a navigation technology influences the feelings of users positively. In other words, it might be understood when the findings given above are evaluated that the use of a technological assistant has positive affectional effects on users. Correlatively, Speake (2015) also notes that when the assistance is not available, such a "positive affective engagement" turns into a "negative affective engagement" and users feel anger and fear (p. 352). Still, it is not the case that a navigation technology has positive effects on the feelings and emotions of users all the time. For instance, Göktürk and Pakkan (2013) also revealed that there were users who experience discomfort if the system suggests them an alley, not a highway.

Based on the information given in this subsection, navigation technologies have been developed to assist travels by providing information related to wayfinding, driving, and travel. Through continuously updated visual and auditory notifications, they offer simultaneous support to the user during the travel. The primary affordance of this synchronized assistance is the execution of wayfinding-related tasks during navigation practice. This affordance results in some users delegating wayfinding-related tasks to the technology during navigation practice. This situation suggests that the initiative in wayfinding decisions partially resides within the technology. During the travel, technology secondarily provides information related to driving and travel that is not available to the user in its absence, such as distance, duration, traffic congestion, etc. This again implies that the agent who takes the initiative in these matters during the travel is the navigation system.

Human-technology relations in technologically mediated navigation practices can be summarized as described above. Additionally, navigation technologies play a role in shaping how humans interact with the environment while using them, as discussed by Speake and Axon (2012) and Dodge and Kitchin (2005). Consequently, there is an extensive body of literature exploring how the use of navigation technologies influences users' engagement with the environment. The following subsection will address human-environment relations during technologically mediated navigation.

3.2.3.2 Human-environment relations during mediated navigation

This subsection will scrutinize users' interactions with the environment during the utilization of navigation technologies. At the beginning, it will delineate the alterations brought about by these technologies in human-environment relationships. Then, it will deliberate on the negative and positive outcomes of the use of these technologies in such relationships as it is an issue widely addressed in the relevant literature. In order to comprehend the impact of employing these technologies on users' engagement with the environment, it is crucial to juxtapose their effects with those of the absence of such tools and other navigation tools. Thus, this section mainly includes comparative results of related studies.

The investigation into wayfinding behavior among users of navigation technologies, map users, and those navigating without assistance has yielded valuable insights, as various studies have delved into the nuanced differences in their navigation performances and interactions with the environment. Ishikawa et al. (2008) concentrated on the variety among these three groups of people in terms of wayfinding behavior (and spatial knowledge acquisition). In their study, navigation technology users, among the three groups of participants who completed a navigation task by walking, travelled the longest distances and stopped most frequently to reorient themselves in the environment during their travel. In terms of travel speed, while the difference between performances of users of navigation technologies and map users is negligible, these two groups performed slower than those travelling with no assistance. Field et al. (2011, July) compare wayfinding behavior of (and environmental knowledge acquired by) two groups of pedestrian who are GPS-based navigator users and paper map users. They intended to understand if navigator users are more familiar to this technology in comparison to paper maps, and if there is an improvement, related to this familiarity, in navigation. Their results partly correspond to that of Ishikawa et al.'s study. First, these two investigations showed that distances navigator users travelled are longer as Ishikawa et al. found. Also, Field et al. deduced that they are more inclined to stop during their travel for reorientation like Ishikawa et al. suggested. Yet, they stop for less time as Field et al. emphasized in contradiction with what Ishikawa et al. found. As another result contrasting to Ishikawa et al.'s findings in terms of travel speed, paces of navigator users are faster than paper map users according to Field et al.. Based on these, they concluded that people were becoming more familiar with the navigation technology and uses of GPS were becoming more prevalent although paper maps were still effective. Ishikawa (2019) conducted a behavioral study in which he assessed long-term effects of the use of various navigation tools. He first evaluated participants' spatial aptitudes and experience of the use of navigation tools which are pedestrian navigator, in-car navigators and paper maps. Then he tested participants in terms of way finding performance and spatial orientation in a way finding task in which each of them was asked to use either a pedestrian navigator or a paper map while walking on the predetermined route(s). Ishikawa associates the results to participants' past experiences with the tools in question. As he reported, people who were accustomed to use in-car navigation technologies made more navigational errors and they stopped more frequently during the wayfinding task in the study.

As to the cognitive effects on engagement with the environment, users of navigation technologies differ from physical map users (Kitchin and Dodge 2007; Laurier and Brown 2008). Krüger, Aslan and Zimmer's (2004) study shows that these technologies, in comparison to physical maps, provides its users poorer survey knowledge and landmark knowledge. Münzer et al. (2006) tested route memory and survey knowledge of physical map users and users of a mobile navigator for pedestrian. They found that navigator users, despite not having poor route knowledge, performed worse in terms of both route knowledge and survey knowledge than users of physical maps. They also discovered that the difference between the level of survey knowledge the two groups acquired is bigger than the difference between their route knowledge. This result is not surprising since, as Schwering et al. (2017) explain, information of decision points on the route are provided, but not a broader orientation is supported, by turn-by-turn instructions. Münzer et al. concludes their study with a more general finding that users of these technologies fall behind physical map users in terms of spatial learning. This is because, for Münzer et al., it is not necessary to process the information related to the environment in some respects during the use of this technology. As they point out, due to the fact that navigation assistance systems do not necessitate users to encode, transform, and memorize spatial information, the spatial orientation knowledge of users relying on navigation assistance tends to be limited. Willis et al. (2009) compare spatial knowledge acquisition of mobile map users and static map users. In their experiment, two groups of participants were given a learning task. While mobile map users were asked to learn a pre-determined outer environment by navigating with the assistance of the mobile map, static map users were required to learn the map of the same environment in an interior isolated from it. After the task, the members of the two groups were brought to a test measuring, first, orientation, second, estimation of the air distance between starting and arrival points, and third, estimation of the whole route distance. According to the results, mobile map users are not as good as the others in various respects related to spatial knowledge acquisition. In more detail, map users are better than mobile map users at the estimation of all three criteria. Also, as the intricacy of the route increases, the discrepancy in estimation performances, which encompass both air distance and route distance, between mobile and static map users widens. Regarding this, Willis et al. cites from Richardson et al. that the difference between learning from a map and direct interaction with the environment is smaller when the space to be learnt has a simple layout. Field et al. (2011, July) similarly claim that acquired spatial knowledge of GPS-based navigator users are poorer, despite not being much worse, than that of paper map users who need to relate the information on the map to the real environment more. As the researchers interpret this result, paper/screen size and the detail of spatial information the medium provides to the user might be a parameter determining the level of spatial knowledge acquired during such tasks. Göktürk and Pakkan (2013), concerning landmark notice, aimed at situational awareness of drivers, and found that driving with the assistance of a navigator causes unawareness of environmental objects. As their study indicates, these technologies impair drivers' perception of the outside world. More recently, Ahmadpoor and Heath (2018) revealed that GPS users are not as good as physical map users in estimation of route distance. Compared to self-experience users, topological accuracy presented by GPS users is worse as noted by Ishikawa et al. (2008) and Ishikawa (2016). Ahmadpoor and Heath (2018) compared landmark knowledge that GPS users and people navigating without any GPS assistance have. Their research points out that GPS users have more difficulties in remembering buildings on their route. Landmark knowledge they build up during a driving with assistance of GPS is also poorer than non-GPS users. Ahmadpoor and Heath associate these findings to the situation that people who use GPS use less environmental information than others do while driving. They state that GPS users "externalize the process of learning to these devices and therefore learn less about the environment themselves (p. 149).

While the discussed impacts of navigation technology on human-environment engagement appear to encompass both positive and negative aspects, the referenced studies do not explicitly categorize these effects as purely positive or negative. In other words, these investigations generally refrain from definitively assigning positive or negative connotations to the outcomes. Nonetheless, there are studies explicitly assert that navigation technologies have discernible positive or negative influences on users' engagement with the environment. The ensuing discussion will explore this perspective in greater detail.

Axon et al. (2012) suggest that interaction with navigation technologies cause intrinsic, and maybe negative, changes on wayfinding behavior of users. As Speake and Axon (2012) reported, users engage passively with the space and place within a behavioral respect. They correlated this result to the active engagement of users with the technology. This means, involvement in the assistant technology during navigation hinders users from involvement in the physical environment. Göktürk and Pakkan (2013) concluded their study with the results which support this idea. Girardin and Blat's (2010) study also concerns the negative effects of this situation on familiarization of users to the environment. They emphasize that the user concerns signs or landmarks less and observes the environment to orient themselves and learn about the route less closely. They add, reliance on such a system is one of the factors hindering inexperienced users' ability to learn the city. Hence, the more they rely on the system to learn the city, the more does their interaction to it deteriorate. This is, as the researchers comment, the "vicious circle" that users unfamiliar with their environment get into (p. 430). Aporta and Higgs (2005) point out the fact that orientation is already provided as a commodity by the technology. In their words, "engaging with the environment becomes a matter of choice" during technologically assisted navigation (p. 744). Concerning behavioral changes that in-car navigation technologies bring about, Göktürk and Pakkan (2013) demonstrate that looking at the device during driving might even pose some security risk.

Wu et al. (2008, September) remark the security risk with a cognitive aspect. They advocate that the users' engagement with the environment is weakened since their attention shifts from the real environment to the representation provided by the technology during assisted navigation. Thus, in the case of an inaccessibility or malfunction of the technology or wrong instruction, the user is mentally unprepared to respond to wayfinding problems in the unexpected conditions of the environment. According to Wu et al., security problems may arise because of such a mental unpreparedness. What they also refer to is the difficulty in developing an overall image of the environment while using navigation technologies. That may be because, as they claim, the information given by the technology is the local environmental information generally. As to knowledge acquisition, Wu et al. emphasize that being provided with step-by-step instructions decreases the necessity of memorizing the route and paying attention to street names and landmarks. Indeed, the study by Parush et al. (2007, p. 238) shows, spatial knowledge acquisition of navigation system users might be negatively affected if the system makes it possible for the users to be "mindless" of the environment during the use as disconnection from the environment. Speake (2015) suggests that when users are disconnected from the environment, additionally, they are disconnected from positive affections that are feelings of safety, control, and happiness as well. As given below, the fact that such negative effects may appear as long-term results of using this technology as well.

Ishikawa (2019) advocates that long term effects of navigation technologies on engagement with the environment must be studied and he undertook research on detrimental effects of long-time and frequent use of three types of navigation tools which are pedestrian navigation tool, in-car navigation tool and paper map on wayfinding performance and spatial orientation. Despite being a behavioral study, its results could be said to refer to some cognitive issues as well. As it shows, besides short-term effects, long-term use of in-car navigation technologies has lasting effects on spatial aptitudes. Similar to this, Parush, et al. (2007) state that navigation skills are negatively affected because of the over reliance of the technology during assisted navigation. McKinlay (2016, p. 574) supports these arguments and defines navigation as a “use-it-or-lose-it” skill. Ishikawa reports that such negative results might be related to the fact that turn-by-turn instructions appearing to decrease the necessity for conscious navigational decision makings and comprehension of the environment. As one of the participants in Speake and Axon’s (2012) investigation conveys her opinions in this issue, she would not come to know about the environment as her father does since what she has interacted with for twenty years is the satellite navigation, not the environment, in contrast to her father who has driven everywhere without the assistance of such a technology for forty years.

In contrast to the negative cognitive effects of digital navigation tools on engagement with the environment, the relevant literature also covers findings which refer to positive ones. It is cited above that such technologies could make users “mindless” (Parush et al., 2007, p. 238) of the environment. However, as the study by Parush et al. shows, when the technology makes the user carry out the wayfinding task more actively, their spatial knowledge acquisition is positively affected. Wunderlich and Gramann (2021) investigated whether spatial learning could be improved when the navigation system provides the user with landmark-based navigational information. They conducted the related experiment in a laboratory environment. Participants were shown a video of the real environment from pedestrian’s perspective and given auditory navigational information spontaneously. They were required to respond to navigational information to resume the video. What participants saw in the video included both navigational landmarks and landmarks not related to the navigation. In the test phase, together with those of these two, photographs of the third type of landmarks which were not included in the video, were shown to participants. Participants were asked to respond to these three types of landmarks by specifying to which direction to turn was required at each one if it was on the route or indicating that it was not on the route if they did not think they had seen them in the video. According to the results, users’ spatial knowledge acquisition is enhanced in the presence of landmark based information during navigation. Another positive cognitive effect of these systems has been reported by Speake and Axon (2012). One of the users who participated in their research comments about the use of satellite navigation technology that it enhances her spatial awareness and increases her orientation speed.

At this juncture, discussions regarding mediated navigation can be concluded with an examination of how the presence of these technologies fundamentally alters the user's relationship with the environment, setting aside the negative and positive outcomes of their use. The relationship between the user and the environment in a technologically mediated navigation process appears to be open to scrutiny from the navigation from one point to another within a maze is entirely reliant on the walker's intentions, expectations, and decisions, in essence, their cognitive processes, which means that the walker's mind serves as the source of information for movement within a maze. Conversely, in a labyrinth, the environment provides directional signs for the walker to follow. This differentiation implies that in a maze scenario, the wayfarer engages in active decision-making whenever encountering a fork. In contrast, the wayfarer in a labyrinth is exclusively guided by the cues provided by the surrounding environment. According to this comparison, in a navigation practice where navigation technology is involved, this technology transforms the user's surroundings from a maze to a labyrinth by providing directions to the user. This shift occurs because, in a navigation practice not mediated by technology, wayfinding is carried out by the user's mind, whereas when this practice is mediated, the technology takes over the user's mind's function in wayfinding to some extent.

In summary, the investigation into navigation technologies, map users, and individuals navigating without assistance has provided insights into their diverse interactions with the environment. The studies discussed have highlighted variations in wayfinding behavior and cognitive effects across different user groups.

Differences in travel distances, speeds, and stoppage patterns have been observed, indicating the complex nature of how users engage with navigation tools and environment. Comparisons between GPS-based technology and physical map users have revealed disparities in survey knowledge, route memory, and spatial learning. The findings suggest that while navigation technologies provide turn-by-turn instructions at decision points, it may have limitations in offering a broader orientation, impacting spatial knowledge acquisition compared to traditional maps. These insights extend to driving scenarios, where evidence indicates potential challenges in environmental information processing for the users of navigation technologies. In essence, the collective observations underscore the intricate nature of navigation technologies’ influence on users’ engagement with the environment.

Some of the studies reviewed above generally discusses the impact of navigation technologies on users' wayfinding behavior and spatial awareness. It highlights the effects such as users becoming overly dependent on technology, passive engagement with the physical environment, and potential security risks during driving. Long-term use of in-car navigation technologies is shown to have lasting effects on spatial aptitudes, and reliance on turn-by-turn instructions is suggested to decrease the necessity for conscious navigational decision-making. These all are considered as negative impacts of the use of navigation technologies. On the positive side, according to some findings given above, active engagement with wayfinding tasks, facilitated by navigation systems, can positively affect users' spatial knowledge acquisition. Additionally, positive cognitive effects include enhanced spatial awareness and increased orientation speed reported by users of satellite navigation technology.

Among the findings presented here regarding the negative and positive impacts of the use of navigation technologies, instances where the user's connection with the environment weakens or is severed are considered a negative outcome of using these technologies. For example, a decrease in spatial awareness and a reduction in spatial knowledge acquisition during the use are regarded as negative outcomes. On the other hand, findings indicating the strengthening of the user's connection with the environment during usage are interpreted as a positive effect of these technologies on human-environment relationship.

The topics addressed in the aforementioned studies on human-environment engagement during navigation practice partially diverge from the focal points of this study. For instance, this research does not delve into subjects such as spatial knowledge acquisition or the long-term effects of the use of navigation technologies while examining the experiences observed during navigation practice. Nevertheless, the studies presented in this section are worth discussing since they provide insights into which variables may make a difference in navigation practice during the utilization of these technologies. Below, the discussion revolves around the individual variables that could potentially impact experiences observed during navigation practice based on research findings from the relevant literature.

3.2.4 Individual variables

One of the individual factors that influences navigation practice is the individual's proficiency in navigation. This concept is expressed in the literature through terms such as navigational aptitude, spatial aptitude, and navigational abilities. Some examples of this are abilities in, such as encoding environmental information, environmental learning (Thorndyke & Statsz, 1980), and spatial orientation (Thorndyke & Goldin, 1981). Ishikawa (2019) advocates that people’s spatial aptitudes played decisive roles in their navigation strategies. Considering survey strategies and route-based strategies, Ishikawa claimed that people with a good sense of direction are inclined to be good at the former type of navigational strategies and configurational comprehension of the environment, whereas the others tended to apply the latter. Montello and Sas' (2006) statements that evokes navigation skills can also be cited here as an example. To reiterate, Montello and Sas define uncertainty regarding one's location or the path to be taken as geographical disorientation, which equates to becoming lost. According to their research, geographical disorientation can range from long-lasting and severe to temporary and mild. The researchers additionally state that individuals with a poor sense-of-direction may experience it regularly.

Learning strategy appears to be another factor that influences how humans perceive their environment. The study by Thorndyke and Goldin (1981) on individual differences in spatial learning strategies reveals distinct approaches employed by the two subjects. These approaches are characterized in the study as visual/perceptual and verbal/analytic approaches. The visual/perceptual approach refers to emphasizing perceptual features, aesthetic judgments, and comparisons with past experiences. In contrast, verbal/analytic approach involves utilizing a grid-like framework, focusing on street names, and organizing knowledge through verbal instructions and global representations. These strategies are found by Thorndyke and Goldin to align with the subjects' spatial and verbal abilities, as the former one excels in visual memory, while the latter one demonstrates high proficiency in both verbal and spatial abilities. The findings highlight the interplay between individual cognitive strengths and the strategic choices made during spatial learning tasks. This variation refers to the individual differences in terms the way they perceive their environment.

Golledge (2003) indicates the discrimination between humans from different educational backgrounds by comparing two groups of humans in terms of the ways they engage with the environment. He suggests (p. 33), Western people for whom Euclidean geometry takes an important place in their educational backgrounds tend to mine spatial information in quantitative formats as "distance, direction, orientation, magnitude, shape, pattern, object class, connectivity, hierarchy, and so on.". On the other side, ones who receive education in which mathematical concepts do not have a wide coverage are inclined to more qualitative spatial concepts, for example, "nearness, proximity, similarity, enclosure, partition, and so on". Even though Golledge does not associate this difference to any variation in wayfinding performances of these two groups of people, it can be interpreted that educational backgrounds, as another individual factor, may have an influence of how humans engage with the environment.

As another individual factor, how experienced the user is in using this technology may has an effect on navigation practice. Girardin and Blat (2010) quote the term *SatNav literacy* from Raper (2008), which is a skill that experienced users have. They mean by this term that inexperienced users are more inclined to rely on the technology during assisted navigation without assessing the quality of information it gives. Besides literacy, the experience in using this technology makes a difference in users' affectional responses to the assisted navigation. Similar to technological experience, *technology aptitude* also appears to make changes in technologically assisted navigation. Göktürk and Pakkan (2013) points out this differentiation with a behavioral respect. They report that drivers who have technology aptitude look more times at the navigation device than other drivers do. This finding is an example of how engagement established between the user and technology is affected by technology aptitude.

The variables that can affect navigation practice has been examined in this section. Being aware of these variables is significant for designing cases to be applied and sample recruiting in field studies on this topic. This is because framing the practices to be implemented in each case, and the selection of individuals to recruite, is possible by understanding these variables. With this awareness, the variables introduced here has been considered while planning the cases and selecting participants in the field research of this study. This means that the information given in this section provides a basis for this study's research design.

Up to this point, navigation and wayfinding have been defined, and the nature of navigation practice has been examined in this chapter. Variables diversifying this practice have been examined as well. The involvement of a navigation system in the practice has also been among these variables. Below, the following section will propose the discussion stemming from the literature reviewed so far. This discussion will illustrate how this study evaluates the information present in the literature. It will also demonstrate how prior knowledge is integrated and applied within the framework of this study.

3.3 Three Agents of Technologically Mediated Navigation

The primary purpose of navigation technologies is routing and giving wayfinding instructions during driving. Considered this, it can be suggested that it is the technology who makes wayfinding decisions in mediated navigation. Even when the user takes the wrong path, it is the technology again who suggests a new route from the new location of the user to the destination. In such a practice, Schwering et al. (2017) expresses that what the user is expected to do is just executing instructions given by the system. Like this, according to Aporta and Higgs (2005, p. 744), the user “can completely rely on technology and travel successfully knowing nothing about navigation and very little about the environment.”. It is also helpful to be reminded that, as the study by Speake and Axon (2012) shows, navigational tasks are carried out by this technology in place of the user to some extent. Based on these, it is possible to say that the technology is one of the agents in navigation practice. In more detail, it can be said that it is the agents responsible for wayfinding decisions in navigation.

The sharing of initiative between the user and technology evokes the concept of human-technology relationships termed as taken-for-grantedness by Kiran (2015). When the navigation technology assumes wayfinding related initiatives, for example, the user can set out for a destination where they couldn't or wouldn't prefer to go to in its absence. They may even do so with positive emotions. As another example, the user may not feel the need to refuel their car before embarking on a journey, as they know they can locate a nearby gas station with the support of the navigation technology at any moment during travelling. This means, trusting technology in this regard can enable them to embark on the journey comfortably, even with a low fuel level.

Yet, it would not be accurate to say that the initiative in the integration of the technology into the practice always lies entirely with technology. For instance, Girardin and Blat (2010), in the study they performed with the participation of taxi drivers as users of navigation technologies, mention information quality, which some drivers assess, of instructions navigation system provides. The study unveils that drivers know inaccuracies of the technology and evaluates the reliability of the instructions when they feel it is necessary, for example, when the technology starts updating the information it gives. In such situations, drivers might simply keep driving, not ignoring it, or prefer to use another navigation tool for the related information, as Girardin and Blat note. What the researchers also emphasize is the interrelation between this technology and user in navigation practice. As they state, drivers somehow adapt themselves to the technology rather than engaging with it simply the way it presents itself. They called this relation as a co-evolution between the technology and user. Wu et al. (2008, September, p. 502) refers to the distribution of the roles between the technology and user in assisted navigation by these words: "navigational tools can either help navigators keep consciously engaged or delegate the role.". In short, it is not the case that the technology is the only agents that plays a role in solving wayfinding problems. Rather, technology and user are two of the agents carrying out wayfinding tasks.

Shared agency in navigation involves environment as well besides the user and technology. In other words, environment can be regarded as another agents that plays role in navigation practice regardless of it is mediated or not. As representing itself to the human, it shapes the character of navigational experiences. This argument can be supported within three perspectives. From a cognitive point of view, first, the notion of schema, which is constituted as a result of internalization of perceived information from the environment, must be reminded here. Both the environment, together with the human cognition, shapes schema and schema shapes how the human perceives the environment. This interrelation is one of the situations that evokes environment as an agent in navigation process. Second, in the case of mediated navigation, it is not the case that the user navigates by just applying the decisions coming from the technology. What they must actually do is "establishing the connection between virtual representations on navigation screens and real-world objects" (Wu, et al., 2008, September). Third, although it seems that the driver receives information from the environment and technology during mediated navigation, there is a constant information exchange between the environment, technology, and human. For example, the navigation tool specifies its instructions based on the objects in the environment and driver's actions. As another example, how other drivers behave in the traffic flow depends to some extent on what the driver in question does, which means, the information environment consists of is partly updated according to the information the driver gives to the environment. Briefly, human, technology and environment change constantly as a response to the engagement between each other. Concerning this, what environment presents is included in the overall information applied in navigation practice, even if a navigation tool is used.

3.4 Agents as Information Providers

In the section 2.3.3 Shared agency, performing an action was exemplified in terms of acting, thinking, and deciding. When the perspectives about agency cited above are considered within the framework of this study, it is argued that information providing also falls within the scope of agency in the practice of navigation. This viewpoint is substantiated below.

As understood from the definition of navigation and wayfinding, what lies behind the solution of wayfinding problems are human perception and cognition. Indeed, Montello and Sas (2006) suggest (regardless of navigational assistance) that wayfinding requires to access and process both internal information as cognitive maps and external information as what the environment displays. Montello and Sas consider the information the human has is internal, and the environment provides, external. This evokes Norman's (1988) perspective of knowledge in the world as the external source and knowledge in the head as the internal source. Ishikawa (2008) has a similar perspective on this issue, but he also refers to the use of navigational technologies. As he establishes, the human uses both internal representations of the environment and external representations like navigational tools during navigation.

It can be deduced from these arguments, first, that agents play their roles in mediated navigation experience as information containers and processors. To put it in different way, they both relay and process information to be used in navigational tasks. Considered this, the three agents of navigation practice, which are human, navigation technology and environment, can be taken as *information providers* of this practice. From the user's perspective, what the three agents determine in a navigation practice are: a) information the user receives from the environment and navigation device, b) which information the user already has internally, c) how the user applies the information they receive and already have and the like.

Secondly, it is meaningful to distinguish the information providers involved in navigation practice and the information they offer into internal and external categories. As the current study accepts, human (human cognition) is the internal, and the technology and environment are the external information providers in technologically mediated navigation. Although the technology and environment are both external information providers, the study considers them separated entities. This is because, according to the phenomenological approach of this study to mediated navigation, technology, must be handled separately from the environment since it is the entity that mediates the navigation experience rather than being just an object included in the environment and experienced ordinarily by the user. In other words, it is not an environmental object experienced but a medium that mediates the experience of the environment.

3.5 Varying Boundaries Between the Agents

According to some studies (e.g., Speake & Axon, 2012; Ahmadpoor & Heath, 2017, March) it could be argued that the use of navigation technologies weakens users' connection to their physical surroundings. In Speake and Axon's (2012) study, participants support the idea that this technology makes the user disengage from the environment even if it is used in an environment the user is familiar with. In relation to this, one of the participants refers to the sense technology gives in the words "the tunnel vision effect" and "the loss of sense of place" (p. 334). In contrast, as Speake (2015) explains, the connection of the users to the real environment declines when the technology is unavailable which means that disconnection from the technology disconnects users from the environment.

These expressions concerning the connection between the human and environment refer to the engagement with the surroundings. These findings exemplify moments when the environment is deemed unexperienced and transparent. Thus, from these expressions, implications arise regarding whether the mind and body extend to the environment during these instances. Consequently, such findings lay the groundwork for a discussion on boundaries. For example, sometimes the user relies on the information coming from the technology so strongly that it comes to the front more. As another example, sometimes the user involves into the practice more by choosing from the provided routes, checking the information the technology gives or take a wayfinding decision different from what the technology suggests. Such a variety applies to the involvement of the environment into the practice as well. For instance, human is sometimes disengaged with the environment, which means it becomes transparent from the perspective of human perception.

It can also be inferred from these that distribution of roles among the three agents in mediated navigation is variable as well. They may share each other's tasks, or one may take over another one's completely. This means, which one is on the foreground, or any of them is transparent or not, at any specific time varies. Thus, among the agents, who plays the role of a doer, who is an object of the experience and who is the thing that remains unexperienced, are constantly changes. Briefly, the three agents seem to replace each other consistently. This leads us to a discussion on boundaries between them.

3.6 Summary

Discussions provided in this chapter can be summarized as follows.

- Navigation is a practice comprising wayfinding and locomotion. Wayfinding involves the cognitive process of making decisions related to finding a route, while locomotion is the bodily process of actual movement. Based on this, while wayfinding can be associated to mind, locomotion refers to the practice of body. These two processes are inseparable from each other.
- In the context of technologically mediated navigation, the framework of the practice is determined by four groups of variables: environmental variables, case-related variables, the presence of navigation technologies, and individual variables. These variables should be taken into account when designing the cases to be applied in field studies and determining the sample group.
- Technologically mediated navigation practice is a process of information exchange that occurs within the intersection of the environment, human, and navigation technology. The human, navigation technology, and environment serve as the three agents of technologically mediated navigation practice. In their roles as agents, they contribute to wayfinding decisions by providing information during the practice. Additionally, the human is the agent who moves during locomotion.
- The concept of agency was illustrated in the previous chapter through actions, thinking, and decision-making. When examining these perspectives within the context of this study, it is proposed that information provision also constitutes a form of agency within navigation practice. Within this respect, agency involves participation in the process of making wayfinding decisions as well as this research accepts.
- In navigation process, there are moments where the environment can be said transparent, prompting questions about the extension of mind and body into the environment. Such observations lead to discussions about boundaries. Besides, users sometimes heavily rely on the navigation technology during making wayfinding decisions while at other times they engage more actively in decision-making. It means that wayfinding related tasks are shared among

the agents or completely taken over by one party. This is another issue prompting discussions about boundaries between them.

Before concluding this chapter, it is important to emphasize the distinction between engagement and experience to avoid any confusion. Primarily, engagement refers to the ongoing relationship between the agents as long as the practice continues. In comparison, if an agent becomes transparent to the human, that agent is not experienced by the human, but even in this case, it can be said that these two are still engaged with each other. In other words, an agent being transparent in a practice does not imply lack of engagement with it, but rather indicates lack of experience. Therefore, for example, it would be erroneous to claim that variables enhancing navigation performance strengthen the human's engagement with the relevant agents, or conversely, that variables impairing performance weaken this engagement. This is because, by definition, there is no correlation supporting claims such as "Environmental familiarity enhances engagement with the environment.". While environmental familiarity may influence factors such as the accuracy of wayfinding decisions or the ease of navigation etc., engagement is not solely about understanding the relevant agent better or establishing a quicker or easier relationship with it. Engagement also exists in situations involving inaccuracies, malfunctions, or unsuccessful navigations.

Thus, to continue with the previous example, one should not generalize that only a person familiar with an environment develops a stronger engagement with it. On the contrary, it could even be argued that the engagement of someone unfamiliar with their environment, who attentively explores it during navigation, may be stronger or more intense than the engagement of someone familiar with the environment. Similarly, any mistakes made during the practice or a decline in performance do not necessarily imply a lack of engagement with the relevant agents.

This means that engagements in a practice are not evaluated based on their *results*. Instead, understanding engagements and experiences in a practice requires examining the moment-to-moment occurrences rather than focusing on outcomes such as accuracy, performance, or success. This notion forms the basis of this study's (post)phenomenological approach, which involves examining the practice it deals with moment-to-moment.

In conclusion, navigation practice has been introduced based on relevant literature, and information regarding technologically mediated navigation has been provided in this chapter. According to this information, agency in navigation practice include participation in wayfinding through information provision and locomotion through movement. Human, environment, and navigation technology involved in the practice have been defined as agents. Drawing upon research findings encountered during the literature review, it has been interpreted that boundaries among these agents change during practice.

As previously mentioned, the information compiled in this chapter will provide insights into designing cases and recruiting samples for field research. Additionally, before proceeding with that, the next chapter will utilize the information gathered in Chapter 2 and Chapter 3 to identify the gap in human-technology-world relations studies that do not encompass the use of navigation technologies.

CHAPTER 4

FIELD RESEARCH

In this chapter, firstly, the identified gap in the literature regarding the use of navigation technologies from the perspective of human-technology-world relations will be discussed, along with the information that this study aims to produce to address this gap. Subsequently, the design and implementation of the field research in line with this aim will be elucidated.

4.1 Gap, Aim and Research Questions

This section will delineate the gap in the literature pertaining to navigation technologies by integrating the theoretical framework outlined in Chapter 2 and the literature review conducted in Chapter 3. In doing so, it will also elucidate why the study focuses on in-car usage. Subsequently, it will detail the aim and goals of the study, followed by the specification of research questions.

(Post)phenomenology defines how the human experiences the world and how experiences related to the world are mediated by the technology. In the definitions of various types of experience, it reveals the engagement between self, technology, and world. Boundaries between these three are changeable and sometimes ambiguous, thus, debatable. The reason for this changeability and ambiguity is the variety in the involvement of the technology into the human's pure experience of the world.

Types of engagements between the self, technology and world have been introduced in Chapter 2. To remind, those are embodiment relations, hermeneutic relations, alterity relations, background relations, robotic re-embodiment and virtual re-embodiment. Although a range of relations have been handled in the field of (post)phenomenology, the mediation with navigation technologies does not completely fit any type of engagement defined so far.

Concerning how navigation technologies mediate users' experiences with the environment, it can be pictured as a type of engagement in which the technology gives simultaneous information about the world through a representation of it, and includes the representation of the self. These types of engagements with technologies evoke hermeneutic relations and virtual re-embodiment as defined in (post)phenomenology. However, the existing explanations of these types of engagements in (post)phenomenology appear insufficient for understanding the technologies examined in this study. The reasons for this are outlined below.

In terms of providing information about the world, it can be said that navigation technologies that this study concentrates on afford hermeneutic relations. However, hermeneutical relationship established with this technology while driving differs from that with a thermometer in an isolated room. In detail, using a thermometer does not require direct interaction with the environment it provides information about. Even if the human is in an isolated room, it is still possible for the thermometer to function since it is not necessary to sense the air temperature to learn about it in the presence of a thermometer. Unlike the use of a thermometer, it is not possible to go from one place to another by the help of the information a navigation technology gives in the absence of the information the environment provides.

As to the representation of self, the use of the technologies in question reminds virtual re-embodiment observed in the case of digital games where the human is represented on the screen. However, it is not actually virtual re- embodiment that navigation technologies make possible. That is because, in digital games, the human *lives in* the virtual media by following the action there in the case of virtual re-embodiment. In contrast, the task carried out during navigation with the assistance of navigation technologies is in the real world. With respect to these, the use of these technologies offers a type of engagement that have not been defined in (post)phenomenology so far. Therefore, technologically mediated navigation is a topic worth studying from the perspective of human-technology-world relations.

Among various uses of navigation technologies, in-car use is concentrated on by this study for several reasons regarding applicability of the field research. Considering these reasons, it helps to start with the comparison between mobility with any means of transportation, not specifically car, and walking. First, many means of transportation provide an isolated environment from many of the details outside unrelated to the considerations of the research. Such an atmosphere seems possible for participants to act with less distraction when it is compared to walking. Further to that, it makes it possible to test and observe navigation process along a longer distance which offers much more mobility and change of the environment. It also provides the opportunity for this study as the researcher to accompany participants to both run the study and document data, whereas walking does not offer such an advantage. Briefly, conducting the study with a medium of transportation is more applicable than that without a medium. In fact, users of navigation technologies consist of not also drivers, but also bikers, and navigators of ships and airplanes (Wang et al., 2018). As concerns the difference of car from the other means of transportation exemplified by Wang et al., it is more accessible to perform such a case study, in comparison to other ways of transportation. Considering these all, concentrating on in-car experience can be said to make the study more applicable.

As to the literature on users' engagement with the environment and navigation technologies during driving, they generally interest in short-term or long-term effects of the use of this technology on environmental, for example, learning. However, the *definition of the experience* of driving in the presence of navigation technologies is an under-researched issue. For instance, the extent the navigation technology and environment play a role in driving experience have not been revealed comprehensively in the related literature. Similarly, the ways these three engage with each other have not been extensively addressed in the literature.

For the reasons above, the aim of this study is uncovering, based on the information exchange between the driver, navigation technology and environment, varying forms of engagement between these three during in-car navigation, and their constantly changing boundaries in this process. In line with this aim, the study intends to cultivate a viewpoint regarding how these boundaries can be examined, understand how the three agents participate in navigation and engage with each other during this practice, and interpret how these interactions alter boundaries between them. It additionally intends to scrutinize the role of the navigation technology in these changes. Followingly, the research questions are:

Q1. How do the driver, environment and navigation technology participate in in-car navigation?

Q2. What type of engagements does the driver establish with the environment and navigation technology during in-car navigation?

Q3. How do the boundaries between the driver, environment and navigation technology vary during in-car navigation?

Q4. How do navigation technologies interfere in the boundaries between the driver and environment during in-car navigation?

Chapter 2 and Chapter 3 investigated how the boundaries of the driver, navigation technology, and environment in technologically mediated in-car navigation can be examined to provide a basis to discuss the results of the field research. Findings related to first and second questions will be presented together in Chapter 5 and Chapter 6. Chapter 6 will also include discussions pertaining to the third question. The issue raised in the fourth question will be discussed in Chapter 7, based on the findings presented in Chapter 5 and Chapter 6. Details of the field research that led to the findings will be provided below.

4.2 Research Design and Conduct

To address the research questions outlined above, two research methods were adopted in this study: participant observation of naturalistic driving (POND) and autoethnography of technologically assisted in-car navigation. The implementation of participant observation of naturalistic driving was also supported by surveys, pre-task orientation sessions, think-aloud protocols during driving sessions, and post-task interviews. At the outset of the field research, two driving sessions assisted by navigation technology were conducted. Insights obtained from pilot studies proved effective in structuring the survey and planning driving sessions of POND and autoethnography. Below, information will be provided about these processes, followed by an explanation of how the methods were implemented and how the analysis was performed. The section will then discuss the limitations encountered, and the ethical and security considerations adopted, during the field study.

4.2.1 Participant observation of naturalistic driving

Given the study's focus on context-related research on real experiences, the targeted information aligns with the naturally emerging data which is concentrated in investigations in "real world contexts" according to Ritchie and Lewis (2003, p. 34). They emphasize this approach when the raw data participants provide is either insufficient or requires the researcher's involvement to discern its underlying meanings. Silverman and Marvasti (2008, p. 217) advocate for observation as the apt method to procure such naturally occurring data.

Ritchie and Lewis (2003) underscore participant observation as a research modality wherein the researcher is included in the study population. Angrosino (2016) elucidates the benefits of this approach, noting that the researcher's immersive presence offers a unique vantage point into participants' lives. He delineates further advantages, highlighting that participants often exhibit more authentic behaviors in their everyday practices, even while cognizant of the researcher's presence there.

This method also equips the researcher with an "insider's perspective" invaluable for subsequent phases of the study (p. 38). Furthermore, Angrosino posits that this close familiarity with the research environment enables researchers to formulate nuanced insights throughout the investigation.

In observational studies where the researcher adopts a participant role, diverse engagement types are feasible. Gold (1957) delineates four potential roles: complete observer, observer-as-participant, participant-as-observer, and complete participant. Given the current study's parameters, the role adopted by the researcher is that of an observer-as-participant. As articulated by Baker (2006), in this capacity, the researcher neither remains a passive observer nor undertakes tasks typically reserved for participants. Instead, avenues like interviewing participants are explored. Within the scope of this study, this participatory stance facilitates interactive engagements of the researcher with the real practices by participants ensuring immersion in the authentic context without disrupting their activities.

Participant observation stands as a cornerstone within naturalistic observation methodologies (Angrosino, 2016). Given the dissertation's emphasis on in-car navigation practices, it inherently intersects with the domain of on-road observation studies. Specifically, this research aligns with what Eenink et al. (2014) term as naturalistic driving (ND). They characterize ND studies as the "observation of everyday driving behavior of road users" (p. 1), emphasizing that participants are expected to drive as they typically would in their daily routines. Eby (2011) further supports this, asserting that ND is particularly apt when seeking visually discernible data regarding drivers' actions. Given the focus on drivers' behaviors within their natural contexts, ND emerges as the most fitting methodological choice for this study.

In discussing the presence of researchers within ND studies, it is noteworthy to address certain debates. Eenink et al. (2014) assert that researchers should abstain from direct involvement in ND studies, contending that participants' awareness of being observed could potentially skew their behaviors. However, Angrosino (2016) offers a contrasting perspective, suggesting that participants maintain authenticity even when cognizant of being watched, advocating for the credibility of participant observation as one of the types of naturalistic observation. In light of Angrosino's insights on the benefits of participant observation, the researcher elected to directly engage in the study, specifically as an observer-as-participant as stated above. As a reminder, such participatory engagement provides researchers with an immersive understanding, aligning their perspective more closely with that of the participants. Consequently, for the current research, the principal data collection method was meticulously crafted as a blend of participant observation and ND.

It is pivotal to elucidate the unique positioning of this dissertation concerning prevalent applications of ND to avert potential misconceptions. Primarily, while ND is predominantly employed in studies centered on traffic safety (e.g., Bärgman, 2016; Groenewoud et al., 2010; Porter, 2011), this research diverges from that trajectory. Unlike traditional ND studies focusing on driving behavior, this dissertation pivots towards capturing participants' innate actions and cognitive processes within in-car navigation contexts, specifically with the utilization of navigation technologies. Nonetheless, the methodologies and frameworks inherent to ND studies remain pertinent and aptly aligned with the objectives of this investigation, as detailed in the subsequent parts.

As stated previously, ND serves as a pivotal method within naturalistic observational on-road inquiries. When delving into the methodologies underpinning both broad naturalistic observational on-road studies generally, and the specific realm of ND specifically, certain commonalities emerge. Central to these studies is the imperative for participants to engage in driving tasks within real traffic (Eenink et al., 2014; Klauer et al., 2011), with equipped cars (Blatt et al., 2015) especially with cameras (Bärgman, 2016; Klauer et al., 2011; Welsh et al., 2010) for data recording. Such camera systems, besides capturing drivers' behaviors, may also encompass external perspectives, encapsulating the broader road and traffic milieu (Eenink et al., 2014). Furthermore, details related to route and physical characteristics of the area, for instance, urban/rural character and infrastructural nuances of the roadway (Blatt et al., 2015), are considered in the research design phase. Following parts elucidate the driving tasks and routes undertaken within the scope on-road sessions.

4.2.1.1 Routes

In determining the geographic context for an ND study, Groenewoud et al. (2010, p. 14) present two primary considerations. Firstly, the study's objectives dictate the selection of relevant variables. Secondly, locations must align with the study's prerequisites. To elucidate how driving tasks are delineated according to the requirements of this study, it is beneficial to recall the directed wayfinding classification by Wiener et al. (2009), provided in the preceding chapter. Directed wayfinding can be categorized based on the nature of the search task or the target approximation. In terms of search tasks, there are informed searches in familiar areas, like commuting on a known route, and uninformed searches in unfamiliar territories, such as a firefighter navigating a burning building without prior knowledge. The classification made from the perspective of target approximation distinguishes between situations where the wayfinder either knows the path or not. If the wayfinder knows how to go to the arrival point, the type of wayfinding in question is path following. If they are familiar with the path but unsure about the destination's exact location, it is termed as path planning; if unfamiliar, it is termed as path search.

From above explanations, navigation practices are discerned based on wayfinding tasks they incorporate and the familiarity of the environment. Above classification offers insights into the potential variability in navigation practices on the basis of these parameters. Following the pilot studies conducted at the beginning of the field research, occurrences in which it is possible to implement the wayfinding tasks provided above were documented. Individual, environmental, and technological variables that define occurrences are presented below in Figure 4.1. As inferred from relations shown in the figure, various combinations of the variables determine the diversity of occurrences. To amass comprehensive data, the routes identified in the driving sessions were planned to encompass as much diversity as seen in the figure as possible. Consequently, driving tasks were structured to encompass diverse routes from environments both familiar and unfamiliar to the participants. Moreover, participants were involved in drives along both familiar and unfamiliar routes. Consequently, both informed search and uninformed search settings were established. Within these settings, it was possible to observe participants' performances in path following, path planning, and path search.

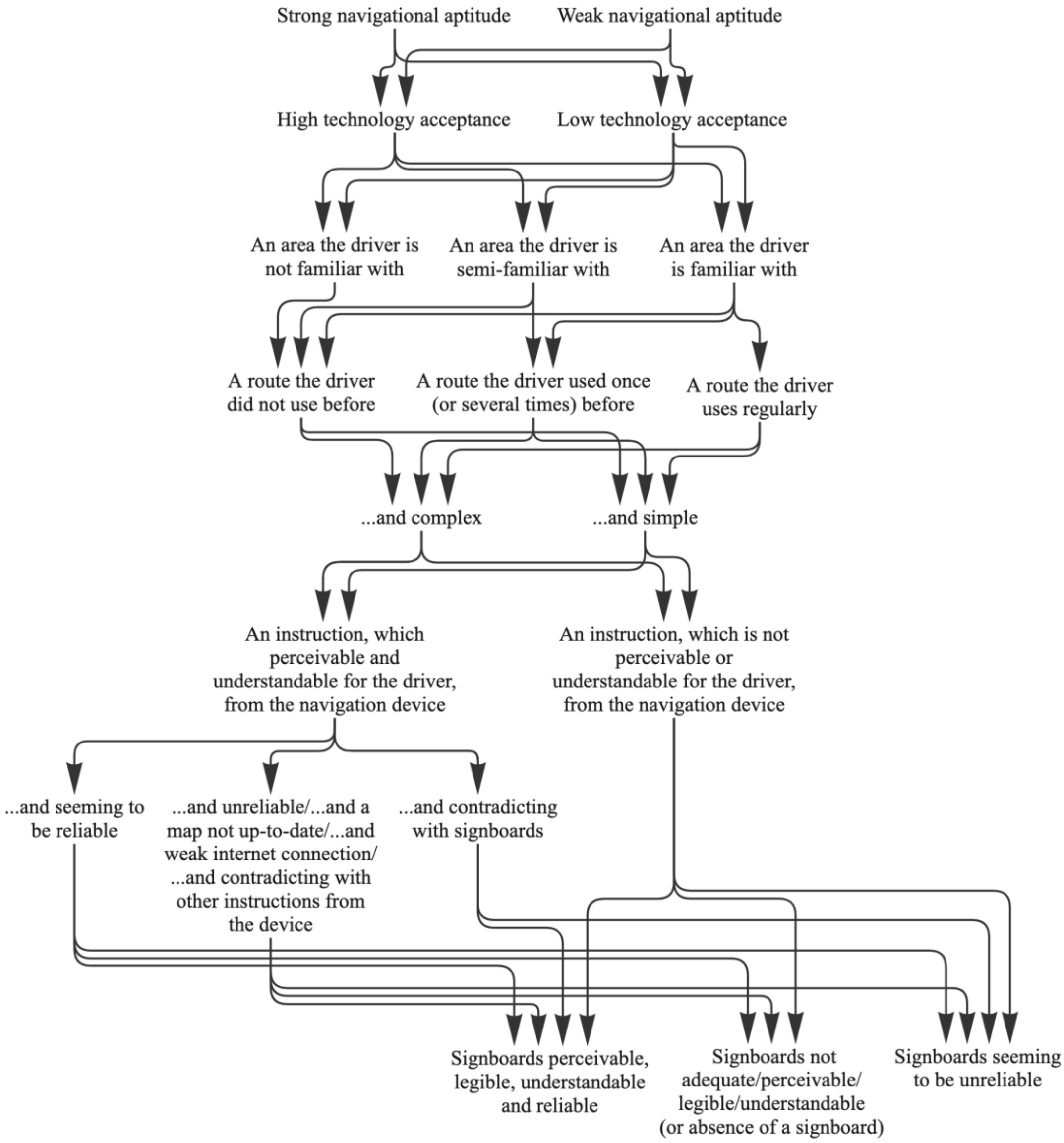

Figure 4.1 The diverse relations between the variables defining occurrences employed in driving sessions

The decision to avoid a singular predetermined route and destination for all driving sessions stems from three rationales beyond the abovementioned purpose of diversifying wayfinding tasks. Firstly, being able to recruit participants unfamiliar with a singular specific location might be almost impossible, necessitating varied points of arrival to accommodate more participants. Secondly, diversifying arrival points facilitates the application of case studies across diverse locales, potentially spanning multiple cities, thus enriching the cultural diversity among sample members. Lastly, offering multiple route alternatives allows for insights into how drivers choose or determine their routes during a trip.

Another reason also underpins the decision not to determine a route for all driving sessions beforehand. This approach is anticipated to enhance the depth of the researcher's experiences. Engaging with diverse routes makes it possible for the researcher to engage in distinct driving practices during each individual driving session, facilitating nuanced post-task assessments tailored to individual scenarios and fostering a more empathetic understanding of participants' perspectives during data evaluation. Given that the methodology prioritizes the quality of experiential depth over quantifiable metrics, the researcher's immersive engagement is deemed invaluable.

The determination of areas, destinations, and routes for each drive was collaboratively undertaken by the participant and the researcher. Central to this collaboration was ascertaining whether drivers possessed prior knowledge of the specified region, destination, and route. In addressing route considerations, urban/rural character of the environment and infrastructure (Blatt et al., 2015) are also significant. Consequently, urban and suburban route combinations were prioritized in driving sessions to ensure variability in factors like traffic density, traffic regulatory norms, navigational signage abundance, and road surface conditions.

Given the absence of predetermined routes, determining or predicting the exact durations of sessions were difficult, leading to an absence of strict time constraints.

However, during the selection of arrival points and routes, feasibility assessments were conducted. It was evaluated before each driving session whether it is possible to perform the driving task and post-task interview, store the digital data collected and analyze it in a reasonable time frame. Consequently, the majority of driving sessions spanned 20-25 minutes. Nevertheless, instances where extended journeys were found beneficial for research insights, drives lasting more were also incorporated. The duration of the longest journey extended to two hours approximately. Journeys that lasted shorter than planned were also included in the study.

4.2.1.2 Think-aloud protocol

As previously articulated, the think-aloud protocol was employed during participant observation of naturalistic driving to elucidate the participants' cognitive processes while navigating. Charters (2003) introduces that within the think-aloud protocol, participants endeavoring to accomplish a task are anticipated to vocalize their internal thought processes spontaneously. In alignment with Charters' explanation, the primary objective of this protocol is the externalization of participants' inner speeches. Following this, it aligns aptly with the objectives of the current research. According to Gibson’s (1997) study, engaging in the study as an observer-as-participant necessitates clarity regarding the recommended level of researcher-participant interaction during the think-aloud protocol. Gibson advocates for minimizing such interactions in these studies. Still, acknowledging that participants might necessitate clarification or guidance, some dialogue is unavoidable, as Gibson acknowledges. Accordingly, it was decided that the researcher would be open to dialogues with participants, while avoiding topics beyond the study's scope, during driving sessions.

According to the literature, the integration of a pre-task orientation enhances the efficacy of the think-aloud protocol (Gibson, 1997). Notably, participants unfamiliar with the protocol may not comprehend its requirements, as posited by Gibson. Thus, a preliminary orientation becomes imperative to familiarize participants with the process. Considered that, a brief pre-task orientation session immediately preceding drives were planned to be conducted. It was also decided that this session would be limited to few minutes since participants may possibly engage in automated thinking if the tasks are repeated (Ericsson & Simon, 1984).

Supplementing the think-aloud protocol with a retrospective analysis augments the reliability of the study (Charters, 2003). Given that participants' verbalizations might lack explicit communicative structure, it may be challenging to understand them for the researcher (Vygotskiĭ, 2012). Charters contends that a retrospective analysis elucidates the outcomes of the think-aloud protocol. As she also claims, it enriches the depth of insights participants offer regarding their cognitive processes. Echoing Gibson's recommendations, POND sessions were planned to be concluded with post-task interviews to pinpoint areas warranting further exploration. Besides being a requirement of think-aloud protocol, since the current study focuses on the details of practices as they are ‘lived’, in depth interviewing as a post-task investigation appears to be a method that can support participant observation.

In relation to the reliability of retrospective studies to support think-aloud protocol, Gibson indicates that such a recall study must be executed after the protocol without spending much time. However, he also suggests taking a short break after the think-aloud protocol for both the researcher and participant since it is a process tiring for them. Consequently, post-task interviews were scheduled immediately following the route task, preceded by a short interlude of which duration were determined at that time according to each participant's requirements. It is also pertinent to mention that these interviews adopted an unstructured format, tailored to each participant's unique think-aloud experience.

As previously highlighted, routes were collaboratively determined with participants. This collaborative ethos extended throughout the driving sessions. Primarily, this fostered the researcher's integration into the navigation practice. Such collaboration provides the researcher with the opportunity to assist the driver both in situations necessitating traffic safety and in instances where the driver personally prefers assistance. Furthermore, this modality empowered the researcher to encourage participants to give real-time data contributions when it was necessary. The tasks carried out by the researcher and participant in a driving session are delineated in Table 4.1.

Table 4.1 Tasks carried out by the researcher and participant during a drive

Researcher	Participant
Assisting the participant in operation of the navigation device in instances where it is necessary for driving safety or when requested by the participant	Operating the navigation device
	Selecting the route from the ones suggested by the navigator
Assisting wayfinding process when it is necessary or requested by the participant	Driving and wayfinding (it was permitted to change the chosen route completely while driving or making wayfinding decisions different than instructions given by the navigation device)
Answering participant's questions, or asking them minor questions to make them talk, as long as it does not seem to have a negative effect on the naturalistic set of driving and navigation performance	Thinking aloud
Operating documentation equipment	
Taking field notes	

4.2.1.3 Sampling

In the current study, experience in driving and familiarity with in-car navigation technologies have been pivotal considerations for recruitment of participants, especially given the nature of the POND sessions. Groenewoud et al. (2010) illustrate, referencing Lansdown's (2002) research, that novice drivers experience a higher cognitive load while driving compared to experienced drivers. Consequently, as they conclude, conducting such studies with experienced drivers is safer. This approach also minimizes potential biases related to driving challenges, as outlined in their study. Hence, individuals who were newly licensed or self-reported inadequate driving skills were found unsuitable for participation in this study. Regarding experience with navigation technologies, candidates merely needed to express comfort in their usage were considered apt for the conduct POND sessions.

Given that a profound comprehension of in-car navigation practices also necessitated revealing the diversity within these practices, the criteria adhered to in participant selection were confined to those mentioned above. While maintaining alignment with the outlined criteria, the study emphasized diversity among participants in various dimensions such as gender, age, educational background, profession, occupation, income level, and more. In the selection of participants, there was also an emphasis on the diversity in the urban/rural character of the environments where participants regularly undertook their journeys.

Another aspect of importance in PONDs was understanding the two extents to which participants engage with their surroundings and the navigation technology during in-car navigation practice. Recognizing the significance of diversity in this regard among observed drivers, a preliminary survey was administered before the driving sessions to gauge participants' tendencies on this matter. The distribution of participants regarding the two extents to which they engage with the environment and navigation technology during in-car navigation was examined based on the survey results. To reveal this distribution, two types of scores of participants were calculated from their responses to survey questions. Each participant was represented in a two-dimensional visualization based on these two types of scores (as will be illustrated in Figure 4.2 later). A sample cohort comprising individuals with their varied inclinations regarding these extents according to the distribution uncovered at the end of the survey was invited to participate in the POND session. In short, participants for the POND sessions were selected based on the survey results. Further details about the survey are provided below.

The survey was structured into four distinct categories of questions: those pertaining to personal information and traffic experience, queries concerning participants' usage patterns and reasons for utilizing in-car navigation technologies, inquiries about their interactions with the surrounding environment and navigation technology during driving, and finally, questions related to contact details.

As previously mentioned, the survey's objective was to shed light to the extents to which users of in-car navigation technologies utilizes their surroundings and navigation technologies during driving. In alignment with this objective, the related group of questions were specifically formulated to address two pivotal parameters: engagement with the information provided by the environment, and engagement with the information provided by the navigation technology. Questions 15-20 focus on the engagement with the information disseminated by the technology, while questions 21-36 center on the engagement with environmental cues. Notably, other questions were excluded from the grading process as they did not directly align with the intended data. To gain insight into participants’ engagement with the environment and navigation technology during driving, decisions were made regarding which cues provided by the environment and technology during a drive the survey must focus on in related questions. These cues to be concentrated on in the survey were determined through two pilot studies conducted beforehand.

Among the variables identified as a result of literature review and pilot studies to diversify driving tasks applied during driving sessions included navigational aptitude and technology acceptance as individual variables. Since this study does not primarily focus on these issues, participants were not tested on them. However, it was expected that the diversity among the participants of driving sessions, which is provided based on survey results, encompass diversity in these matters as well.

The survey encompassed three question formats: multiple-choice, open-ended, and Likert scale questions. Notably, questions associated with participants' engagement with the environment and navigation technology while driving are exclusively framed as Likert scale questions, facilitating a graded assessment of respondents based on their responses. For consistency in the survey and ease of comprehension for the participants, the response options across all graded questions were standardized, allocating points ranging from 0 to 4, as delineated in Table 4.2.

Table 4.2 Grading Likert scale questions

Answers	Grades
Never/Noways	0 point
Rarely/Unlikely	1 point
Sometimes/Maybe	2 points
Often/Most probably	3 points
Always/Certainly	4 points

Given that the maximum score attainable for any individual question is 4, the cumulative scoring for the engagement with the navigation technology amounts to 24 points (6 questions multiplied by 4 points each), while the scoring for the engagement with the environmental information totals 64 points (16 questions multiplied by 4 points each). Finally, a 24x64 unit plane was established to depict the distribution of participants based on these two extents. Below, Figure 4.2 provides an illustrative breakdown of the responses from participants to the survey questions.

It is noteworthy that certain questions within the survey offer participants response options such as "I am not cognizant of my behavior at that time" and "I do not remember those instances." Additionally, participants are afforded the discretion to abstain from responding to specific questions. Responses falling under these aforementioned categories, or those left unaddressed, are categorized as *indecisive responses* for the respective participants. Such responses remain unassessed in the evaluation process. However, if an individual registers only one indecisive response within the questions 15-20, or a maximum of two within the questions 21-36, the remaining answers provided by that participant are evaluated, and their cumulative score is computed based on the total number of graded questions. Conversely, if a participant accrues multiple indecisive responses beyond these thresholds, they are wholly excluded from the evaluation process. This exclusion is predicated on the understanding that an elevated incidence of indecisive responses decreases the reliability of the grading, potentially rendering the participant's overall responses unreliable.

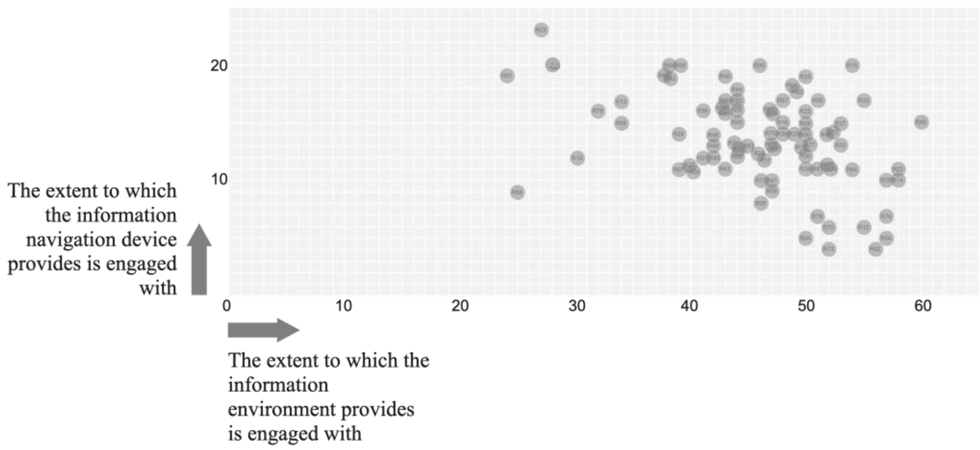

Figure 4.2 Distribution of users in terms of the extents to which they use information the environment and navigation device provide

As depicted in Figure 4.2, there is a variety in the extent to which users utilize information from the environment and navigation technology during in-car navigation. Predominantly, a significant majority of participants actively utilize information from both information providers, as illustrated in Part A in Figure 4.3. However, some users predominantly rely on environmental cues over technological inputs, as represented in Part B. Conversely, there are those who heavily depend on technological information, overshadowing their reliance on environmental cues, as depicted in Part C. Furthermore, as seen in Part D, a subset of users whose answers to the survey shows that they engage minimally with both environmental and technological information.

Considered this data, it can be inferred that users largely correspond to the profile illustrated in, or closely aligned with, Part A in Figure 4.3. However, there are other regions within this distribution where participants are situated. Part B, for instance, represents a cluster predominantly consisting of users who adhere more, during in-car navigation, to information they obtain from the environment and utilize the information they obtain from the navigation device less in comparison to other users. Conversely, Part C, contrasting with the usage patter that Part B refers to, encompasses participants who rely more on the navigation device that the environment. Part D encompasses the ones who relatively utilize information from both the environment and navigation device to a lesser extent according to survey results.

For the participants who utilize the environment and technology to varying degrees in in-car navigation, engagements they establish with these two during the practice also varies. This perspective relies on the notion that individual differences in the manner of interacting with the environment and navigation technology constitute factors shaping experiential context of a navigation practice. Based on this idea, participants for the POND sessions were selected from all four parts shown in Figure 4.3 to represent this diversity.

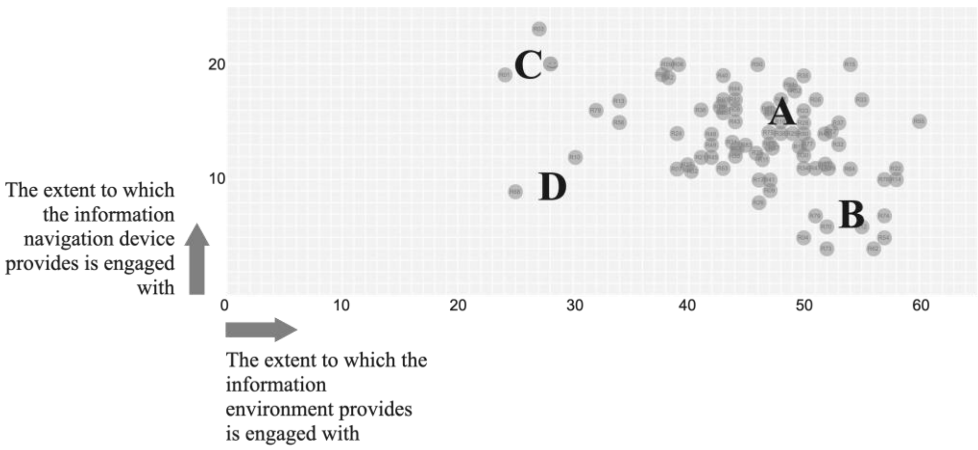

Figure 4.3 Segmentation of the distribution among the participants of the survey

As outlined in this section, POND consisted fundamentally of two phases. One was the survey phase aimed at identifying participants for driving sessions, and the other was phase where driving sessions took place. Table 4.3 illustrates the methods used in these phases. Additionally, as indicated earlier, the study also employed autoethnography alongside POND. Elaboration on this method will be provided in the following section.

Table 4.3 Methods employed for POND

	Methods	
Phase I: Pilot studies	Two sessions of POND	2 participants
Phase II: Participant recruitment for driving sessions	Survey	83 participants
Phase III: Driving sessions of POND	Before the drives: Pre-task orientation	14 participants
	During the drives: Think-aloud protocol	
	After the drives: Post-task interview	

4.2.2 Autoethnography

Autoethnography is a form of autobiographical writing and qualitative research designed to delve into an individual's distinctive life experiences within the context of social and cultural institutions (Custer, 2014). Qualitative research, as defined by Adams et al. (2015), centers on human intentions, motivations, emotions, and actions, prioritizing an exploration of these aspects over the generation of demographic data and general descriptions of interactions. According to Adams et al. autoethnography represents a qualitative approach providing nuanced, intricate, and specific insights into individual lives, experiences, and relationships, instead of offering generalized information about larger population groups.

Adams et al. (2015) characterize autoethnographic narratives as both artistic and analytical demonstrations of how individuals come to understand, label, and interpret personal and cultural experiences. The researchers posit that autoethnography enables the use of personal experiences to engage with oneself, others, cultures, politics, and social research. Similarly, Custer (2014) emphasizes that autoethnography is inherently subjective, contributing to self-awareness of the researcher/writer and honoring their capacity to affect the surrounding world.

Sikes (2022) elucidate the focus of autoethnography on first-personal experiences, describing it as an existential practice where engaging in it is also being. This is because it serves as a practice that allows for an exploration of the complexities involved in the experience of being within specific contextualized situations. Such exploration may lead to altered comprehensions and perceptions, impacting the way we are in the world to varying degrees.

When considering the philosophical traditions that constitute the theoretical framework of this study, it is observed that autoethnography shares commonalities with them in terms of focusing on understanding and interpreting the individual's experience.

Phenomenology, in particular, is recognized as a methodology centered on comprehending an individual's relationship with the world. It emphasizes the perspective of the human to describe, depict, and understand experiences. On the other hand, autoethnography involves the examination of the researcher's own experiences and the process of interpreting these experiences. The integration of these approaches in a research study allows the researcher to consider their own experiences as a phenomenon and relate them to the experiences of other participants. Therefore, combining phenomenology and autoethnography contributes to providing a profound and subjective understanding.

In essence, the inclusion of autoethnographic methods in research driven by phenomenological inquiries creates a space to explore participants' experiences from a first-person perspective and to understand and interpret them. By incorporating the researcher's own experiences into the research process, insights into the participant's world can be gained. This approach can offer a rich understanding of both general phenomena and how individuals experience these phenomena. Based on this rationale, autoethnography is included in the research design in addition to the other methods discussed in this chapter.

Adams et al. (2015) outline the key priorities of autoethnographers, emphasizing, first, foregrounding of personal experience in both research and writing. Second, according to them, autoethnographers also contribute to the sense-making process by offering perspectives that others can use to comprehend similar experiences. Additionally, the researchers highlight the importance of reflexivity in autoethnography, involving a critical examination of one's experiences, identities, and relationships to understand their impact on the ongoing research. As they also report, autoethnographers provide insider knowledge of cultural phenomena and experiences, offering descriptions and critiques of cultural norms, experiences and practices. The researchers additionally note about the priorities of autoethnographers that they aim for reciprocal responses from diverse audiences.

Based on this information, the researcher conducted driving sessions under conditions presented to the participants. Variables such as starting points and destinations of journeys, routes, durations etc. were not structured, and environmental familiarity was not considered, mirroring the richness inherent in the driving sessions performed by participants. The reason for this approach is to ensure that the driving sessions conducted by the researcher encompass the same diversity present in the participants' sessions. Additionally, some of these drives were undertaken with one or more passengers accompanying the journey. The primary purpose was to obtain observations and comments about the researcher's driving experience from individuals who witnessed the drive. These individuals, often selected from the participants who were partially immersed in the research. This choice was driven by the thought that these individuals could reflect their knowledge related to the research in their comments on the researcher's driving experiences. Another reason for conducting some of the autoethnographic drives with accompanying passengers was to adhere to a naturalistic approach, staying true to the organic organization of each journey (for instance, abiding by the decision, which made independently of the research, to have several people in the car during a trip to a vacation organized among friends).

In summary, the fieldwork of the research comprised POND and autoethnographic driving sessions. Samples of the POND sessions were selected from among the participants of the relevant survey. Among the 83 individuals who participated in the survey, 14 took part in the POND sessions. A total of 22 drives were conducted with these participants. The researcher also performed four drives within the scope of autoethnographic study. In total, 15 drivers, including the researcher, completed 26 driving sessions. As previously stated, the research underscored the importance of diversity among participants in multiple aspects including gender, age, educational history, profession, occupation and so on. When selecting participants, there was also a focus on ensuring diversity in the urban or rural nature of the environments where participants routinely engaged in their in-car navigation activities. The relevant demographic characteristics of the drivers participated in the study are provided in the Table 4.4. Subsequently, Table 4.5 represents information related to the drives.

Table 4.4 Demographic characteristics of drivers involved in driving sessions

Driver	The related group in Figure 4.2	Sex	Age	Level of education	Occupation	Place of residence
Researcher	C	F	32	Master's degree	Research assistant	Urban
P1	A	F	33	Master's degree	Designer	Urban
P2	A	M	37	Bachelor's degree	Lawyer	Urban
P3	C	M	36	Master's degree	Software developer	Urban
P4	A	F	30	Master's degree	Pharmacist	Urban
P5	D	F	38	High school degree	Hairdresser	Rural
P6	A	M	25	Bachelor's degree	Civil engineer	Rural
P7	A	M	21	High school graduate	Undergraduate student	Rural
P8	B	F	58	High school graduate	Retired nurse	Urban
P9	A	M	65	Doctoral degree	Medical doctor	Urban
P10	D	F	45	Less than high school degree	Stay-at-home parent	Rural
P11	B	M	27	Master's degree	Software developer	Urban
P12	B	M	45	Doctoral degree	Scholar	Urban
P13	C	F	30	Master's degree	Architect	Urban
P 14	A	M	41	Bachelor's degree	Lawyer	Urban

Table 4.5 Overview of driving sessions

Driving session	Driver	Passengers in the car		Familiarity of the route		Familiarity of the destination		Approximate duration
		Absent	Present	Familiar	Unfamiliar	Familiar	Unfamiliar	
1	Researcher	X		X		X		1 h and 45 mins
2	Researcher	X		X		X		1 h and 55 mins
3	Researcher		X		X		X	20 mins
4	Researcher		X		X		X	15 mins
5	P1	X		X			X	15 mins
6	P2	X			X		X	20 mins
7	P2	X		X		X		20 mins
8	P2		X		X		X	30 mins
9	P3	X		X			X	35 mins
10	P3	X			X		X	30 mins
11	P4		X		X	X		30 mins
12	P4		X	X		X		25 mins
13	P5	X			X		X	45 mins
14	P5	X			X	X		20 mins
15	P6	X			X	X		15 mins
16	P6		X	X		X		25 mins
17	P7	X		X			X	30 mins
18	P7	X		X		X		25 mins
19	P7	X			X		X	1 h and 10 mins
20	P8	X		X		X		20 mins
21	P9		X		X		X	25 mins
22	P10	X			X		X	20 mins
23	P11	X		X		X		20 mins
24	P12	X			X		X	20 mins
25	P13	X			X		X	30 mins
26	P14	X	X		X			1 h

4.2.3 Documentation

During POND sessions, documentation methods employed included video recording, which is a prevalent technique in ND studies (Groenewoud et al., 2010; Welsh et al., 2010), alongside note-taking. For driving sessions, a digital program that provides three synchronized audio-visual recordings was developed.[2] The program captured the driver, the road view, and the screen display from the navigation device as shown in Figure 4.4[3]. This implementation afforded the researcher insights into participants' visual perceptions in both actual and screen views, as well as their behavioral responses, even in the instances where they refrained from verbalizing their actions.

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[2] The application was developed in Python, primarily using PyQt, pyAudio, OpenCV, and Pillow for the GUI, audio recording, video recording, and image processing, respectively. Screenshots from an Android device (Samsung S8 in the research setup) were acquired at 1 frame per second via a shell command through the Android Debug Bridge. Multiplexing of the merged video streams to match the audio recording was achieved using the FFMpeg library. The code is available in https://github.com/FeritBuyukkececi/MultiStreamManager

[3] The screenshot was captured during the pilot study conducted with Ferit Büyükkeçeci, the developer of the software designed for documentation, to test it. His consent has been obtained for the sharing of this image.

Figure 4.4 A screenshot from one of the pilot studies

The utilization of the program necessitated the integration of various devices during the driving sessions. The primary instruments encompassed two web cameras—one oriented towards the driver and the other towards the road—as well as a navigator display, and a laptop. Additionally, auxiliary tools were incorporated to ensure data and power transmission, and facilitate the attachment of primary devices in the car. These secondary tools included a USB multiplier, a mini-USB connector, and holders compatible for the cameras and navigator, adaptable for in-car usage.

In instances where participants of the POND sessions might not feel comfortable being recorded, video capture was abstained from during drives. In the vast majority of drives, even if video recording was not applied, audio recordings were consistently obtained. However, during extended driving sessions, video and audio recordings were intermittently disrupted due to constraints associated with digital storage capacities. In such cases, the documentation proceeded through field notes.

During post-task interviews following POND sessions, participants' driving and navigation experiences were meticulously investigated. Consistent with prior recommendations, each post-task interview was promptly conducted after the respective driving session, likely following a transition to a suitable location conducive to interview conditions from the destination journey. Interviews were both audio-recorded and documented through field notes.

Since it was not deemed appropriate for the researcher to handle video recording equipment while driving herself, only audio recordings were made during the autoethnographic driving sessions. Field study notes related to those sessions were taken by the researcher immediately after the drives.

4.2.4 Analysis

As to the data analysis, Eby (2011) identifies three categories of variables inherent in naturalistic observation studies that researchers must contend with. As delineated by Eby, the first category comprises descriptive variables, necessitating researchers to make interpretations. An example from Eby's research is the examination of whether participant drivers utilized their seat belts. The second category encompasses inferential variables, from which researchers derive inferences. The third category, evaluative variables, demands both inferences and judgments from researchers, such as assessing whether non-use of a seat belt constitutes risky behavior.

During the coding and analysis phases in this study, videos were scrutinized, and conversations recorded during drives and interviews were transcribed, as a method underscored by Silverman and Marvasti (2008). Thematic analysis was employed to examine the data. The data was segmented into thematic categories based on drivers' preferences and tendencies concerning the utilization of wayfinding devices and environmental information, the decision-making processes behind wayfinding, situations encountered both before and during drives, drivers' behavioral and emotional reactions to those situations, and their perspectives regarding these reactions and opinions. Drawing from Eby’s definitions, these categories align with descriptive variables. The underlying reasons for these behaviors, which can be categorized as inferential variables, were also integrated into the coding process. Consequently, it can be asserted that the data was examined through both descriptive and inferential lenses.

It is pertinent to highlight that the case studies yielded a substantial volume of visual and verbal data, which, as noted by Groenewoud et al. (2010), presents challenges in comprehensive analysis. To address this issue, they advocate for the identification of specific video fragments containing pertinent information, thereby optimizing the analysis duration. Consequently, a data reduction approach, wherein the researcher discern areas of focus within the raw data as outlined by Miles and Huberman (1994), was employed in the current research. To elaborate, initial data from the first few drives and interviews were analyzed holistically without any data reduction to ensure a comprehensive perspective. However, as recurring patterns in the derived codes emerged, subsequent data from following drives and interviews were analyzed in alignment with these codes. This systematic approach expedited the analysis of each drive and interview, offering the researcher the flexibility to expand the number and duration of POND sessions.

Coding in the analysis process was conducted in three stages. The first stage, which is carried out immediately after the transcription of speeches, involved an analysis aimed at developing a general overview about in-car navigation. The second stage focused on the convergence of information providers during their practical activities. This stage addressed the matches of information providers that result in wayfinding decisions and locomotion. The third stage aimed at analyzing how navigational tasks are distributed among agents in their matches.

4.2.4.1 The first stage of coding

In the first stage of coding, the transcribed texts were examined comprehensively but not in-depth. The coding conducted was shallow and focused on what the conversations were about. Therefore, it can be said that this stage served a descriptive purpose. The codes that emerged in this stage are listed below.

- Driver-environment engagement
  - Being interested in details
  - Complexity of the environment
  - The use of environmental information
    - The use of wayfinding boards
      - Misleading boards
      - Inefficiency of wayfinding boards
    - The use of landmarks
    - The use of other references
    - Scanning the real view
      - Capability of perceiving details
      - Need for more precision
    - Driving behavior influenced by the information from the environment
  - Inaccessibility of environmental information
  - Inexistence of environmental information
  - Perceived environment
  - Dependence of the information coming from the environment
    - Trust
    - Mistrust
    - Navigational aptitude
- Driver-navigation technology engagement
  - The use of the device before the drive
    - Route selection before the drive (RSBD)

- Considerations about the routes during (RSBD)
- Failure in search during (RSBD)
- Studying on the selected route during (RSBD)

▪ Physical engagement

- Placing the device in the holder (or somewhere else)
- Checking the device's battery level

o The use of the navigation device during driving

▪ Tracking instructions

▪ Manipulation of the instructions

▪ Need for more precision

▪ Failure of the navigation technology

- Inexistence of wayfinding instructions
- Inaccessibility of wayfinding instructions
- Deficiency of wayfinding instructions

▪ Reorientation of the navigation technology

▪ Route selection during the drive (RSDD)

- Considerations about the routes during (RSDD)
- Failure in search during (RSDD)
- Studying on the routes during (RSDD)

▪ Physical engagement

- The device obstructing the operation of the car's components
- The device falling from where it is fixed
- The device running out of battery
- The screen unreadable due to sunlight

o Driving behavior influenced by the instructions

▪ Lane selection

▪ Frequency of checking the device's screen

▪ Adjusting instantaneous speed

After the notifications about turns and corners

After the notifications about lane changing

After the notifications about traffic congestion

        - Adjusting average speed
    - Dependence on the instructions
        - Trust
        - Mistrust
        - Navigational aptitude
        - Technology aptitude
- Affections
    - Emotional expressions
    - Emotions
- Driver-navigation technology-environment engagement
    - Retrieving information from the mind
    - Evaluation of information coming from the information providers
    - Derivation of new information
- Other driving related issues
    - Social factors
    - Operation of the car
        - Consideration of fuel level
    - Driving safety
        - Failure in driving safety
        - Insecure situations
    - Comfort and enjoyment
        - Seating comfort
        - In-car temperature
        - Music
        - Small talk

The first stage of coding primarily aimed to comprehend the navigation practice in broad strokes and to identify the agents participating in the practice. This stage facilitated framing the agents involved in in-car navigation practice as information providers. More specifically, the information sources provided by agents during practice were identified by the end of this stage. The related findings will be presented in Chapter 5, in the section 5.1 Definitive Frame of the Agents as Information Providers.

Additionally, during this stage, examples were provided on what kind of relationships between the driver and navigation technology could be established by examining drivers' behaviors and statements during drive and interviews. Based on these relationships, various roles of navigation technology during in-car navigation were defined. It was determined which of the three information providers were used in each of various situations. It was determined which of the three information providers were utilized in various situations and why alterations in this usage occured. Among the reasons for this change, those dependent on the driver's preference and those not dependent on it were identified. Moreover, instances when the driver acted unaware of the environment began to be uncovered during this stage. These insights formed the groundwork for the second and third stages of coding. In other words, they were not directly used to reach research findings but rather to deepen the analysis. Therefore, the sections presenting the findings encompass the results of the subsequent stages of coding rather than these insights. The contribution of the second and third stages to the research findings is given below.

4.2.4.2 The second stage of coding

The second stage of coding involved a more in-depth coding process compared to the first stage. Its objective was to elucidate the relationships among the codes extracted in the initial stage, which are of particular interest in this study. The codes extracted in this stage are *matches* and *bases of wayfinding decisions* and *bases of locomotion.*

The codes associated with matches include *compatible matches*, *conflicting matches*, and *lack of matches*. Compatible matches represent moments where information providers give corroborating or complementary information during practice, while conflicting matches represent moment where they provide contradicting information. During this stage, it was found that sometimes all three information providers were involved in these matches, while in other cases, one or two of were not. Moments where one or two of the information providers were not participate to navigation were coded as lack of matches. It was determined that these situations stemmed from the non-provision of relevant information by those information providers or the inaccessibility of the information they provided. These situations were also coded as *inexistence of information* or *inaccessibility of information.*

The code bases of wayfinding decisions consists of two separate codes as *active information provider* and *reasons*. The first one was used to code speeches indicating the information providers utilized at specific moments of decision making. The second one, reasons, was used to analyze what factors influenced each decision. As a result of this analysis, these reasons were categorized into *preference*s, *trust*, *capabilities*, *awareness*, and *lack of matches*.

Bases of locomotion contains three categories of codes. The first one, *consistence with the wayfinding decision*, was used to code situations where locomotion is performed in line with a wayfinding decision, indicating that the movement is correct according to the decision. The second one, *inconsistence with the wayfinding decision,* was used to code situations where a locomotion is performed erroneously in contradiction to a wayfinding decision. *Absence of a wayfinding decision* was used to code moments of unaware movements where locomotion is performed without a wayfinding decision. Upon examining the situations encoded with this code, it was founded that locomotion performed without wayfinding decisions are divided into two categories. It was understood that some of these movements are prompted by a movement in the environment, while others are prompted by the knowledge that is already possessed by the driver. Therefore, these two types of situations were coded separately as *environment-induced movement* and *self-induced movement*.

The codes extracted during this stage are listed below.

- Matches
    - Compatible matches
    - Conflicting matches
    - Lack of matches
        - Inexistence of information
        - Inaccessibility of information
- Bases of wayfinding decisions
    - Active information provider
    - Reasons
        - Preferences
        - Trust
        - Capabilities
        - Awareness
        - Lack of matches
- Bases of locomotion
    - Consistence with the wayfinding decision
    - Inconsistence with the wayfinding decision
    - Absence of a wayfinding decision
        - Environment-induced movement
        - Self-induced movement

The findings shed by this stage have particularly facilitated the delineation of navigation practice in Chapter 5. The definition of practice as the convergence of the three information providers is primarily a result of this stage. Examples of the participation of the three information providers in the practice have also emerged at this stage. Other outcomes of this process include the participation of information sources provided by the information providers in the practice, and how they are experienced, which is presented and discussed in Chapter 6.

4.2.4.3 The third stage of coding

The third stage of coding shed light on the shared agency during wayfinding-related decision-making, and locomotion. Coding was conducted in this stage particularly to analyze which information provider had a greater share in the wayfinding decisiona at certain types of moments. This stage also considered where locomotions were carried out without a wayfinding decision. Additionally, codes were established at this stage to determine the driver's initiative regarding the contribution of each information provider to navigation. The analysis conducted in this stage was based on two main codes: *contribution* and *initiative*. Details regarding these codes are provided below.

Three distinct codes were derived from the code contribution. These are *non-participation in the match*, *participation in the match and decision*, and *participation in the match but not in the decision*. Instances marked with the code non-participation in the match represent situations where an information provider does not provide information at a given moment, or the information it provides is not perceived, or it is inaccessible. The code participation in the match and decision pertains to cases where the information provided by an information provider is used in making wayfinding decisions, regardless of the correctness of the information or decision. Here, the focus is on the involvement of the information provider in both the match and the decision. The code participation in the match but not in the decision identifies situations where an information provider provides information for wayfinding decisions, but the information is not used in making the decision despite the driver being aware of it.

The code contribution provided an analysis of agency shared among information providers. However, during the analysis, it was noted that shared agency could be discussed not only in the respect of the contribution of agents but also in respect of their initiative. Therefore, this analysis also addressed the levels of driver's initiative concerning the extent to which they play a role in navigational tasks. From this point of view, the code initiative was divided into the following codes: *inability to* *participate in decisions*, *compelled participation in decisions*, *preference not to participate in decisions*, *preference to participate in decisions*, and *acting unconsciously.*

The code inability to participate in decisions applies to situations where, for example, the driver lacks knowledge of the route or exhibits weak navigational aptitude. In such circumstances, the enivronment and/or navigation technology exert greater influence on decisions than by the driver. In these instances, being compelled to defer to decisions lies outside the driver's initiative. The code compelled participation in decisions designates moments when information providers other than the driver are unable to contribute to decision-making. These are moments when the driver is left to find their own way in the absence of, for example, wayfinding signboards and non-functioning navigation technology. The code preferably not to participate in decisions denotes situations where the driver has the capacity to influence wayfinding decisions, for instance, when they partially or completely know the route but choose not to exercise their authority. Lack of self-confidence may be cited as an example of the reasons for such situations. In these instances, the driver refrains from actively participating in wayfinding decisions; however, by choosing non-participation, they still play a role in practice as the ones who make a choice. Preference to participate in decisions implies that the driver engages in decision-making both by actively participating and by exercising the option not to participate. For instance, reliable information may be provided by the environment and/or navigation technology at a given moment, yet the driver, perhaps due to overconfidence, may choose to disregard such information and make wayfinding decisions independently. The code acting unconsciously refers to instances where there is no wayfinding decision, and the driver moves without a decision. This code encompasses situations where the driver unawarely moves either in accordance or in discordance with the route.

Below is the list of codes used in the third stage of analysis.

- Contribution

    - Non-participation in the match
    - Participation in the match and decision
    - Participation in the match but not in the decision
- Initiative
    - Inability to participate in decisions
    - Compelled participation in decisions
    - Preference not to participate in decisions
    - Preference to participate in decisions
    - Acting unconsciously

The outcomes of the third stage of coding particularly underpin the discussions outlined in Chapter 6. It can generally be stated that the second and third stages have facilitated an understanding of how information exchange among information providers occurred in the processes of wayfinding-related decision-making and locomotion. These findings have formed the basis for the discussion on how boundaries among information providers evolved during navigation practice in Chapter 6.

4.2.5 Limitations

In the context of the aforementioned research, several potential limitations emerged. These encompassed challenges related to sample size, the availability of technologies suited to the study's demands, and the reliability of the acquired information.

The limitation pertaining to sample size primarily stemmed from the fact that the driving sessions, when coupled with subsequent interviews, extended for a minimum of two hours—a duration demanding substantial commitment from participants. Recruiting participants willing to allocate such a timeframe posed significant challenges. The requirement for participants to be physically present in the research environment further complicated the task of identifying potential participants willing to allocate the necessary time for the study. Nonetheless, individuals with interests in driving, traveling, and technological systems exhibited readiness to engage. leading to the predominant involvement of such participants in the POND sessions. Thus, the PONDs were predominantly conducted with individuals possessing such characteristics.

For ND studies, the requisite for superior video recording equipment, encompassing aspects like frame rate and zoom capabilities, presents potential financial impediments (Welsh et al., 2010). However, for the feasibility of the case studies, there were other criteria for the selection of devices to use during documentation. Devices needed to be car-compatible for using and charging, resilient to vibrations during drives, and capable to store the huge amount of data. Such stringent criteria narrowed down the available device options. Another challenge was that some specific devices, which had been found suitable for the study, imposed restrictions on data transfer for security considerations. Consequently, devices used were characterized by extended battery life and rechargeability in the car, high capacity of data transfer, and suitability for in-car deployment in terms of their physical dimensions. As a result of these decisions, compromises were made in terms of video quality. However, the attained visual quality was sufficient to meet the requirements of such a study. The audio clarity was also adept at capturing participants' vocalizations, including even their murmurs and whispers. Hence, the achieved video quality sufficed for the study's objectives as well.

Regarding the think-aloud protocol, potential limitations were anticipated prior to the conduct of POND sessions. One concern revolved around the possibility of participants discontinuing verbalization during the drives. Another pertained to the extent of participants' externalizations concerning their inner dialogues. Participants might verbalize only what they notice, as theorized by Ericsson and Simon (1984). Furthermore, the articulation of inner thoughts could potentially oversimplify them (Vygotskiĭ, 2012), potentially masking the intricacies of participants' inner processes. Additionally, participants' expressions could be incomprehensible to the researcher as suggested by Vygotskiĭ. Despite these reservations, which cast shadows on the reliability of the study, participants demonstrated a pronounced inclination to communicate and provide insights during drives. Hence, it can be posited that such limitations did not significantly undermine the study's reliability.

4.2.6 Ethical and Security Considerations

The primary ethical and security consideration of the study revolved around driving safety. As previously indicated, individuals perceived as inexperienced drivers were excluded from the sample to prioritize safety. Peak traffic periods were similarly avoided while scheduling drives with this safety-centric approach. Given the influence of weather conditions on driving safety, PONDs were performed on days characterized by clear or partly cloudy skies.

Consistent with the recommendations of Banks et al. (2018) for ND researchers, participants were initially briefed on the paramount importance of safe driving for the research at the beginning of drives. Each participant was informed that they could halt the driving session at any moment if they needed.

Regarding safety protocols during PONDs, participants were permitted to handle the navigator themselves, provided it did not jeopardize safety, given the use of a navigator during driving is already a widely accepted routine. However, as mentioned earlier, the researcher intervened to assist participants in the operation of the navigator when deemed necessary or upon participants' request.

4.3 Summary

Below is a brief summary of this chapter.

- During the review of studies examining human-technology-world relations, a gap related to mediation by navigation technologies was noted. As an extension of this gap in the literature, there is also a scarcity of studies defining the experience in the use of in-car navigation technologies.

- The study aims to reveal diverse types of engagements among the driver, navigation technology, and the environment, drawing from their information exchange during navigation practice. Accordingly, it seeks to uncover how roles and responsibilities are allocated among them, how they engage with each other, and the circumstances under which shifts in their engagements occur.
- To achieve the objectives of the research, POND and autoethnography were employed in the field research. Additionally, the conduct of POND was complemented by a survey, pre-task orientation sessions, think-aloud protocols, and post-task interviews.

The findings obtained from the field research have been compiled into two chapters. The following two chapters will present these findings. Chapter 5 will discuss how three information providers come together during navigation practice, based on the analysis of observations. Chapter 6, on the other hand, will examine how the convergence of information providers is experienced and how the boundaries between them change during these occurrences.

CHAPTER 5

CONVERGENCE OF THE THREE AGENTS DURING IN-CAR NAVIGATION

This chapter focuses on the information contributed to derivation of navigational information during in-car navigation. It first uncovers the information provided during the practice by the environment, navigation device, and driver. Following that, it defines the concept of navigational information before elaborating the nature of the practice. Then, it pictures this nature, specifically the derivation of navigational information by the converged environment, navigation device, and driver. Additionally, it provides insights into the instances where the support from any of these three for the practice may diminish.

5.1 Definitive Frame of the Agents as Information Providers

Based on the section 3.4 Agents as Information Providers, the drivers participated in the study, navigation devices they used and their environment during driving sessions will be considered as information providers in their navigation processes in this chapter. Consequently, one of the outcomes of the chapter is framing these three agents as information providers. This section aims to introduce them by presenting their frameworks as information providers. For this purpose, it will introduce the *information sets* they presents.

5.1.1 Environment as an information provider

The comprehensive array of information offered by the environment encompasses various information sets. These sets comprise *road network*, *three-dimensional* *elements, traffic, wayfinding instructions (by the environment)*, *ambient conditions*, and *companions*.

Road network is a fundamental information set consisting of roads, turnouts, intersections, squares, pots and lands. Roads provide geographical connections between locations. In untouched areas, there may not be a road, not even a small path. There, one can travel from one point to another along random straight or curved lines connecting these two points. However, in built environments, moving from one place to another requires experiencing the road network.

The category of three-dimensional elements pertains to both large-scale and small-scale three-dimensional elements in the environment. For example, architectural elements including buildings, tunnels, bridges, viaducts, and statues are human-made three-dimensional elements. Other examples of human-made three-dimensional elements in the environment are streetlights, garbage containers and rubbish bins, advertising boards, wayfinding signboards, caution signboards, traffic lamps, traffic calming measures like speed bumps and humps, guardrails, concrete barriers, bollards, jersey barriers, traffic barriers and the like. The category of human-made three-dimensional elements additionally includes decorative elements such as suspended or freestanding ornaments or lighting fixtures. Besides, plants, rocks, stones and so on are natural elements included in this information set. Finally, it should be clarified that this information set involves all moving and non-moving masses in the environment. This means that, for instance, vehicles, a ball that rolled onto the road, and even the humans and animals are also included in this category.

Traffic covers both moving and non-moving vehicles and pedestrian. It also encompasses traffic management elements that includes a wide range of elements from traffic signs and signals to wayfinding signboards and traffic calming measures such as speed bumps, guardrails, barriers, cones and the like. Most of the traffic management elements, together with vehicles and pedestrian, are included in the information set three-dimensional elements as well. In addition to this, there are traffic management elements which are not three-dimensional, such as road markings as traffic calming measures. There are also auditory traffic calming measures such as voice messages given in tunnels. Furthermore, traffic is a social medium that conveys messages from other individuals outside the car to the driver. For example, hazard lights, brake lights etc. provide non-verbal information exchanges among drivers. As well, drivers in close proximity can communicate through gestures. Taken all together, it can be summarized that traffic is an information set including vehicles and pedestrian, traffic management elements and a social setting.

Wayfinding instructions (by the environment), as an information set, includes wayfinding signboards, directional road markings, directional voice messages given in tunnels and the like. These are also constituents of traffic, which is another information set. Wayfinding signboards additionally fall under the category of three-dimensional elements as another information set.

The information set ambient conditions encompasses local environmental factors such as topography, weather conditions, and other elements that determine aesthetic and kinesthetic sensory characteristics of the surrounding. Other elements that determine aesthetic and kinesthetic sensory characteristics of the surrounding refer to sound, odor, enlightenment, road texture that is shaped by ramps, slopes, potholes, bumps, pavement quality and slipperiness, and path shapes that is determined by straightness or curvature of the road, as well as descents and inclines.

Companions, as another information set, refer to all individuals with whom the driver engages during a particulat period of time in navigation practice. This set includes passengers inside the car, ones on the phone, a passerby to whom the driver mas ask for directions. Pets present in the car during the drive can also be taken as part of this category. The driver can receive oral and gestural information from companions. The pieces of oral and gestural information may be received for navigational purposes. This information set may additionally involve information taken for purposes not related to navigation. These could be, for instance, engaging in a conversation on another topic.

5.1.2 Navigation device as an information provider

During driving, the navigation device participates in the navigation practice with the following information sets: *dynamic abstracted view*, *texts*, *digital buttons*, *notifications*, and, in some cases, *material existence*. The dynamic abstracted view suggests the abstraction of the environment as a map view and the representation of the driver on the map. The route is marked on the map along the roads displayed. Roads not included in the route may also be visible on the map depending on the level of abstraction. As to the roads with traffic congestion on the route, they are marked on the map. It is also possible to capture the map partially and entirely both before and during the journey. Texts, as another information set, includes names of roads and places, numbers and arrows. Names of roads and places are, first, the names of the streets and avenues that the driver currently is on and will turn to. Additionally, depending on the chosen map type, the names of the other roads and some other places in the vicinity can also be displayed on the map. Numbers present current time, the remaining time and distance to the destination, the speed of the car, and the distance to the location where the next navigational action will be taken. Arrows specify the directions of the navigational actions. They are placed both at the points of the map where the actions will be taken and in the areas outside the map on the screen. As another information set, digital buttons refer to the digital keypad on the device. Notifications are pop-up visual and auditory messages related to the wayfinding instructions (by the device) and alternative route suggestions. Material existence of the device refers to its mass presence, which encompass its casing, and, if present, buttons, electronic components, and the like. Whereas some navigation technologies have a material existence, it is not a uniform information set offered by all navigation technologies. If the device is embedded in the car, it cannot be considered as an independent material.

Regarding the information sets provided by the navigation device, it is important to note that all of them are visual, while notifications are messages given both visually and auditorily. Another important point to be reminded of at this juncture is that the driver can disable certain types of information according to their preferences. For example, they can turn voice messages off or increase the abstraction level of the map. In doing so, the relevant pieces of information do not participate in the practice.

It should also be indicated here that navigation technology is not the only technology that is used in in-car navigation. The car is the first of these technologies. It participates in the practice with, primarily, its mechanical operation and the dashboard. Pieces of information coming from the mechanical operation can be exemplified as engine sound, vibration etc. Even an occasional odor emanating from the mechanical components serves as an example of such information. Dashboard information involves related to speed, time, distance traveled, and current active functions. It also serves as a system to alert the driver with pieces of information such as speed limit excess, low fuel levels, or a malfunction. Furthermore, the car provides the driver with information on various aspects such as road grip, roadway noise, seatback angle and even firmness of the seats. All these pieces of information participate to the practice of in-car navigation.

A car and navigation device are, of course, essential technological tools in the practice of in-car navigation. Other technologies that may be utilized during this practice may include phone (even though it is not used for navigation), radio, dash camera etc. With these technologies, one can listen to a radio broadcast that includes music or conversation, engage in a phone conversation, access an alternative vision of road view and so on. The information received through such technologies also participate in the practice in question. Even the alarm that driver's watch sounds, or the texture of its watchband, are pieces of information to the practice. These technologies appear to be highly diverse, however, it is not one of the purposes of this study to deal with all of them as stated before.

5.1.3 Driver as an information provider

Information sets provided by the driver during in-car navigation are information both related and unrelated to navigation. These information sets can be examined in two categories: *pre-acquired information*, and *dynamically derived information*. Below, pre-acquired and dynamically derived information relevant to navigation will be introduced. Followingly, information irrelevant to navigation will be mentioned.

During navigation, the driver contributes to the practice with several information sets relevant to navigation, which are *remembered routes*, *remembered areas*, *remembered three-dimensional elements*, *remembered ambient conditions*, *remembered wayfinding instructions by the navigation device*, *remembered experiences*, *remembered anecdotes*, and *previously embodied navigational knowledge.* These information sets are acquired by the driver before embarking on a journey.

Remembered routes and remembered areas refer to a path and area that driver knows completely and partially. These are what driver remembers through route knowledge and survey knowledge they obtained from their prior journeys. Still, it is important to note that having experienced a route or area before is not the only way to have pre-acquired information it. Driver may have received direction from others or made a search about that route or area by using a digital navigation system or a paper map. Additionally, the driver may have been at various points within a specific area before. For instance, they may have been in several separate cities within a country, gaining general geographic knowledge about that country. Similarly, they may have been in various neighborhoods of a city, experiencing their positions relative to each other. This type of an information is information that constitutes a remembered area as well.

Remembered three-dimensional elements and remembered ambient conditions, similar to remembered routes and areas, are obtained from either prior practices in specific locations or information received about them from other sources. For example, someone giving directions to the driver before the journey may have said: "Turn left after you see a red-roofed building. There is a tree with a garbage container next to it." When the driver starts the journey, the information about the red-roofed building, tree and container contribute to the navigation practice as remembered three-dimensional elements. The person giving directions may have also add: "Turn right after seeing the tree and go straight. Then you will see the entrance of a narrow and dark street ahead. It smells bad, but do not mind, enter that street." In this case, information about narrowness and darkness, along with the unpleasant smell, function as remembered ambient conditions during the journey.

Remembered wayfinding instructions by the navigation device represent, as the name suggests, device's instructions that the driver remembers. The driver may have come across these instructions among the recommendations of the navigation device during the route search before the journey. They may also have experienced them during previous journeys on the same route.

Remembered experiences are the memories of events that the driver has experienced during a drive and has not forgotten. Remembered anecdotes involves anecdotal information about an environment, someone else's drive and the like. Lastly, previously embodied navigational knowledge is the source of information, which refers to the tacit knowledge derived from past practices.

As mentioned above, remembered routes and remembered areas are information sets coming from route knowledge and survey knowledge. Also, remembered three-dimensional elements, remembered ambient conditions, remembered wayfinding instructions by the navigation device, and remembered experiences, are associated to landmark knowledge. Simply put, they serve as landmarks during a journey as discussed in more detail in the following sections.

During a navigation practice, the driver also dynamically derives information from the information environment and/or navigation device provides, and the pre-acquired information they possess. The information they generate through interpretation, calculation, association, recall and so on are this kind of information.

In addition to the navigation-related information coming from above information sets, the driver may have and derive an unlimited variety of information, irrelevant to navigation, during the journey. They may be driving with the information, for instance, that they need to take a break soon or that fuel prices are rising. Indeed, anything from the movie they watched the previous day to the job interview they will have the next day can be examples of the information sources that the driver has while driving.

The driver may also engage in mental or physical activities that have nothing to do with driving. They might be trying to remember the lyrics of a song that has come to their mind at that moment, or they might be having a heated debate with someone on the phone. They may be trying to turn on the air conditioner or poking around in the glove compartment. While these activities are taking place, all the related information participate in the practice as well.

In this section, the information sets presented by the three information providers that may participate in a navigation practice were categorized as shown in Table 5.1. In this categorization, all available information sets, whether related to navigation or not, were included. However, the driver does not experience all these information sets during the drive. Similarly, even while engaging with a piece of information, the driver may not engage with the entire information set to which it belongs.

Table 5.1 Overview of information presented during in-car navigation

Information provider	Information set	Related information
Environment	Road network	Roads, turnouts, intersections, squares, pots and lands
	Three dimensional elements	Architectural elements, three-dimensional traffic, management elements, three-dimensional, three-dimensional decorations and other products, plants, rocks and stones, vehicles, humans, and animals
	Traffic	Vehicles and pedestrian, traffic management elements and a social setting
	Wayfinding instructions	Wayfinding signboards, directional road markings, directional voice messages
	Ambient conditions	Topography, weather conditions, aesthetic, and kinesthetic sensory characteristics of the surrounding
	Companions	passengers and pets inside the car, ones on the phone, a passerby to whom the driver mas ask for directions
Navigation device	Dynamic abstracted view	The abstraction of the environment as a map view and the representation of the driver on the map
	Texts	Names of roads and places, numbers and arrows
	Digital buttons	The digital keypad
	Notifications	Pop-up visual and auditory messages of wayfinding instructions and alternative route suggestions
	Material existence	The device’s physical presence
Driver	Remembered routes	Pre-acquired information related to routes
	Remembered areas	Pre-acquired information related to areas
	Remembered three-dimensional elements	Pre-acquired information related to three dimensional elements
	Remembered ambient conditions	Pre-acquired information related to ambient conditions
	Remembered wayfinding instructions by the navigation device	Pre-acquired information related to wayfinding instructions by the navigation device
	Remembered experiences	Memories of events
	Remembered anecdotes	Anecdotal information about an environment, someone else’s drive and the like
	Previously embodied navigational knowledge	Tacit knowledge related to navigation derived from past practices
	Dynamically derived navigational information	Information generated during the drive through interpretation, calculation, association, recall and so on
	Information irrelevant to navigation	All pre-acquired and dynamically derived information irrelevant to navigation

5.2 Navigational Information

Navigation devices are designed to assist navigation, and as such, the instructions they provide is directly oriented toward it. Furthermore, there are signs in the environment that directly aim to guide navigation. In addition, the driver may already have information about the actions they need to take during a navigation practice. Such information coming from the three information providers, the environment, navigation device, and driver, are the ones that directly aimed at navigation. Still, the information used for navigation in this practice is not limited to these ones. However, the above explanation on the information sets did not introduce a specific type designated as *navigational information*. This omission is attributed to the absence of a fixed category exclusively defined as such. Indeed, regardless of the primary reason or purpose behind the existence of any information participated in navigation, it has the potential to serve as navigational guidance as being involved in the process of generation of navigational information during the practice.

The term navigational information in this study refers to both the information underlying wayfinding decisions and the information prompting locomotion performed without a wayfinding decision. The information underlying wayfinding decisions encompasses two types of information. One is information related to routes leading to a destination. For example, if the driver relies on the existence of a tree to recognize a corner at which they must turn, the piece of information that "the tree is there" (existence of the tree) is an information related to the route. The second type of information underlying wayfinding decisions are unrelated to routes, but wayfinding decisions are influenced by them. For instance, if the driver refrains, while travelling, from entering a road on which they see that there is a construction work and make a U turn, what makes them to make turn is the information related to the existence of the construction work. Hence, it is a piece of information that influences the wayfinding decision here. As to the type of information that prompts locomotion without a wayfinding decision, an illustrative example involves the information, of previous practices on a particular road, that makes the driver turn at an intersection without a conscious decision making just because they are familiar with turning there. In such a case, the driver turns inadvertently, perhaps even mistakenly which means that where they turn without awareness may not even be a location they have to turn in their current route. However, the information related to their habits they acquired in the past lead them to make that turn.

It is evident in these scenarios above that pieces of information not referring to navigation are incorporated into the generation of navigational information as well, just like the ones aimed at navigation. Having provided these examples related to navigational information, generation of navigational information can be defined as the process of making wayfinding decisions and/or executing locomotions without making decisions. The next section will examine how the three agents, as information providers, of in in-car navigation generate navigational information.

5.3 Generation of Navigational Information

As mentioned earlier, in-car navigation practice is a period of convergence characterized by constantly changing matches between the environment, driver, and navigation device. This section is dedicated to explaining how those matches occur. The discussion on the convergence will begin with how road-related information sets coming from the information providers match. This is because picturing how road-information is used provides introductory insights about in-car navigation practice as well. From this perspective, the introduction of the section 5.3.1 Basics of wayfinding in in-car navigation will commence with the theme of the use of road-related information during navigation. When discussing the matching of information sets relaying road-related information, the presence of the navigation device in the practice will be set aside at the beginning, and the matches between the environment and driver will be focused on. This will offer a straightforward introduction for grasping the processes of matching. Consequently, first, the matching of road-related information sets from the environment and driver will be explained below first. Following this, the presence of navigation device in the practice will be considered as well. The section will proceed with the discussion on the use of landmark-related information in in-car navigation. Throughout that part, how wayfinding decisions are made with the support of information from the three information providers will be illustrated. Subsequent subsections, 5.3.2 Threads outside and 5.3.3 Threads inside, will define cases where locomotion occurs without wayfinding decisions.

5.3.1 Basics of wayfinding in in-car navigation

At every moment of a journey, the driver sees the road extending ahead. This implies that, at any given moment, the driver is optically engaged with the segment of the route they currently traverse. In other words, the environment consistently presents a specific segment of the route to the driver in each moment of the drive. The segment appears to the driver undergoes constant changes as the driver progresses along the route.

In the practice of driving, the environment also provides a set of relations among roads spatially interconnected. When driving on a particular road, the driver frequently passes by or turns onto roads intersecting with the current one. During that, intersections fall within the driver’s field of vision. If the surroundings are not densely populated with large scale three-dimensional elements, like tall buildings, garden walls, or trees, other roads around may also be visible to the driver. In some cases, particularly when the route is short and the environment has few and scattered or low-rise three-dimensional elements, even all roads the route includes may be within the driver's field of view. In summary, the environment optically presents the network of roads on the route partially or entirely.

Not all road relationships, as stated above, a route encompasses are always visible to the driver. Especially during navigation practice on a long and intricate route, particularly in the presence of high enclosing walls, there is never a moment when all roads of the route are visible to the driver. Conversely, when the other roads are either too distant or concealed by elements such as three-dimensional elements or topographic elements, sometimes the only road visible to the driver is the one currently being traversed. Nevertheless, even in such situations, the driver may have grasped the relationships between the road on which they are travelling, and other roads connected to it. For instance, the driver may understand the intersection relation between the roads just traversed and the one being traversed currently. As another example, they can comprehend the location of the road they are on in relation the entire route, suggested by the navigation device before departure. Road network offered by the environment appears to the driver in these ways. Such comprehensions also contribute to the driver's orientation. Additionally, these pieces of information constitute the data that forms survey knowledge.

If the driver has previously used a route and learned about the relations of roads included in that route, they may recall these relations from prior practices to find their way while travelling on the same environment. This retrieved information aids the driver in recognizing the branch of the road network they currently use and orienting themselves. This means, the recollection of past journeys can play a significant role during navigation. In such cases, there may be less reliance on navigational directions provided by the environment. Indeed, in situations in which the driver relies on a route they remember, they may need to check what wayfinding signboards suggest less. Still, it is important to note that the driver remembering the route does not necessarily mean they disregard the information environment provides. Instead, the utilization of the remembered route requires matching it with the road view constantly. During such a drive, the road network must be compatible with the remembered route. For example, if the next action based on the remembered route is turning right, the road network should present a right-turn option at the junction ahead. In some cases, the alignment between the road network and the remembered route operates as follows: if the driver cannot recall certain details of the remembered route, encountering the road network may clarify its details.

In some cases, the driver may have partial or no route knowledge but possess survey knowledge about the area. Then remembered area comes into play. For example, they may be familiar with the area but may be going from a location they have never been to before to a place they have never visited. In such cases, the driver can develop an idea about the direction they need to take using their survey knowledge and orientation skills. This means they use a route they derive, not one they simply remember. During this kind of a practice, the driver may still refer to navigational directions provided by the environment, and possibly navigation device, but the role the driver plays here is undeniable.

In some instances, the driver may have never been in that area before. This implies not only a lack of the information about the route but also a lack of the information about the area, which could have gained from past practices. However, the driver may have received directions from someone else, learned about the area and route from a paper map, or studied the directions on a navigation device before the drive. These instances illustrate the driver acquiring information about the route and/or area beforehand. The experiential nature of the information obtained from others, paper maps or navigation technologies, of course, different from the experiential nature of the information gained from previous journeys. Nevertheless, in these examples, just like in the use of the information related to previous journeys, the driver utilizes pre-acquired information related to the route and/or area. This kind of a utilization can take the form of either recalling the related pieces of information from the memory and using them as they are, or deriving new information based on those pre-acquired pieces of information. It is also important to point out that in such practices, even if the driver is receiving the information about the route and/or area from the environment or navigation device during the drive, they are still drawing on pre-acquired information. Therefore, while the driver may use the information presented by the other information providers during navigation, the role of their mind in this practice is still significant.

During all of these, in in-car navigation, the practice is supported by the route on the dynamic map. It means that the map is involved into the alignment between the road network and the remembered route. To understand how the device assists the practice, it is crucial to make a general comparison between the dynamic map by the device and road network by the environment.

The navigation device displays a model of the environment, the actions taken by the driver at the given moment (through the moving representation of the driver on the map), and the actions they need to take thereafter. While doing so, it presents some information from the environment as is, omits certain details, and gives some information that the environment does not provide. Below, the focus will be on explaining the incorporation of road-related information given by the navigation device into the practice.

The route information by the navigation device is partially overlaps with the information the environment already provides. Notably, the relationships between roads on the route on the map, are the same as the relationships between those roads in the real view of the environment. Furthermore, the angular variations required during directional changes are accurately portrayed on the map. For instance, when it is necessary to turn at a turnabout, the turning angle is visually depicted with a corresponding curvature. In this regard, among the information sources provided by the device, the one that is most consistent with what the environment offers is the route displayed on the screen. The role of this consistency in navigation practice can be exemplified by this behavior of a participant: while approaching a complex intersection with multiple exits in an unfamiliar environment, the participant sees the direction they should turn. However, they may not immediately understand at what angle they must turn (which exit to take). Therefore, when they reach the intersection, they turn the steering wheel in the turning direction and begin to closely monitor the representation of their movement on the map moment by moment. They continue to turn on the real road until the representation completes the curve of the turn displayed on the map, and while the turn on the map is being completed, they straighten the steering wheel. In this example, the driver uses information from the device to a large extent, instead of the environment, to make the correct turn on the real road. Of course, they still engage with the environment, but they do so not to obtain information about where to turn but to avoid disrupting traffic, staying on the road, avoiding collisions, etc.

In contrast to the consistency mentioned above, some of the information navigation device relays does not entirely align with the specific details presented by the environment. Such discrepancies can lead to limitations in the device's capacity to effectively assist the driver in certain situations they feel in need of support. An instance illustrating this occurred during a driving session when the road is forked a short distance ahead. The two branches of the fork were parallel to each other and aligned with the trajectory of the current road, which means that the driver did not need to make a turn to proceed along the correct side of the fork. Instead, a subtle adjustment of the steering wheel, almost maintaining a straight trajectory, was sufficient for the driver to proceed. Therefore, at that moment, the route displayed on the screen appeared to be straight. Consequently, the navigation device was unable to guide the driver regarding the choice of the fork's branches. Due to the rapidly approaching vehicles from behind, the driver lacked the time for thoughtful consideration and opted for one branch randomly.

Lastly, there are pieces of information that the navigation device provides in addition to the pieces of information available in the environment. Primarily, the route is as such an information source. It is true that the environment presents the road network to the driver, albeit not in its entirety, however, in unfamiliar environments, except in situations where the destination and all roads leading to it are within the real view, the road network alone is not sufficient to guide the driver on the route to be followed. In contrast, the navigation device provides a defined route. Another information that the device offers in addition to that environment presents is the road segments where the traffic was congested. This is also one of the reasons why 67 out of 83 participants of the survey use a navigation device. Even though the driver can naturally perceive traffic by looking at the surroundings when caught in congestion, this is a moment when they turn to the device for more information. Five of the drivers in driving sessions tended to immediately check the device screen when encountering traffic, demonstrating an inclination to examine the length of congested routes. This study interprets this behavior as a tendency for participants to turn to the device when it provides information that cannot be obtained from the environment.

This feature is utilized even when the driver is fully acquainted with the route, which means, when the remembered route is complete. Briefly, users may wish to see congested roads before or during the drive, and they refer to the device for this purpose, even if they are entirely familiar with the route.

Another example of information navigation device gives in addition to what environment presents is the advice regarding the lane to keep. This allows the driver to choose the appropriate lane before a turn in cases where the environment does not provide a wayfinding signboard. Even when there is a relevant wayfinding signboard in the environment, it may be positioned very close to the turn. In such a case, even if the driver learns where to turn from the signboard, they may not have enough time to switch to the lane where the exit is located if the car is moving at high speed or if the traffic is congested. This can result in missing the exit. Therefore, the device giving this information, which surpasses the information by the environment, can be beneficial for the driver. Six of the drivers in driving sessions also listed this as a reason for using the device. It has been uncovered in the interviews that they use the device to obtain this information even when using routes they are entirely familiar with. They were also asked why they used a navigation device for turns and lanes when the remembered route was available. All participants who received this question mentioned that, despite knowing the route, they could sometimes miss exits due to moments of distraction. As they share, this can happen either in the moments of inattention or when their attention is diverted to to irrelevant information during.

In the example above, compared to the previous one, there is a greater similarity between the remembered route and the dynamic abstracted view on the screen. To elaborate, the remembered route inherently includes information about where turns should be made. In this case, it might be thought that the driver would not need the navigation device when the remembered route is present. However, the preference demonstrated by the participants in the example above indicates that, even when they are completely familiar with the route, the remembered route may not appear during driving, especially in moments of driver distraction. During such times, the role of the navigation device becomes prominent for them.

In the above passage, the convergence of the environment, driver and the navigation device in the context of the participation of road-related information in in-car navigation practice has been examined. The discussion has focused on how this convergence occurs when the driver is familiar, unfamiliar, or partially familiar with the environment. In the remainder of this section, variations in the convergences of the three information providers will be specified.

Additionally, the passage has also compared navigation device and environment regarding the pieces of road-related information they present. As it has been introduced, the device provides certain information from the environment as is, excludes specific details, and offers information that is not supplied by the environment. Differences in the uses of road-related information in in-car navigation have been illustrated based on these variations. In fact, examples beyond road-related information can also be provided regarding such variations. For instance, the navigation device does not provide information about three-dimensional elements while environment does. Also, it provides other kinds of information that cannot be obtained from the environment. Numerical values such as the distance between locations, remaining time to the destination etc. represent such information (distances are environmental information in fact, but human perception is not capable of understanding the distance between, for instance, two cities by looking at the environment).

Below, the section will continue with how landmark-related information is involved in navigation practice. Landmark-related information is included in various information sets. First of all, based on the idea that three-dimensional elements in the environment provide the opportunity to be associated with their locations, it is possible to say that they can be used as landmarks. However, as this study accepts, environmental elements with the potential to be landmarks are not limited to three-dimensional elements. As it will be given below, ambient conditions, notifications by the navigation device, remembered experiences etc. can serve as landmarks as well.

Before the beginning, it is essential to note that every type of landmark usage requires remembered elements. That is because, to be able to use an information provided by the environment as a landmark, it is necessary for the human to have the information in mind that it is a marker for that location. This means, the use of a landmark requires the matching of that perceived landmark and the relevant remembered landmark. With this reminder in mind, let's delve into the participation of landmark-related information provided by three information providers in in-car navigation practice.

One of the elements that can serve as landmarks during navigation are three-dimensional elements as stated before. For instance, if the driver does not know how to go from one place to another, and gives directions from another person before the journey, the other person may use three-dimensional elements as landmarks. Then, during travelling, the driver relies on their remembering of those three-dimensional elements to find their way. In this process, what driver does is matching the three-dimensional elements in the surrounding with the remembered ones. This is an example of the utilization of these elements as landmarks in unfamiliar environments.

5.3.1.1 "Let's meet at the dog."

In familiar environments, people can also develop their own landmarks from three-dimensional elements in the environment. The following examples illustrate alternative uses of these elements as landmarks during navigation practice on the routes previously travelled.

During an autoethnographic drive, the researcher was recorded the following words about how they recognize the exact location for a turn:

> This road is a tree-lined path, with no wayfinding signboard. There is not even an attractive element in the vicinity to tell me where I need to turn. So, there were times in the past when I would miss the turn, but then one day I noticed that there's an olive tree further ahead, which could be barely

> discerned on the roadside densely covered by thick trees; that was my turning point. Now, when I see the olive tree, I make the turn (The researcher, driving sessions). [1]

In this example, the olive tree mentioned is not an attractive element. It may not even be used as a landmark by anyone other than this participant. Also, maybe no one else using that road is even aware of the existence specifically of that tree. However, for the researcher, it has become a landmark based on her previous practices on that road. In a similar yet more unconventional example of landmarks is the stray dog mentioned in the following statement by another driver. It demonstrates that even in a living creature as a three-dimensional element the environment provides can serve as a landmark.

> There is an old dog old in our neighborhood. It always lies down at a specific point on a walking trail and never moves from that spot. One day, one of my friends and I decided to go for a walk. I asked her where to meet and she said without awareness, let's meet *at the dog*. Since that day, we always meet at the dog for our walks (P1, Post-task interviews). [2]

5.3.1.2 "Turn right at the left turn sign."

Wayfinding signboards, as information sources included in the information sets both traffic and three-dimensional elements, can be used as landmarks as well. In fact, having wayfinding signboards in traffic serves the purpose, as the name implies, of providing navigational guidance. As the prevalent usage, the driver utilizes the information written on these boards to find their way. For instance, a signboard may indicate that the entrance to the upcoming village is on the right in a hundred meters. When the driver sees this content, they naturally acquire this piece of information. However, signboards can also participate in the practice of navigation in a different manner than the directions they provide. To make it clear, the driver may have previously passed through a road and remembers a specific board on the road; they might also know that, for instance, there is a tree-lined road after it. In this scenario, it can be said that the board is a landmark for the tree-lined road.

This can be exemplified by the P5's behavior in one of her drives. Despite being unable to read the written text on a particular group of wayfinding signboards from a distance, she managed to determine where to turn to go to the village she set out for. she elucidated this situation with the following words:

> In truth, my vision is not particularly sharp, and I cannot make out what is written on the signboards from this distance. But I have memorized that it is the point from which I should make a left-turn. When I see those boards, I understand that I should turn shortly to the left. By the way, I know from my previous travels on this road that they are indicating to the right, ha ha. But where they indicate is entrance to the city, not the village (P5, Driving sessions). [3]

In this case, the information P5 utilizes is not the content provided by the boards but the location of them. In other words, in such situations, the boards participate in this practice not only through the meanings they convey but also their physical presence which is independent from that content. This illustrates the use of wayfinding signboards as landmarks.

Caution signboards, traffic calming measures and traffic lights are not fundamentally designed as navigation-related elements, but they can also be used as landmarks like wayfinding signboards. While the driver is travelling on a road they have used before, the presence of these elements can help them recognize the environment. The example of a driver recognizing the environment by entering a road with frequent speed bumps, is related to this issue. Likewise, traffic lights can also be suggested as landmarks when giving directions to someone. For instance, in directions like "Stop in a hundred meters after passing through the traffic lights", the traffic lights serve as a landmark. This example can also be adapted to caution signboards.

In addition to the individual ones as mentioned in the previous examples, a driver's memory can also store a combination of multiple three-dimensional elements. For instance, a road adorned with attractive plants along the roadside can be recognized by the driver based on the line of these plants. The road surface or speed bumps placed at close intervals can also facilitate the recognition of the environment by these elements. P2 described this in an interview as follows:

> When I enter that gravel road, I know that I am just a few kilometers away from the entrance to the bypass road. When the gravel part of the road is over, I continue a bit further, and there is an intersection ahead. I take that exit and enter the bypass road (P2, Post-task interviews). [4]

Drawing from these, not only visual, but also tactile features of the three-dimensional elements can serve as references for recognizing an environment.

Up to this point, the use of three-dimensional elements as landmarks has been discussed. However, as previously introduced, it is not the only information set that contain information sources that can serve as landmarks. Ambient conditions, despite not being navigation specific elements, represent another information set whose elements can be used in a similar way in navigation practice. Those elements can facilitate the recognition of the environment due to the distinctive characteristics they add to the surroundings. When the driver remembers those characteristics during the drive, they may recognize the environment from them. This occurs when, in other words, those characters match with remembered characters.

5.3.1.3 "Enter the village behind the fog."

Among ambient conditions, topography is one of the elements that improve the recognizability of the environment. The driver's awareness of the topographic elements in the environment can facilitate orientation or inference about that environment. For instance, they can determine their direction in reference to the location of the sea. Additionally, topographic elements can serve as landmarks. For example, while climbing the slope of a mountain, they can discern which city they have reached.

As to weather conditions, they may not initially appear to be landmarks that can be used to recognize an environment. Indeed, even if the driver has driven on a road in rainy weather before, it may not be rainy when they drive on that road again later. Even if it is raining at that time, rain is not specific to that place, it is a weather event that can be encountered almost anywhere. Therefore, rain cannot serve as a reference for the driver to recognize the environment. However, there are situations where weather conditions take on the role of distinguishing features. For example, in the case of a high-altitude location that is always foggy, fog may be a reference that allows the driver to identify that environment. In such a case, it becomes a distinguishing feature that makes the driver recognize the environment. It should also be reminded here that recognizing a place from ambient conditions requires the driver to utilize remembered ambient conditions as well during the drive.

The uses of landmarks given until this point are not supported by the type of navigation device under discussion. This is because such devices rarely or never provide information on these matters. For example, during driving, it is possible to see the locations of certain buildings on the device's screen, but the device's primary purpose is not to reference them. Therefore, it does not display them in a way that would draw attention. Though, some of the information it relays may still be landmarks for the driver in specific cases as exemplified below.

5.3.1.4 "Can't you see the notification nailed over there?"

If the driver has previously traveled on a specific route with the support of the navigation device, wayfinding instructions by the device and remembered ones may match, helping the driver recognize the environment. An example is available in the following quotation.

> On a route I frequently traverse, yet remain unfamiliar with, there exists a point at which the navigation device instructs me to make a turn after travelling six hundred meters. After receiving the notification, there begins a retaining wall right on the side of the road. So now, whenever I get that notification, I know I am about to arrive at the wall. The turn, by the way, is right at the end of the wall. There are plenty of wayfinding boards along that road, in fact, and there's probably one at that turn as well, but I don't even bother looking since I already know I will turn there, ha ha. Or rather, I always forget to pay attention to the boards because when I receive the notification, I feel relieved and forget to check the boards. So, I still do not even know what is written on those boards (P3, Post-task interviews). [5]

In the above case, the driver's memory contains specific information related to the instruction given by the device. He has encoded the moment when the device issues the instruction as a recognizable feature of that location. It can be argued based on this that the information presented by the technology in this example indeed serves as a landmark in his process of contextualizing their environment. In this context, the transition of the environment from being a mere space to becoming a place is contingent upon the presence of instruction.

P13 expressed a similar situation with a joke in her drive. Pointing forward with her finder, she said, "There it is! It is standing right at that corner! Can't you see the notification nailed over there?" [6]. The experience underlying her gesture is the association of the notification with the environment, much like a physical landmark. From this perspective, it can be interpreted that the notification belongs to that environment as if it were nailed there just like a nailed physical element. Also, despite being nailed there, it is not the case that everyone can see it because only the one who experienced it in their previous journeys is able to see it. This means that the remembered notification in P13's mind functions like a filter that allows her to see the notification nailed at that corner.

Based on what has been illustrated so far, landmark-related information coming from the driver during navigation are remembered three-dimensional elements, remembered ambient conditions, and remembered wayfinding instructions by the navigation device. The use of these information sets implies the use of recollections from previous practices. In essence, the pieces of information included in these sets are contents of the prior experiences. Hence, the use of this kind of information can be summarized as the driver recalling *what they experienced* before. What is meant here is the driver remembering *the object of the experience*. On the other hand, sometimes the driver directly recollects a prior experience as a lived situation. In such a scenario, what the driver recalls is not the object of the experience but *the experience itself*. This is what happens when the environment is matched with remembered experiences. In such instances, remembered experiences can be said to be used as landmarks.

5.3.1.5 "Azrael was here."

An example of a situation in which the environment and a remembered experience match could be as follows. An area where the driver had an accident before may be imprinted on their mind, and they do not forget that area, and they use it as a reference point if it is on their way in future journeys. In that case, what the driver remembers is not only the physical being of that area but also the experience they had there before. The following quotation refers to a similar situation.

> One day I was driving to work on an intercity road with one of my friends in the car. The road was wet because the plot along the way was regularly watered, but I did not know that at that time. As I was turning around the plot, my car skidded, and I lost steering control for a moment. I almost had an accident. Right after that, I glanced at my friend in fear and astonishment, and murmured, Azrael was here, and started crying! It was terrifying for both of us. Now, I relive those moments whenever I pass there, and do not need navigational guidance on that turn anymore (P5, Post-task interviews). [7]

It is evident from this case that P5 could not forget this event where they experienced strong emotions. As it can be inferred from this, undergoing such a memorable event even once can be influential in subsequent experiences related to that environment. Also, remembered experiences used for navigation need not always be as dramatic as in the example above. It means, the impact of remembered experiences on the environmental experience is not limited to crisis moments like that.

As an illustration of remembered experiences, P4 expressed remembering an area during a driving session by saying in a mumbled manner: "Is it not this road where we stopped to eat on a trip with friends? I am starting to get hungry. Shall we stop by there on the way back?" [8] In this case, she recalled the pleasure of having a meal at the mentioned restaurant before. The experience of the pleasure is what she has matched with the environment. As another example, a memory articulated by the researcher pictures the effect of a childhood routine on the experience related to that environment. While passing by a terrain covered with trees during one of her drives, she pointed and said, “When I was a child, my dad used to stop the car here and say, this is the forest where Hansel and Gretel live, and I used to believe it, ha ha. We used to wander around a bit. Here is still Hansel and Gretel’s forest for me.” [9]

In these examples, what is remembered is more than the physical features of that environment. In particularly those areas, drivers do not just see their surroundings as a combination of roads, trees, buildings etc.; rather, they view them as the sites of their past experiences. Those areas have become more than just a part of space, they are where a part of their lives belongs. They experience a new version of those experiences every time they enter those environments. This is attributed to the previously embodied navigational knowledge. As mentioned earlier, this information set comprises previously embodied areas and previously embodied navigational actions. Here, what the driver brings to the navigation practice is previously embodied areas. In each of the cases above, the driver has embodied the space they have previously been in through the experiences they have had there.

At this juncture, the elucidation regarding the use of landmarks in in-car navigation has concluded. Akin to Lynch’s concept of landmarks, this study accepts that elements such as buildings, plants, sculptures, and the like can be landmarks. These are examples of individual physical landmarks. According to this study, plural (or collective) physical elements, as exemplified by a row of trees, can also be used as landmarks. Furthermore, the elements that can serve as landmarks do not always have to be physical ones. In this respect, this study deals with landmark usage within a broader context. In summary, three-dimensional elements in the environment, ambient conditions, notifications by the navigation device, and remembered experiences all possess the potential to serve as landmarks.

Before concluding the discussion on the use of landmarks, it is worth mentioning one more aspect related to this topic: *shared landmarks* and *individual-specific landmarks*. When a driver receives landmark information from someone about an unfamiliar environment, these two individuals have developed a partnership in accepting a particular element as a landmark. This means that the prevalence of the use of that element as a landmark, albeit by a very small amount, increases. On the other hand, in some cases, an element can be used as a landmark by a considerable portion of the population familiar with that environment. For instance, a historic clock tower in a bustling area of a large city or an old tree in a small village could be an element used by everyone in that environment for giving directions. Whether used by the entire population in a city, or just a group of friends, or even just two individuals, in such cases, it can be said that landmarks appeal to a community. Accordingly, it can be argued that the use of shared landmarks may bring people together in terms of a shared environmental information. In addition, while some elements that have the potential to be landmarks can be shared by a community, others may be individual-specific. For instance, a notification given by the navigation device on a specific route may be known as landmark only by a single individual. Based on this distinction, the variations in bringing people together by landmarks are open to discussion.

5.3.1.6 "You used it to the last drop."

Besides the use of road-related and land-mark related information, the driver can generate navigational information by also resorting to numerical data during navigation. These pieces of information are provided by the environment and/or navigation device during the practice, such as the car's speed, distance covered, time remaining to the next navigational action, and so forth. Utilizing such information, the driver can computationally generate navigational information.

For instance, in a driving session, P11 once received a notification from the navigation device about how many kilometers were left to the next turn. Then he checked the number on the car's odometer. He continued driving until the displayed number on the odometer increased by the remaining kilometers to the turn, as mentioned in the notification related to the turn. During this, knowing that there was no need to make a turn yet, he drove without seeking any other navigational guidance. When the odometer indicated an increase suggesting proximity to the related turn, he started paying closer attention to the environment and the device and made the turn. In this case, it can be said that he, in a sense, tracked this segment of the road through the odometer. During the subsequent interview, the researcher expressed astonishment at such an unexpected use that was not initially anticipated in the research, stating, "Do you really utilize the device to its fullest capacity like this always? You used it to the last drop!". [10]

Another driver shared an example of information usage, akin to the one mentioned above, during the interview conducted with them. According to what they shared, when undertaking an intercity journey, they learn the distance to the next exit they need to take from the roadside wayfinding boards. Aware of this distance, they check the current speed from the device and calculate the time it will take to reach the upcoming intersection at that speed. Until the calculated time elapse, knowing that there is no need to turn, they continue driving without monitoring any navigational direction. Once the calculated time pass, they direct their attention to the environment and navigation device and execute the turn.

In these examples, the participation of drivers in navigation led to the derivation of account-based navigational information. In this context, the driver takes on the role of generating new information. Although the use of account-based navigational information was encountered in less frequently during driving sessions compared to other cases, this utilization is crucial in illustrating the tasks the driver may undertake in the context of navigation practice.

5.3.1.7 “The mission is to track the shopping bags, alright?”

Beside calculation, the driver may occasionally derive navigational information through commentary during the practice of navigation. Statements by various drivers serve as examples of the generation of such information. Examples from the driving sessions include “Here is a rural area, the map the device shows hereabouts may not be up to date." (P7), [11] "The road is both narrow and in poor condition, then it must be leading to a village at most." (P9), [12] and "The navigation device suggests a straight road, so I assume we are on the main highway through the city." (P2). [13]

At times, these commentaries also influence the driver's decisions in navigational actions. The driver forms an understanding about their surroundings based on the comments they make at that moment. Subsequently, they decide what to do based on this understanding. For example, P11 noticed heavy traffic while driving. Drawing from his previous experiences on that road, he commented, "There is usually no traffic jam on this road. Now there is congestion ahead, the road must be closed. I think we should turn at the next juncture.". [14] The researcher who performed a driving session in a rural area made an interpretation-based decision as well. Despite being unfamiliar with the environment, she made the following comment on what to do based on similar journeys she took before:

> I am here for the first time now. But recently, the navigation device gave conflicting pieces of information and led me onto the wrong roads in a similar area. It seems there can be such issues in rural areas, and now it feels like there is a similar risk. So, I will navigate by following the wayfinding boards (The researcher, Driving sessions). [15]

Abovementioned cases are moments where past experiences and information from the other information providers are matched with each other. Additionally, remembered anecdotes may participate in matches while making interpretations to take wayfinding decisions. These words by P2 during a drive serves as an example: "I have never been to this neighborhood before, but I always hear there are nice restaurants in the back streets. Then, there must also be a gas station nearby. Then I will continue in this direction to buy gas." [16]

In some cases, the environment and navigation device provide less information that would aid the driver in making wayfinding decisions. In such situations, the driver may have to derive navigational information as well. For instance, in another driving session P2 participated in, he was expected to go to a restaurant he had not been to before. There was almost no signboard on the road and the assistance provided by the navigation device was interrupted due to the weak Internet connection. Upon seeing a convoy of parked cars, he found the restaurant by stating, “These must belong to those coming to the restaurant. The restaurant must be at the end of this convoy.” [17]. Another driver, P4, said while searching for a market whose exact location is not precisely registered into the navigation system, “Do you see people walking with shopping bags? Wherever they are coming from, the market is on that side. The mission is to track the shopping bags, alright?” [18]. Indeed, she noticed the direction from which people with shopping bags were coming and found the market by heading that direction. In these two examples, the drivers have utilized pieces of information included in the traffic as an information set. In this sense, they have benefited from the information provided by the environment while making wayfinding decisions. However, compared to situations where the environment and navigation device provide more reliable information, they have had to rely more on their own interpretations in these cases.

Situations requiring the driver’s interpretations may also arise not the from the lack but from the excess of information from outside. Unexpected pieces of information presented by the social setting within traffic can be of this kind. P6 noticed during a drive that someone in an oncoming car was flashing their car’s headlights. From these signals, the participant comprehended the other driver’s attempt to caution them on a certain matter and made the following comments: "Are my car's high beams on? No, they are not. Why did he flash the headlights? Is there a bear trap on the road? Is that what he means? There might be a radar ahead. Then, I will turn from there; I will not proceed further." [19] This case is an example of the fact that driving in traffic is a social practice as well, and the social setting the traffic includes doesn't always consist of clear and universally known traffic signs but also messages that require the driver to interpret them thoughtfully.

This subsection provided a general overview of the basics of wayfinding by examining the processes of making wayfinding decisions with examples. As structured in this subsection, these processes can be divided into two parts which are the use of pre-acquired information, and the use of dynamically derived information.

The first group of processes involves the use of road-related information and landmark-related information while the second group encompasses information derived through calculation and interpretation.

It should be noted that the type of information mentioned in a process of wayfinding decision-making is not the only type used in that process. For example, processes involving dynamically derived information require the use of pre-acquired information as well. Similarly, making wayfinding decisions, even though it is pre-based pre-acquired information, is essentially producing new information. In fact, the phrase generation of navigational information already implies the creation of new information, which means all navigational information generation processes entail complex interactions between the use of pre-acquired and dynamically derived information. However, to categorize the processes of wayfinding decision-making as simply as possible, only the predominant type of information used in each process, which is the type that dominate it, is specified. This categorization is illustrated in Figure 5.1. The figure also depicts the information sets involved in each process.

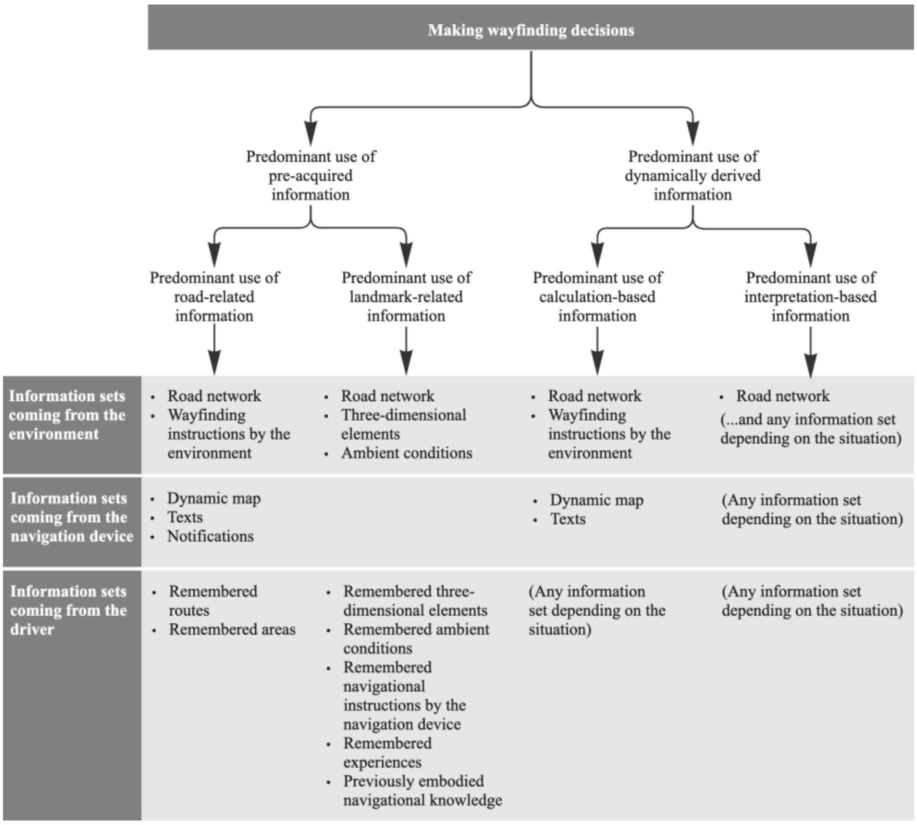


Figure 5.1 Wayfinding decision-making processes and related information sets

Having covered the basics of wayfinding, this section will proceed with locomotions performed without wayfinding decisions. These actions are the outcomes of embodiment relations. This study categorizes embodiment relations into two groups, which will be examined in the subsequent subsections 5.3.2 Threads outside and 5.3.3 Threads inside.

5.3.2 Threads outside

This and the following subsection are dedicated to the moments of embodiment observed in the field research. Despite the use of a navigation device during observations, these two subsections barely mention the device because the encountered embodiment relations occurred between the driver and environment. These subsections will define embodiment relations as the *embodiment of threads*. According to the outcomes of the field research, these relations are divided into two categories: embodying a thread during driving and translating a previously embodied thread into movements during driving. Below, the former one will be explained.

5.3.2.1 "Who pushed me?"

During in-car navigation, if the driver understands the route taken by the car in front, they may choose to follow it. For instance, if the destination is a school, the driver might decide to follow a school bus encountered in the vicinity. Here, it is through interpretation that driver arrives at the possibility that those vehicles are on the same route as theirs. Hence, this resembles making anticipation-like wayfinding decisions through interpretation. In this behavior, although the driver may not have made the wayfinding decision with great certainty, it is a conscious decision. In other words, even if they do not have full confidence in what to do, they are the one who made the decision, and they carry out the navigational action based on their own will. These are cases like the ones given the above subsection. However, there are also navigational actions that the driver performs unintentionally under the influence of traffic-related information. For instance, they may mistakenly turn after a vehicle, which turns right ahead, by unconsciously following it. This situation occurred three times in driving sessions (All these mistakes were immediately recognized by the drivers). One of the drivers who made such a mistake was the researcher. She expressed her astonishment when she noticed a turn she made unconsciously: "It happened completely absentmindedly! I did notice I was turning. It was not me who turned, ha ha! It was like someone turned me. Did someone pushed me? Who pushed me? Ha ha!" (The researcher, Driving sessions) [20]

As driving sessions have revealed, such situations indeed occur beyond the driver's awareness. In these moments, the driver behaves as if they were not the one performing the locomotion, as if they were caught by something. The cases provided below also refer to similar situations.

5.3.2.2 "They were the ones speeding up."

Other instances of drivers moving without awareness unfolded as follows. Sometimes, they unknowingly increased or decreased the speed. However, despite being absentminded, they never drove excessively slow or fast compared to the traffic flow. That is, they never behaved inconsistently with it. In such a moment in driving sessions, when P6 exceeded the speed limit, the car gave a warning. He was surprised since he had exceeded the limit and explained this situation with the words "They were the ones speeding up, not me.". [21] What he was trying to say by these words is he had unknowingly accelerated when the surrounding vehicles did.

In these examples, the driver is implementing the information they receive from the environment without conscious thought (Despite the absence of conscious thought, it cannot be denied that they engage with environmental information. The fact that the driver stays on the road, do not collide with other vehicles, moves in accordance with the speeds of other vehicles, mimics their movements demonstrates their engagement with the information environment presents). Here, locomotion is involved, but there is no wayfinding decision. This can be explained as the participant embodying traffic flow, and their body moving as a part of it.

These instances brought attention during the research process to the concept referred to as threads in this study. The concept threads can be defined as a series of successive information. For instance, throughout the practice (or in a specific segment of the practice), the series of images engaged by the driver can be briefly defined as a thread of views. As another example, when referring to successive perceptual information more generally, it can be called a thread of aesthetic and kinesthetic information. Accordingly, traffic flow itself is another example of threads. Still, the term thread does not necessitate the generalizability of successive pieces of information within a series. For example, a thread can comprise successive pieces of information such as a view, a scent, a sound, and the like. Within this respect, any information source that extends over time can be considered a thread. For instance, a musical piece playing for a certain duration, a thought pondered over a period, a conversation, or the flow of traffic may each be regarded as a thread. When these exist concurrently, it can also be said that they collectively form a thread as well. Based on this, it can be stated that a thread typically involves multiple pieces of information that are synchronized at each point in time. (The reason for adopting the term thread in the study is the need for a word to succinctly denote situations where humans engage with successive pieces of information as a whole).

In the moments of embodiment exemplified above, the driver is both unaware of the thread but unintentionally conforming to it. In those instances, it is as if the driver is not doing anything, but rather the thread is pulling them along as participants tried to express when they ask “Who pushed me?” or say “They were the ones speeding up”. Hence, it is appropriate to refer to such situations as a state of *being carried away by an outside thread.*

Before concluding the discussion on the embodiment of the traffic flow, it might be beneficial to recall other relationships between the driver and traffic flow, and compare them with the embodiment between these two. The relations between the driver and the traffic flow can be introduced in three main points. Firstly, the driver must adhere to the flow while driving. This means adjusting their actions in the traffic based on the movements of other vehicles, pedestrian etc. Secondly, as exemplified in the case of following a school bus, the driver can sometimes make wayfinding decisions by considering the movements of other vehicles. Therefore, information about the traffic flow can be used to make wayfinding decisions. Thirdly, as described here, traffic flow presents a thread carrying the driver away, in which there is no wayfinding decision but locomotion. The first two situations are instances where the driver can consciously follow the traffic flow. In these cases, the driver is aware of it. The third situation is when the driver moves without being aware of the flow.

5.3.2.3 “It turned me itself.”

Other cases like the embodiment of traffic flow were also encountered during the observations. In one of them, P13 was progressing on a straight road. There were no other vehicles on the road. She had paused the think-aloud protocol. She was moving along casually, even humming a song. After a while, the road connected to a crossover road with a sweep. It was not a turn, but rather a bend in the road. Since it was not a road junction, the navigation device did not provide any notification regarding this turn. She started turning on the sweep; she was on the right path. Yet, while turning, her humming suddenly stopped, and she snapped out of it, and asked in astonishment, “When did we enter this road? I mean, how!”. [22] She had not been aware of the turn they made. She tried to explain the situation by saying, “I did not notice the curve, it turned me itself.”. [23]

In this example, the driver has embodied the threads offered by the road. For instance, as both the shape of the road and the movement of the driver on it chance, the road view continuously changes, presenting a thread. The changes in the road shape also offer another thread, which is the series of changing kinesthetic experiences with it. This study does not claim whether the driver embodied both of these threads or just one, or they were intricate already, but it is evident that the driver has been carried away by an outside thread in this example.

At this juncture, while not related to mediation by the navigation device, the following case could be included in the examples to better illustrate the concept of threads and how they are embodied. P4 missed a turn while singing along to a song during a driving session she participated in. She explained this situation after the drive as follows.

> The music was very lively. I unknowingly stepped on the gas pedal under the influence of it. Then the navigation device notified me of an upcoming turn, but it was not possible for me to switch to the correct lane to make the turn at that moment. This was because I had accelerated, and the turn was imminent. So, I had no choice but to proceed without making the turn (P4, Post-task interviews). [24]

This case illustrates the incorporation of participant's body into the experience of the flow of the music. This example show that the pattern of a song's tempo can be considered the thread it presents, and this flow may also be embodied by the driver when they are listening or singing a song while driving.

This subsection, titled 5.3.2 Threads outside, has discussed the concept of a driver embodying a thread currently present in their surroundings during driving. It can be argued that in the situations depicted here, the environment resembles a flowing river, and the driver, a floating piece of wood in that river. Subsequently, the subsection 5.3.3 Threads inside, will provide examples of cases where the driver encounters threads that they have previously internalized.

5.3.3 Threads inside

In all situations introduced in 5.3.1 Basics of wayfinding in in-car navigation, it was possible for the drivers to clearly express how they made wayfinding decisions or why they performed the locomotions they carried out. In contrast, as illustrated above in 5.3.2 Threads outside, sometimes the driver finds themselves on the right or wrong path without taking any conscious decision that they can easily put into words. The following excerpts will show that drivers may sometimes find it more challenging to define their actions during navigation. Indeed, the participants whose words are quoted below struggled in both driving and interview sessions to articulate how they knew what to do at those moment, and sometimes they had no choice but to resort to analogies. The reason the excerpts given here are relatively long compared to the others is due to this difficulty in verbal expression.

5.3.3.1 “I kind of woke up from a deep sleep.”

In certain instances where drivers engage in locomotion activities without consciously making a wayfinding decision during driving sessions, threads that they have previously internalize but are unaware of have also been encountered. Such occurrences were observed three times during drives two participants attended. Also, six individuals reported experiencing similar situations during interviews, stating that no deliberated thought underpinned such actions. Examples of instances where drivers unconsciously chose the correct route could only be articulated in post-task interviews through statements such as “I felt I needed to do it.” (P13), [25] “I did it absentmindedly.” (P19), [26] and even “I was not aware I had taken that route.” (P3). [27] An excerpt from a driving performed by the researcher regarding this matter is provided below. Just before uttering the following words, she was traveling on a route that she had frequently traversed before but had not memorized at all. What she knew about that area was that there was a tunnel somewhere on the road only. However, she suddenly realized that she had forgotten to turn the device up and taken the correct road herself. Then she understood that she somehow had some knowledge about the environment.

> Oh, I did not know this road, but I realized I was approaching the tunnel just now! How did I realize it? I always use the navigation device to navigate these roads; I cannot find my way around here on my own, I do not even know where I am, actually! But just now, I understood I was going to enter the tunnel without the any notification from the device. I had even managed to take the correct route myself also! Here is how it happened. While I was driving without being aware where I am, suddenly I kind of woke up from a deep sleep because of a familiar change in my surrounding. I realized that the big trees surrounding me had just disappeared, and dry grass took their place. It was as if the surrounding greenery suddenly turned yellow. It was that yellowing that woke me up. The feeling I was about to enter the tunnel accompanied this awakening. Then I really came across the entrance of the tunnel right after that (The researcher, Driving sessions). [28]

In this example, it was not feasible for the researcher to describe the road in question, and even when she understood that the tunnel was ahead, she struggled to articulate how she accomplished it. However, her ability to occasionally choose the correct way implies her knowledge of that area. This knowledge possessed but not easily verbalized is tacit knowledge, and it is embodiment through which this knowledge is acquired.

The researcher has mentioned moving insensibly along a tree-lined path for a while, indicating a state of continuity, and the abrupt change within that continuity. Accordingly, what she is said above to have embodied is a thread including this change. That is, it is an outside thread presented by the environment, like in the examples given in the previous subsection. However, the examples in the previous subsection were about embodiment relations established during driving. In those cases, the driver did not use any prior knowledge about those environments. Rather, those cases exemplified drivers' current relationship with outside threads. The example presented here, in contrast, illustrates a previously internalized thread manifested during driving. It is also because of the influence of this previously internalized thread that the researcher was on the correct path. This type of knowledge is previously embodied navigational knowledge introduced in the subsection 5.1.3 Driver as an information provider.

The moment when large trees are replaced by dry grass represents a change in the thread internalized by the driver. The researcher, before this event, was unaware that she had internalized this thread. In other words, she did not know she had knowledge about this moment of change. However, while driving and unconsciously engaging with that thread, there came a moment when her awareness suddenly triggered by the change between trees and dry grass. That moment was when this knowledge was first noticed. Still, even if the researcher had not recognized this moment of change, she possessed this knowledge, which means that she had previously acquired it.

In such a learning scenario, what is learned is previously embodied thread(s). It is evident from the researcher's words that she did not have landmark knowledge, route knowledge or survey knowledge. She stated that she did not know the correct route. However, through repeated practices on the same route, she had inadvertently become able to travel without any navigational assistance.

5.3.3.2 "Did I say hill?"

It would be beneficial to provide another example of previously embodied knowledge related to threads during a journey. Below is a quote from P3 regarding his engagement with a route he uses frequently.

> I never learn routes, ha ha! I every time use a navigation device while going there. But nowadays the device has started suggesting a different route that it always recommends on that way. So now it does not give instructions where it used to give before. But I have recently realized that I could follow that route myself, at least on certain part of it. It has turned out that I can understand, I do not know how, which turn I should take on that part of the road. It is so interesting because I still do not know the route at all. I do not know how many turns I took before that turn, I do not know how the route will continue after it, I can never describe that route to anyone, I cannot even draw it… Because I do not know the way at all! But while using that route last week, for a moment I found myself saying, hey, that junction should be hereabout. Just then, as I turned around the hill, the junction suddenly appeared ahead! I still do not know how I could understand that! It was like a feeling inside me, ha ha! Wait a minute, did I say hill? I have not even been aware that there was a hill there, I have just realized it! I have just realized I knew it! It should be that hill that I match with that juncture! Isn't it so weird that I have not realized it before, ha ha ha (P3, Post-task interviews)! [29].

In this example, it is understood that the participant, even though he took the right path, did not know how come he could do it. He attempted to explain his tacit knowledge as "It was like a feeling inside me" since he could not put it into words in a better way. In fact, what he had in this case is the tacit knowledge of a pattern consisting of a thread. His internalization of the thread and its influence on his actions during the drive occurred unnoticed. This thread might be the pattern of the relations between consecutive views of elements, for example, the views of the hill and juncture that he had encountered during his previous drives on the way. It might also be the relations between consecutive actions he had taken there, which are passing the hill and then making the turn. Under the influence of the embodied knowledge of this thread, he performed locomotion in a correct way.

In the last two subsections, embodiment of threads in in-car navigation practice has been defined. To remind, the underlying information beneath the embodied knowledge is not verbal, thus, possessing this type of knowledge is insufficient for the driver to describe the related route or actions taken on that route. Indeed, the participants in above cases, for instance, could not even talk about their routes in the interviews although they can find their way on some parts of those routes. This is because performing those actions is only possible within the related context. In other words, the driver can perform those actions with their corporeal presence in real practice, rather than being able to envision them in their mind when they are outside of the context. In such a practice, the body is more active than the mind. This indicates that, just as in the case of being carried by an outside thread explained above, the manifestation of tacit threads in the driver's actions is more about locomotion, than wayfinding.

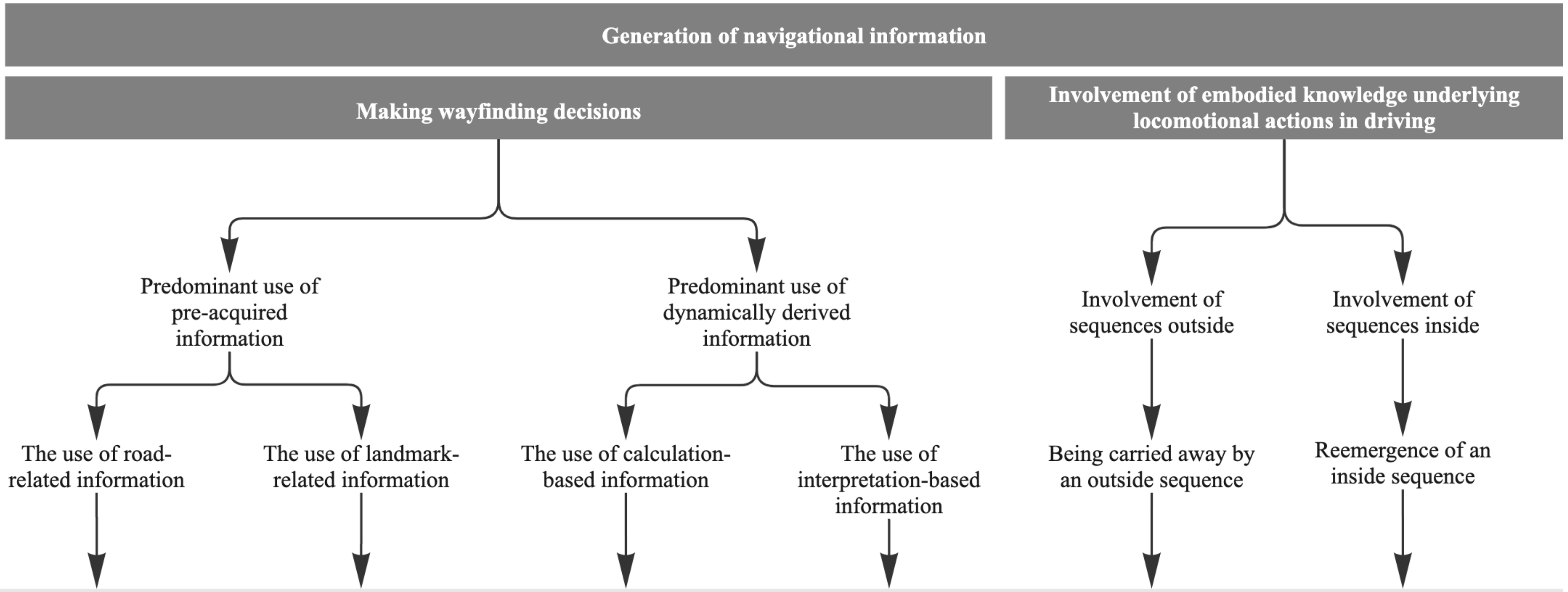
As to the difference between the cases given in the subsections 5.3.2 Threads outside and 5.3.3 Threads inside, it can be summarized as follows: While the former group refers to being carried away by an outside thread, the latter refers to *the reemergence of an inside thread.* In the first group of cases, the driver is influenced by a current thread which they embody at that moment. In the second, a thread they practiced and embodied before is now manifesting itself beyond the driver's control. Accordingly, the former is the penetration of external information into the body through embodiment, while the latter is the outward manifestation of internal, which is embodied, information.

Beside above examples of the reemergence of an inside thread, it can be encountered on a route the driver is familiar with. As an example of this, a participant shared a recurring situation where they deviate from the correct path. According to their account, there is a route that they everyday use when going to work, and they are well-acquainted with. While going somewhere else, they may need to follow a part of this usual path for a while and then take a different turn. However, at such times, they mistakenly turn to the exit they use everyday when going to work, attributing this to a momentary lapse in attention.

In this example, the participant has embodied the thread occurring during their drive on a familiar route. The embodied knowledge acquired during previous drives is reflected in the participant's actions. This situation is a moment of the reemergence of an inside thread as well. It is true that the driver knows the route (the one they are familiar with) well enough to describe it, but they have embodied it also. This example can be interpreted to mean that the mind momentarily stepping out of picture during driving allows the embodied thread to come to life in the driver's body. From this perspective, the mind can be considered as a factor that may mask the information stored in the body. According to this viewpoint, when the mind recedes into the background, the information stored in the body has the opportunity to emerge.

In the case of being carried away by an outside thread and the reemergence of an inside thread, to emphasize ones again, locomotion occurs without wayfinding decisions. This, contrary to the activity of making wayfinding decisions, is an experience where the mind recedes, and the body takes prominence. During these moments, the navigation device seems not to contribute to locomotion.

The process of making wayfinding decisions, which is one group of processes considered as generation of navigational information, has been categorized above, in Figure 5.1, based on the types of information used in them. Figure 5.1 has additionally indicated information sets contributing to each of those processes. Figure 5.2 below extends Figure 5.1 by including this kind of a categorization of locomotion activities that occur without wayfinding decisions.



	The use of road-related information	The use of landmark-related information	The use of calculation-based information	The use of interpretation-based information	Being carried away by an outside sequence	Reemergence of an inside sequence
Information sets coming from the environment	• Road network • Wayfinding instructions by the environment	• Road network • Three-dimensional elements • Ambient conditions	• Road network • Wayfinding instructions by the environment	• Road network (...and any information set depending on the situation)	• Road network • Traffic	• Road network • Traffic
Information sets coming from the navigation device	• Dynamic map • Texts • Notifications		• Dynamic map • Texts	(Any information set depending on the situation)		
Information sets coming from the driver	• Remembered routes • Remembered areas	• Remembered three-dimensional elements • Remembered ambient conditions • Remembered navigational instructions by the navigation device • Remembered experiences • Previously embodied navigational knowledge	(Any information set depending on the situation)	(Any information set depending on the situation)	(Locomotion)	• Previously embodied navigational knowledge

Figure 5.2 Processes underlying generation of navigation information and related information sets

A general examination of Figure 5.2 reveals several points about the participation of the navigation device in the practice. First, during the use of landmark-related information, the device seems not to contribute to wayfinding decisions because it does not provide information in this regard. Furthermore, during both being carried away by an outside thread and the reemergence of an inside thread, the device appears not to contribute to the practice either, as these situations involve relations between the driver and environment solely. However, it would be incorrect to generalize that the device is never perceived during the use of landmark-related information or during being carried away by an outside thread or during the reemergence of an inside thread. At such moments, the device may continue to provide notifications which the driver can notice. Even if it does not provide any notification, the driver may still turn to look at it and incorporate it into their field composition. In such instances, although the device seems not contribute to the generation of navigational information, it still participates in these moments of the practice. Thus, it can still be considered as one of the agents who characterize those moments of the practice.

5.4 Alterations in Matches

Up to this point, how various information sets coming from the environment, navigation device and driver converge in the process of generation of navigational information during in-car navigation has been introduced. The examples given cover cases where the relevant pieces of information are available, comprehensible, reliable, and consistent with each other. It is necessary to remind at this juncture that in certain cases, the support of an information provider for the practice can either decrease or be eliminated. Brief mentions of the reasons for this are outlined below.

The reasons that diminish the support of the driver for in-car navigation practice can be listed as follows. In some cases, they may face obstacles in using sufficient pre-acquired information or deriving new information. One of these situations is the driver lacking pre-acquired information. In some cases, pre-acquired information sets may be available, but the driver chooses not to use them, either because they find the pieces of information coming from them insufficient or unreliable. Another reason for not using those pieces of information is lack of self-confidence. Especially if the driver feels inadequate in navigational aptitude, they may avoid using existing information or deriving new information. In some cases, the driver may be genuinely lacking in navigational aptitude, hence they are able to participate in wayfinding decision making processes at a low level. In such cases, the necessity for information from the environment and/or navigation device becomes more prominent.

In some cases, the environmental information used in in-car navigation may decrease. One of the factors that diminish the support of the environment for the practice is the inexistence of necessary environmental information sources. In some areas, for example, there may be no wayfinding signboard for navigational directions, or another kind of navigational cues such as landmarks, around. In some instances, there may be wayfinding signboards on which the contents conflict with each other and confuse the driver. Sometimes navigational cues in the environment may not be accessible. For example, wayfinding signboards may be covered by tree branches, or a large vehicle may block their view, or a building that could be used as a landmark may not be visible at night. These are environment-induced reasons that decrease the support of the environment for in-car navigation.

In this context, it is also necessary to mention here the reasons, which arise from the convergence between the environment and driver, which impede the support of the environment. These reasons include, first, the imperceptibility or incomprehensibility of navigational cues in the environment for the driver, even if they are accessible. For instance, the content on wayfinding signboards may be visible, but the font size may be too small for the driver, making it unreadable from a distance due to their optical limitations. Or the direction that arrows indicate may not be understandable for the driver. This could be due to unsuccessful wayfinding signboard designs in terms of cognitive ergonomics, and/or the driver’s cultural incompetence in understanding them. In some cases, the driver may be completely lacking in knowledge to understand the content of sources of wayfinding directions and cues in the environment. Additionally, the driver may have doubts about the reliability of the information the environment provides. For example, when wayfinding signboards are poorly maintained, the driver may feel that they are old and not up-to-date in that area. During interviews, some participants have mentioned that this feeling of unreliability intensifies in rural and mountainous areas. Sometimes, even if the information on the wayfinding signboards seems to be up-to-date, the driver may doubt that they suggest the shortest or simplest route. Also, the pre-acquired information the driver has and/or the information they derive during driving may contradict the information provided by the environment. Therefore, in such cases, the information possessed and derived by the driver, together with the information provided by the navigation device, can offer more support to the practice than the environment. Especially if the environment is also unfamiliar to the driver, it may be more probable for the driver to attempt to access navigational support from the navigation device.

A navigation device may be employed due to the insufficiency of the support of the driver and/or environment for navigation. Also, even in the absence of such insufficiency, the driver may choose to make extensive use of the device during the practice according to their preference. Another reason for incorporating a navigation device into the practice is that it presents some information provided by the environment in a more understandable format for the driver, and more, provides additional information to what the environment presents. Enjoyment in using technology or finding it more reliable may also be the reasons for the driver to prefer to use a navigation device to a large extent during driving.

Nevertheless, in some cases, the assistance from the navigation device may be poor. Imperceptibility or incomprehensibility of the information it provides is one of these factors influencing the benefit of the device to the practice. This could be due to the screen dimensions not being sufficiently large, resulting in small font sizes; or the device may be turned down, causing auditory notifications to be unclear. The information may also bi incomprehensible for the driver for cultural reasons. These situations can be said to arise from the convergence of particularly that driver and navigation device. Another reason for the diminished utility of the device in this practice is the low precision of the information it gives. For instance, it may not always accurately convey the remaining distance to the next turn, especially if in the case of closely situated or adjacent turns, making it inadequate for the driver to anticipate which turn to take. Contradictions between the instructions it provides can also hinder the benefit derived from the information by the device. Additionally, even if they are consistent, frequent instructions for the next navigational actions may confuse the driver. For example, if the device provides an instruction for one action and then gives another for the next action before the first one is executed, the driver may become confused about which one to follow. This situation can be referred to as information overload. Contrary to providing excessive amount of information, at times, the device may provide very limited information or no information at all. For instance, it may lack map information in certain areas, making it ineffective at that point. Certain situations related to the material existence of the navigation device can also hinder its information delivery. For example, the device's screen may glare in sunlight. If it is not embedded in the car, it may run out of battery or fall off from where it is mounted.

It can also be observed that the support from two or all three of the information providers may concurrently decrease during navigation. For instance, information from two or all of them may conflict with each other. Also, driver's distractions may cause them not to pay attention to the information offered by the environment and/or navigation device, or they may momentarily forget the information they possess. The omission of any information from the driver's attention implies a lack of support of the related information provider for navigation for that moment.

In summary, in some instances, if a necessary piece of information does not come from one of the information providers, it may inevitably be obtained it from another information provider. In certain situations, even if a necessary piece of information is available and deemed reliable by the driver, they may choose not to use it. This can be attributed to the driver perceiving a relevant information source from another information provider as more reliable or easily accessible. At times, relevant pieces of information from the two or three information providers may be inconsistent. Furthermore, in some cases, information providers may offer more information than the driver can handle at a given moment. In such an inconsistency or information overload, the driver may intentionally or randomly select and adhere to a specific information provider, while calmly ignoring others. It is also possible for the driver not to be able to ignore any information provider in such situations, leading to confusion with useless pieces of information. In essence, the driver may inevitably resort to, or intentionally or randomly choose an information provider due to the absence of others or the difficulties they cause.

The driver's behavior regarding whether to trust or distrust an information provider, to prefer or not to prefer it, and to be or not to be able to use it, is often determined by the specific situation they are in. Many of the examples provided above illustrate the variables that define those situations in these aspects.

It can also be argued that some drivers have their own tendencies in these matters. In other words, the driver may exhibit a specific inclination towards preferring or not preferring an information provider during in-car navigation independently of specific situations. Similarly, some drivers may excel in engaging with a specific information provider compared to their skills in engaging with another information provider.

5.5 Alterations in the Uses of Navigation Technology

During the use of navigation technology, the driver does not use all the information provided by the device. Considering the moment of driving, the primary reason for this is that the driver's foremost task at that time is operating the vehicle. Even though the device continually updates accessible information, it does not overshadow the essential information the driver needs to focus on during driving. Another reason why the driver may not receive all the information provided by the device (before and during driving) could be attributed to their preferences or the specific occasion. Depending on the preferences and occasions, a variety of approaches, as shown in the Table 5.2, can be observed in the utilization of the information provided by the navigation device.

Table 5.2 Various uses of navigation technology

Before driving	While determining the destination	Using the coordinates digitally sent by another one
		Entering the address
		Choosing another location as point of arrival
		Determining stops along the way
	While examining the route and environment	Not reviewing the route
		Reviewing the route in general terms
		Examining the photographs of the surroundings along the route and/or destination
During driving	In terms of receiving and implementing instructions	Being selective about the type of instructions
		Forgetting even the presence of the device
		Being highly skeptical about the instructions

There are several ways to utilize a navigation application for determining the destination within the system. One method involves directly using the information related to the coordinates sent by someone else in a digital format. In this scenario, the driver does not establish a relationship with the destination's address or its relation to surrounding areas before embarking on the journey. In this scenario, the navigation technology does not contribute to the driver's environmental experience related to the destination prior to the journey. Another application of navigation technology for determining the destination is by entering the address into the system. This approach involves defining the destination only through names of places. Thus, like the other one, it offers no support for the spatial experience before the journey. An alternative use in determining the destination in the system involves selecting the location of a place close to the intended location as the point of arrival. For instance, a driver who needs to reach the location where a friend is waiting for them on a street might choose a nearby shopping center as the destination in the system. This approach allows the driver to begin engaging with the spatial relationships between these two points before starting the journey. Additionally, the driver can determine not only a destination but also stops along the way in the system. In that case, they experience the spatial relationships between the predetermined destination and the stops beforehand.

After determining the destination within the system, it is possible for the driver to embark on the journey without reviewing the relevant route and surroundings in a digital format. Alternatively, the driver may choose to review the route in general terms. For example, they can examine winding and straight paths on the route, determine whether the route involves complex roads and so on. Additionally, the driver can review photographs related to the route. By examining the route and its photographs it can be stated that navigation technology contributes to the driver's relationship with the environments they will engage with along the journey, even before the journey begins.

There are also various ways to utilize the device for receiving and implementing instructions from navigation technology during driving. In certain situations, the type of instructions utilized by the driver can be highly selective about the type of instructions utilized. For instance, on multi-lane roads with heavy traffic, a lane recommendation might appear on the screen before turns (this information can vary between applications). As previously mentioned, the driver might use navigation technology solely to receive this type of information. Besides, in some cases, the driver may even forget the presence of the navigation device since they do not need it over a period of time. This is particularly plausible on roads where turns are infrequent and the travel is routine, such as intercity highways. Another characteristic use of the device is the critical assessment of the information it provides. For example, in rural areas, the potential for outdated map information might lead to this use. On complex roads, whether in urban or rural environments, it is also possible for the driver to question the device's ability to handle the complexity, leading to increased scrutiny of the information provided.

Based on these, it can be interpreted that the information retrieved from the navigation device prior to driving may influences how the driver engages with the environment. This is because the driver's experience of their surroundings is expected to differ based on whether they have prior knowledge about the destination, route, etc. (by examining these on the screen) or have no prior knowledge about them (when they just digitally select the location of destination and start the journey without examining them). Another variation in the way environment is engaged with can be observed during driving. It can be attributed to the varying interactions with the device across different driving environments. This variation in how environment is engaged with arises from the device's emphasis on different types of information (for example, prioritizing lane information on certain roads), the variability in the way it presents information (such as frequent instructions at times versus no instructions for extended periods), and its potential failure or unreliability in providing certain types of information.

5.6 Summary

The summary of this chapter is provided below.

- In the context of in-car navigation practice, navigational information is generated through the collaboration of the three information providers. Within this triad, there is an ongoing series of correlations that this study refers to as *chain of matches*. The level of assistance provided by each information provider in the practice can vary from one match to another. The study has revealed certain situations that diminish the support of each provider in the practice. However, throughout the study, no default hierarchy was identified regarding the contribution of the three information providers to navigation. In other words, the research did not yield a conclusion that suggests a provider inherently contributes to the practice more frequently or is prior to the others.

- The driver's tendency to trust or distrust, to prefer or not to prefer an information provider, and the ability to use it are frequently influenced by the circumstances they find themselves in. It could also be asserted that certain drivers have inherent inclinations in these aspects. To put it differently, it is also possible for drivers to demonstrate a distinct preference or aversion to an information provider during in-car navigation, regardless of specific situations. Yet, it is important to note that this study did not explore potential variations in drivers' tendencies regarding this matter.
- During a journey along a specific route, any information that remains constant can serve as a landmark. Whether it is a building, a tree, or a dog that consistently present in the same place, a navigational instruction by the navigation device associated with the area in which it is given, a natural event always recurring in a specific location etc. can be used as landmarks due to their status as fixed elements and features of an environment. Additionally, even an event consistently experienced (recalled and/or lived again) by the driver during a visit at a location can be considered as a landmark for them.
- The use of landmarks can be either individual or public. Using an instruction given consistently at the same point of a route by the navigation device as a reference for that environment is an example of individual landmark usage. This is because the driver is the only one who takes that instruction as an element that belongs to the that area. On the other hand, indicating a location based on an element by everyone in a city is an example of the public use of landmarks. While public landmarks imply a shared understanding among people regarding how they engage with that environment, individual landmarks do not.

- Throughout in-car navigation, the engagement between the driver and navigation device is conducive to establishing hermeneutic relations, background relations and alterity relations. However, no embodiment relations have been observed between these two during the study. Embodiment relations are established between the driver and embodiment only, according to findings of this study.
- During driving, it can be observed that a driver performs locomotion without a specific wayfinding decision. The study employs the concept of thread to describe such situations. Thread refers to a series of changes engaged with during driving. This study identifies two separate situations related to the driver's experience of threads. One is being carried away by an outside thread, and the other is the reemergence of an inside threads. In both situations, the driver performs actions without being aware of what they are doing.

Throughout this chapter, a general overview of the convergence of the environment, driver, and navigation device has been provided. The processes through which the three information providers converge to generate navigational information have been explained. Emphasis has been placed on the variability of matches among this trio during convergence, and situations triggering this change have been pictured.

As this chapter primarily focuses on derivation of navigational information, the examples given above revolve around the information participated in relevant practices. However, the chapter has not mentioned information not taking place in the derivation of navigational information but participating in the practice. Information not participating to the practice despite being present, so available, has not also been given in this chapter.

The next chapter will classify the pieces of information, which exist at a specific moment during in-car navigation practice, according to whether they participate in the practice or not, and are transparent or not. It will also examine varying roles the information providers play in the practice. Through these inferences, it will discuss how boundaries among the environment, driver, and navigation device alters in various matches.

CHAPTER 6

FROM KNOWING AND DOING TO BEING

This chapter will examine how the driver engages with information providers during in-car navigation, focusing on their participation in the practice. The way each piece of information participates in the practice also shapes the way the driver engages with the respective information provider. Therefore, the chapter will first investigate how pieces of information enter the field composition in 6.1 Alterations in the Field Composition, then explore how they appear to the driver in 6.2 Participation of Information in Navigation. These two sections will form the basis of the section titled 6.3 Participation of Information Providers in Navigation. Subsequently, the chapter will concentrate on the boundaries of information providers based on all these findings. It will discuss how the boundaries between them change, and the role of the navigation technology in this process.

6.1 Alterations in the Field Composition

6.1.1 Field composition as a dynamic combination of information

During navigation, the environment is mostly dynamic to a noticeable extent. There are, for example, vehicles and people being moving in the environment. Other living and non-living entities can also change location. A dog can be walking, and a hat can be flying in the wind. It may get dark or brighten up, the weather may either warm up or cool down. Environmental sounds also constantly change. Car horns, engine and tire skid noises, people calling out to each other, announcements, birds chirming and so on emerge and fade away in the combination of information presented by the environment. These examples show the constant transformation of the environment. As well as the environment transforms, the driver's surroundings also constantly change since they are moving within the environment. Since driving, compared to walking, considerably increases mobility, the driver’s surroundings change more rapidly during a driving practice. Therefore, driving can be said is a practice during which the combination of information offered by the environment undergoes transformations and changes at every moment.

As for the navigation device, its purpose is to assist navigation simultaneously. During this assistance, as the environment transforms and changes, the environment model provided by the device also changes. Additionally, driving-related information such as time, duration, distances, speed, etc., also varies based on the driver’s movements. And, as the driver travels, the technology issues notifications. In short, the combination of information provided by the device is in a constant state of change as well.

The driver engages with two separate combinations of information provided by the environment and navigation device. Based on the changes in these combinations, the combination of information received and provided by the driver also changes. For example, when transitioning from a dirt road to a gravel road, the driver can recognize texture of the road. If the street where the navigation device instructs the driver to turn to is the street where the school they attended in their childhood is located, childhood memories can also be included in the information they provide to the practice. Besides, new information irrelevant to driving and navigation also comes to the driver’s mind during the practice. For instance, if the driver senses that the weather is cold, they can generate the information that the car windows will fog up. The information engaged in the derivation of this information may include some physics knowledge or perhaps a recollection of past driving practices where the car windows fogged up. These examples can be multiplied. At a specific moment, the driver may remember the song they were trying to recall just a moment ago. Or they may forget the job interview they are currently thinking in a little while. All these imply that new information may emerge in the driver’s mind at any particular moment within the course of practice, whereas it was not an element that driver engaged with at previous moments. Or conversely, a piece of information that was present in their mind at a specific moment may be forgotten shortly thereafter. From these examples, it is understood that the information combination provided by the driver to the navigation practice is constantly in flux.

In essence, the combination of pieces of information coming from the three information providers change throughout the practice. Hence, the combination of information, that the driver is aware of at each moment also undergoes constant variation. This implies that the driver's field composition is in a continuous state of change during the practice.

6.1.2 Emergence and continuity of information in the field composition

Pieces of information available for the driver during in-car navigation may either emerge with a smooth transition or instantly. For example, the *gradual* darkening of the sky as the sun sets during driving provides a gentle transition in the information about it. On the other hand, for a driver travelling on a well-lit road entering a tunnel, the transition from the brightness to darkness occurs suddenly. In this case, the change in the information is *abrupt*. Quick appearance and disappearance of buildings, trees, signboards etc. in the road view, the driver glancing at the navigation device, a single notification the device relays and so on are abruptly emerging elements during the practice.

Whether the driver notices an information, regardless of emerging gradually or abruptly, depends on the situation. That is, although a combination of pieces of information is available, some of them enter the field composition while others do not. For example, when a piece of information emerges gradually, this transition is not always noticed by the driver. Indeed, in the case of the darkening sky, the driver may not immediately realize that the sky is getting darker. However, when suddenly entering the dark tunnel, they are more likely to notice the darkness. When the car suddenly hits a pothole or a human steps onto the road, they notice this abrupt changes as well, indicating that related information has entered their field composition. Nevertheless, it is not accurate to generalize that abruptly emerging information will always be noticed. For instance, buildings and trees along the roadside may suddenly emerge in the road view, but often the driver passes by without being aware of them. In fact, the driver may not even notice abruptly emerging voice messages from the navigation device.

In addition to the variations in the emergence of pieces of information in the field composition, their continuity there during the practice of in-car navigation varies. The presence of pieces of information in the field composition can be *continuous* or *momentary*. Noticed decorations along the street, the surface of a rocky road that is felt etc. are long-lasting pieces of information. Despite being perceived intermittently, speed bumps placed at frequent intervals constitute continuous information as well. As other examples, repeated notifications from the navigation device about the distance to the next turn or the driver's representation on the screen changing during a turn, are continuous information in the field composition as long as the driver perceives them. Such a time interval, during which the driver engages in the continuous decoration, senses the road surface for a length of time, or repeatedly receives information from the navigation device, defines a continuous time span. In contrast, a striking building rapidly passed but noticed by the driver during the drive, a pothole on the road, or a singular speed bump are information that stays in the field composition momentarily. These continuous and momentary time spans will be revisited in the subsection 6.1.4 Experience periods.

6.1.3 Interruptions of experiences

As stated above, when a piece of information captures the driver's attention, it gets involved in the field composition. This alteration in the field composition means the *interruption* of the current experience. It means that a piece of information entering the field composition interrupts the current experience and initiates a new one. This is inevitable, because the field composition in the absence of that information is not the same as the field composition in its presence.

A piece of information emerging gradually often represents an unnoticed gradual transformation in the available information. It subtly infiltrates into the combination of available information, but it may not draw attention despite being available. That is, while a piece of information is gradually emerging, the field composition may not undergoe change which means that the information may not initiate a new experience. In the case of the darkening of the sky, for instance, it is only when the driver notices the darkness that it enters the composition, interrupts the current experience, and initiate a new one. The same applies to a piece of abruptly emerging information. If it enters the field composition, a new experience begins at that moment.

The exit of information from the field composition also initiates a new experience. A piece of information which is momentarily available, by its nature, can stay in the field composition momentarily only. The experience it initiates is also momentary for this reason. For information continuously available, two possibilities exist. Sometimes they remain in the field composition continuously, meaning the driver is aware of them for a length of time. Sometimes, however, despite being continuously available, they exit the field composition. Thus, the experience they initiate does not last as long as their availability. For instance, when the driver notices the rows of trees along the road, the trees have entered their field composition, initiating an experience which is related to them together with other information perceived at that moment. Even if the driver keeps travelling along the road, their awareness of the trees may diminish after a while. If that is the case, despite the continued availability of the trees, the experience, which has been initiated by the awareness of them, ends.

6.1.4 Experience periods

The onset and conclusion of an experience during in-car navigation were exemplified with several instances above. The duration between each onset and conclusion can be defined as an *experience period*. Within each experience period, multiple elements can be experienced. Also, a period can be momentary or continuous based on whether the information experienced during that period remains momentarily or continuously in the field composition. Below, an example of a momentary experience period is illustrated.

At a particular moment of the practice, the driver may be looking at the navigation device's screen to understand where to turn. Simultaneously, they may be listening to the music playing in the car, interpreting a memory they just remember, and hearing a dog barking from outside, and feeling the cold weather inside the car. All these from the map view to the air temperature are elements that the driver is experiencing at that moment. Meanwhile, they are also inevitably exposed to roadway noise, the car’s vibrations, and the like, yet they may not be consciously aware of them, which means those elements are not experienced. As the driver is focused on the navigation device's screen, they do not perceive the road view. As well, a ship off the coast is not within the driver's field of view at that time. Hence, the road and ship are not visually perceived, then not experienced, too. The duration during which the combination of experienced information remains unchanged is termed an experience period. The examples of experienced and unexperienced elements during this period are listed in Table 6.1 under the column Experience 1. This period concludes under the circumstances exemplified below, marking the beginning of a new experience period.

If the driver, who is looking at the map display as in the above case, shifts their gaze to the road, the map exit the field composition, while the road enters it. Then a new experience period begins. However, if, for instance, the navigation device falls from where it was mounted in the car, this period ends. In that case, the device's material existence, which was not experienced previously, becomes present for the driver. Then a new period in which the material existence of device is experienced begins. Examples of experienced and unexperienced elements during these two periods are provided in the columns labeled Experience period 2 and Experience period 3 in Table 6.1.

Table 6.1 An example of successive experience periods

	Experience period 1	Experience period 2	Experience period 3
Elements experienced	Map display, Music, Dog bark, A memory, Air temperature	Road view, Music, Dog bark, A memory, Air temperature	Materiality of the device, Music
Elements not experienced	Roadway noise, Vibration, Materiality of the device, Road view, A ship off the coast	Roadway noise, Vibration, Materiality of the device, Map display, A ship off the coast	Roadway noise, Vibration, Road view, Dog bark, Map display, A ship off the coast

As the practice continues, experience periods in Table 6.1 are followed by new ones. For instance, as previously mentioned, if the driver turns their head towards the sea and spots a distant ship, a period where the ship is experienced begins. Concurrently, if the driver spots a cute puppy by the roadside, a period begins where it is experienced. If the driver quickly passes by it and it exits their field of view, the puppy transitions from an experienced element to an unexperienced one, then a new period begins. In this period, if the driver continues to think how adorable the puppy was, this thought becomes one of the experienced elements in the absence of the puppy.

Above, examples of the beginning of periods have been illustrated. Those are instances of short-lived periods. The act of the driver looking at the map or the ship, or directing towards the fallen navigation device, generally occurs rapidly. These elements swiftly enter the field composition and remain there briefly. Even when the driver is merely observing the road, they might momentarily see the vehicle ahead, then a broken curbstone, then traffic lights and so on. These are brief, even momentary, periods of experience. However, experiences can also endure for longer durations. As pictured above, the driver can think about an adorable dog for a while and experiences this thought throughout that duration. Other examples could be as follows: If the driver notices the ambient temperature or an unfamiliar engine sound, they may continue travelling by sensing and/or contemplating them. They could recall a memory from their youth and dwell on it for a while, or they might think about the lyrics of a song for several minutes without distraction. These represent continuous periods of experience.

In summary, momentary and continuous information that emerge abruptly during in-car navigation practice both concludes the current experience and initiates another. This means, each in-car navigation practice is a timeframe where consecutive alterations in the field composition occur. Briefly, every change in the matches between the three information providers creates a distinct experience. Therefore, for this practice to be a chain of matches also implies it is a chain of periods of experience. Indeed, the abundance of examples provided here indicates that Table 6.1 would appear as a chain of consecutive experiences if it were extended.

In in this subsection, experienced and unexperienced information have been discussed. Experienced elements, as implied by its name, are a group of elements participating in the practice while being experienced. However, it is not the case that it is only this group of elements that participate the related period of the practice. The following subsection will classify pieces of information available during an experience period according to their participation in the practice. This information will demonstrate the ways in which the driver can engage with them.

6.2 Participation of Information in Navigation

In the previous chapter, the contribution of information from three information providers to in-car navigation was discussed. In this context, only information involved in the generation of navigational information was addressed. However, during in-car navigation, information that is not involved in the process of generating navigational information is also experienced. Those, together with the foundational information for navigation, are pieces of information that accompany them. Additionally, pieces of information both transparent and absent also participate in the practice. All these pieces of information will be examined in terms of their presence and absence in the field composition at a particular moment. From this perspective, they will be classified for a given moment in terms of being present, absent and transparent for the driver.

6.2.1 Information in the field composition

The information present in the field composition during in-car navigation at a given moment is the information experienced by the driver at that time. While information experienced during the practice primarily relates to the generation of navigational information, there are also pieces of information unrelated to this process.

Examples of navigation-related information experienced during the practice include information that keeps the driver on the correct route and information that may mislead the driver navigationally. In addition to these, there may be instances where elements providing correct guidance misunderstood or misapplied by the driver. These are experienced elements as well in the practice as well. The examples can be further elaborated as follows.

In some cases, the driver may have difficulty evaluating pieces of information to make a wayfinding decision. For instance, when pieces of information are incorrect, unreliable, or contradictory at a given moment, the driver may be in a confusion created by them. Sometime more information is perceived by the driver than they can evaluate together. In such situations, some of these information sources do not contribute to navigational actions but still draw the driver's attention to the confusion they create. These are experienced intrinsic information as well.

In some instances, the driver may choose not to implement pieces of information during making wayfinding decisions, even if they know they can lead them in the correct direction. They can choose to ignore them even despite continuing to perceive them. If information sources provide incorrect, unreliable, or contradictory information, the driver may, again, choose to ignore, but perceive them. In such moments, now that those pieces of information are perceived, it can be said that the driver experiences them at those moments because they are aware of them.

In addition to elements related to the generation of navigational information, as stated above, there exist other elements that can be experienced during in-car navigation. Examples include road noise, the car's handling, the sensation of skidding in turns, the texture of the seats etc. Despite not being related to navigation, these are elements driver encounters them inevitably during the journey. Therefore, there is always engagement between the driver and these elements during the practice. However, this does not necessarily imply that they are always experienced. They may be experienced during certain moments of the practice and remain transparent during others, as will be mentioned in the subsection 6.2.2.2 Information transparent for the driver.

During the practice, there are also pieces of information that is engaged with and experienced, although engagement with them is not inevitable. For instance, the visual images of the surroundings that is not captured in the road view are such elements. An example is a ship in the open sea, which the driver can see only if they turn their head and look in that direction while driving along a coastal road. That is, such pieces of information are available but not naturally given in the practice. Another example is the parts of the map presented by the navigation device that are outside the currently displayed image on the screen at a given moment. The parts outside are pieces of extrinsic information at that moment since they are not given to the driver. Despite not being experienced inevitably, such extrinsic information is experienced when the driver's consciousness is directed toward them.

6.2.2 Information not included in the field composition

Information that is not present in the field composition during in-car navigation refers to the information that the driver is unaware of. These encompass information that absent and transparent for the driver at that time. The former includes information that the driver neither engages with nor experience, while the latter consists of information that the driver is engaged with but does not experience.

6.2.2.1 Information absent for the driver

Information that is absent for the driver during in-car navigation is the information driver does not engage with. Thus, it can be said that they do not participate in the practice at those moments. For instance, at the moments where the driver is not looking at the map display, there is no engagement between these two. Similarly, in the case of the ship at the sea, as exemplified above, the driver does not visually engage with it unless they look at it.

In the two examples above, since it is observable whether the driver looks at the relevant element, it is possible to track whether these elements are experienced at those moments. For example, if the driver does not look at the distant ship, it is evident that they are not engaged with the image of the ship and do not experience it. However, there are some pieces of information for which it is difficult to determine whether the driver is engaged with them, even if they are not observed to be experienced. This is because it is possible for such information to be either information that is not engaged with or information engaged with transparently. It can be said, based on this uncertainty, that there is a gray area regarding whether elements are experienced at a certain moment. Before examining this gray area, it is useful to discuss information that is transparent.

6.2.2.2 Information transparent for the driver

Information that is transparent refers to the information withdrawn from the field composition. In fact, the driver engages with this information, but they are unaware of it. For instance, a tree or a building right ahead of the driver within the road view is an intrinsic element, but the driver may not notice it. Another example is that when the driver turns at a corner, they undoubtedly perceive the corner optically, but this does not imply awareness of the details of the corner. Additionally, during driving, the driver may not be aware of, for example, conversations among passengers in the car as another available source of information. If the sound of the ship at the sea is within audible range of the driver’s location, the driver inevitably engages with the sound, but may not notice it. As another example, the gradually increasing darkness during twilight, which may not be immediately distinguished is transparent in this period. In addition to these examples, although the driver actively performs navigational actions, they may not be consciously aware of these actions. They may even embody these actions, or another thread as discussed in the subsection 5.3.3 Threads inside.

These are elements ready-to-hand at that moment. However, at certain moments, they can move to the mode of presence-at-hand by losing their transparency. For instance, material existence of the navigation device is generally transparent, that is ready-to-hand, during in-var navigation. Nevertheless, if there are buttons of the car obscured behind the device where it is mounted, its material existence becomes present in the driver's consciousness when the driver needs to use those buttons. Based on these examples, all these situations revolve around elements that are inevitably engaged with by the driver. That the driver is not aware of them implies that they have been withdrawn from the field composition during engagement with them. Therefore, in such cases, such information is not absent but transparent for the driver, even if it is not present in the field composition.

Nevertheless, it is not always clear whether a piece of information that is not present in the field composition at a particular moment is absent or transparent for the driver.

As mentioned above, these pieces of information are in a gray area in terms of whether they are absent or transparent. This uncertainty will be introduced below.

6.2.2.3 Information in the grey area

The idea that an element not observed to be experienced is transparent, rather than being absent, stems from the inevitability of the driver engaging with it. For instance, in the two examples of transparent elements above, what makes the idea that they are transparent reliable is the inevitability of the driver's engagement with them. On the other hand, there are elements for which it cannot be determined whether they are engaged or not, even though they are not observed to be experienced. Such elements encompass those for which engagement is possible but not certain. If it is not observed that the driver experiences such information, it is difficult to determine whether the driver does not engage with it, or they are engaged with it transparently.

The above uncertainty can be illustrated by the following contradiction. At the moments of the reemergence of an inside thread, which is the bodily practice of the knowledge embodied before, it is understood that certain elements that did not seem to be experienced in previous practices were internalized there, which means that there was an engagement between the driver and them. It can be stated based on these that it is not possible to know whether any information not observed to be experienced during a drive will reemerge in subsequent drives. Therefore, it cannot be immediately determined at first glance whether that information was internalized transparently without being noticed.

In conclusion, during a specific moment of in-car navigation, some of the available information is engaged with, some is not. Pieces of information engaged with by the driver is either experienced or transparent ones. These are present-at-and and ready-to-hand for the human at that moment, respectively. On the other hand, pieces of information not engaged with at a particular moment are the ones absent for the driver during that time. Figure 6.1 illustrates this categorization. It also includes the grey area mentioned above. In the related part of the figure, the dashed lines indicate the categories to which the elements in the grey area may belong. The use of dashed lines in this part of the figure is due to the ambiguity regarding the category to which any piece of information in the grey area belongs.

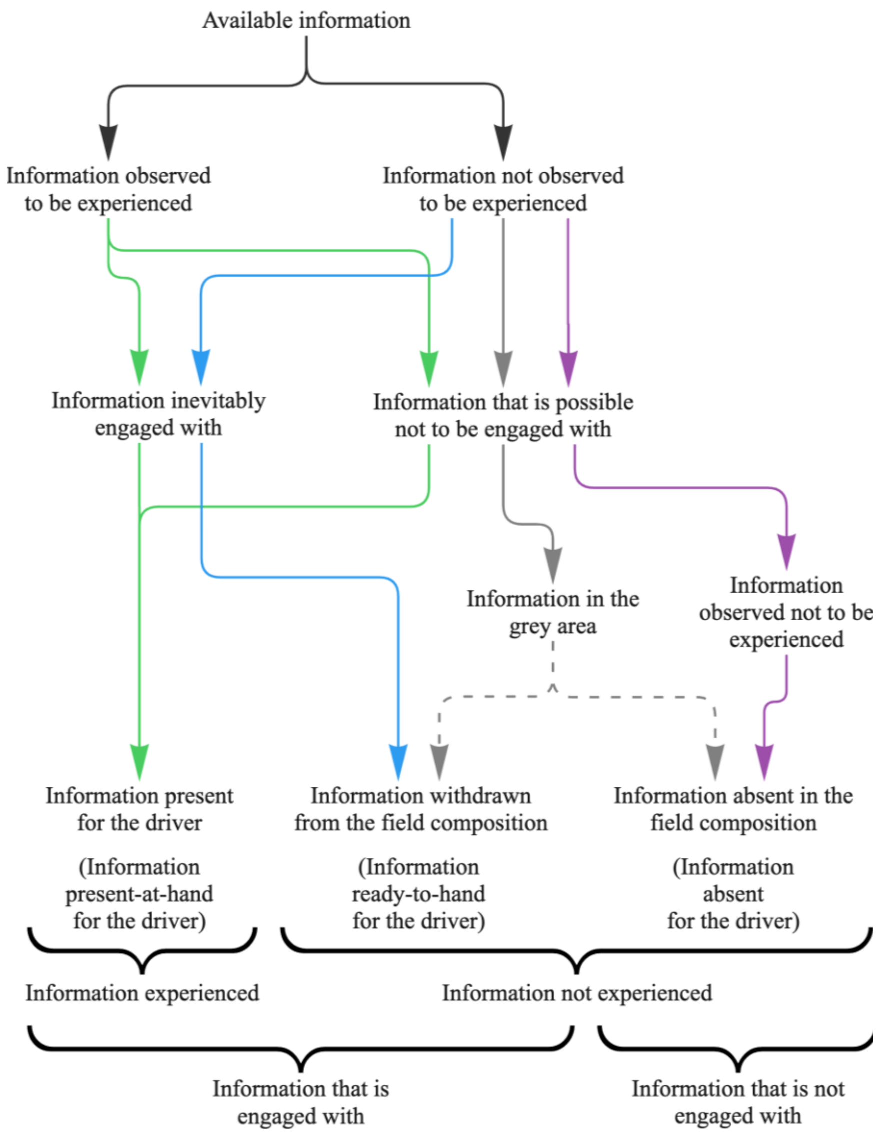


Figure 6.1 Information categorized according to driver's engagement with them at a given moment

Up to this point, the driver's relationships with pieces of information during in-car navigation has been described. The way the driver engages with each piece of information also determines the engagements with the respective information provider. Based on how the driver engages with information presented by the environment and navigation technology, 6.3.1 Semi-transparency and 6.3.2 Quasi-otherness in the upcoming subsection will discuss how these information providers appear to the driver during in-car navigation.

6.3 Participation of Information Providers in Navigation

In the preceding sections, discussions revolved around whether the information is encompassed within the field composition. Pieces of information included in the field composition reflect which part of the related information providers are extended to by the mind. Besides that, pieces of information withdrawn from the field composition reflect which part of the related information providers are extended to by the body. It means that analyzing field composition offers insight into the relationships established between humans and other information providers in a practice. The first three subsections in this section will examine how information providers participate in in-car navigation based on how the information they present participates in the practice. Followingly, the final subsection will discuss how the agency is shared among the three information providers during in-car navigation by examining their tasks during the practice. The purpose of this section is to provide the foundation for the perspectives adopted in the discussion on the boundaries between agents in the next section.

6.3.1 Semi-transparency

During an experience period, the information presented by information providers can be experienced by the driver, engaged with transparently, or remain absent without engagement. The combination of information experienced during the practice delineates the experienced portions of the related information provider, representing what is salient to the driver about it.

For instance, while driving, a driver looking ahead visually perceives some of the elements such as the intersection ahead, the traffic lamps at the intersection, the wayfinding boards over the traffic lamps and so on. If they are passing over a series of speed bumps, they feel them kinesthetically. At the same time, they may hear the music playing and the horn of a car behind. These are the parts of the environment that appear to the driver at that moment. If the navigation device delivers a voice message at that time, it appears to the driver in that manner. These elements are illustrated as opaque areas in Experience Period 1 in Figure 6.2. These parts encompass all that the driver is aware of regarding the relevant information providers. Although other pieces of information may be available at that moment, from the sea and mountain views to the cat next to the statue and the map display, the driver does not perceive, hence, does not engage with, them. They do not even notice the conversation of the passengers in the car which means it is transparent for them. Therefore, for the driver, the environment and technology are limited to what they perceive. This implies that the perceived elements determine the *breadth* of the related information providers for the driver at those moments (As a reminder, the car is a technological artifact embodied by the driver during driving. However, since the study focuses solely on navigation device as technology, information related to the car is considered as information presented by the environment. That is way the sound of the engine is illustrated as an environmental information source in the figure.).

Looking at the representation of Experience 2 in Figure 6.2, the driver is looking at the device's screen and perceiving some of the visual elements. They are also hearing a voice message from the device and a horn from behind. Additionally, they notice what the passengers are talking about, perhaps because their name has just been mentioned in the conversation. As represented in the figure, in Experience Period 2, the breadth of the environment for the driver has decreased, while that of the device has increased. This comparison suggests that the breadth of the information providers for the driver can vary across various periods of experience.

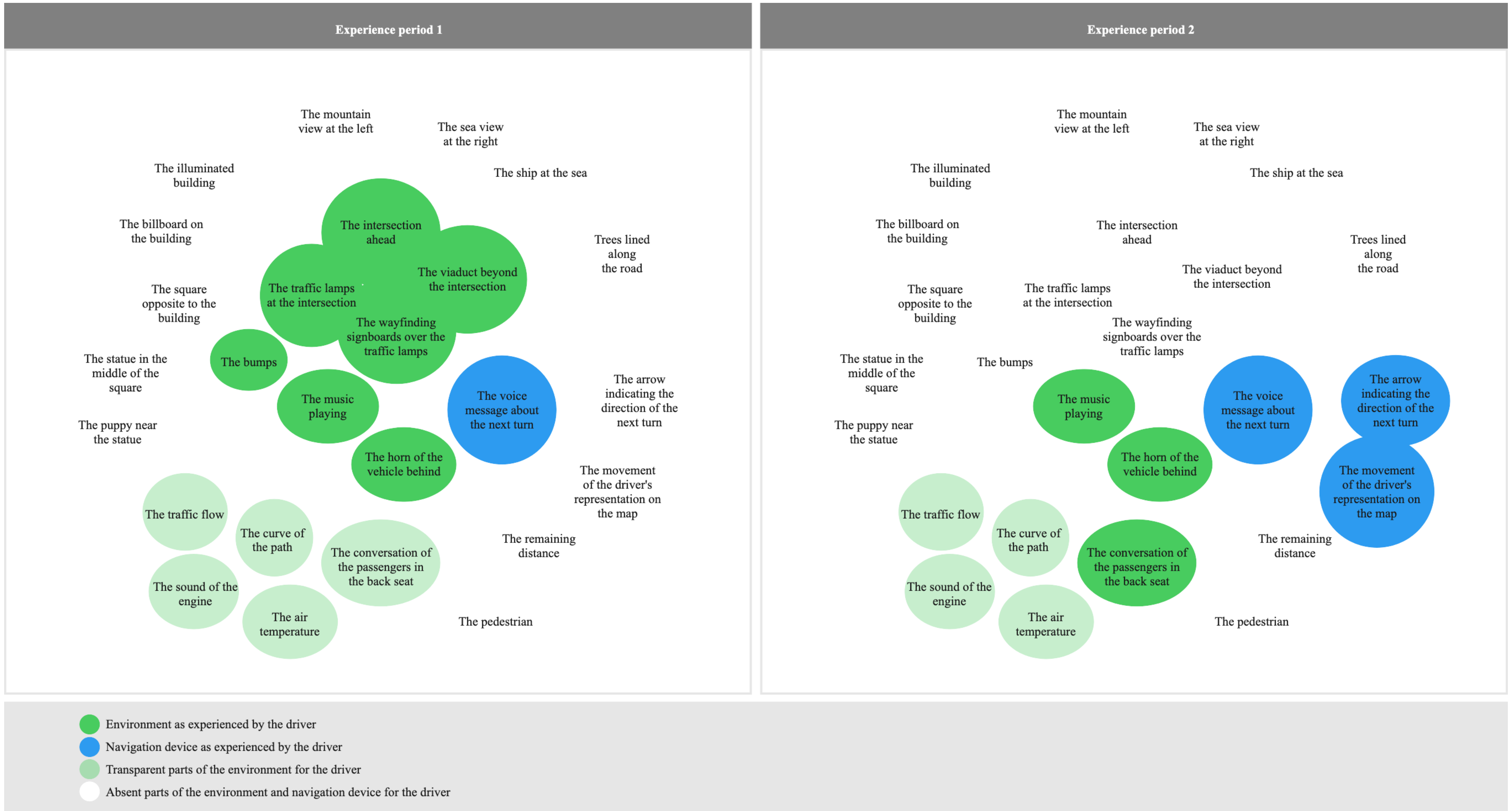


Figure 6.2 An illustration of experienced, transparent and absent elements at two different instances during in-car navigation

Like experienced elements reflecting the experienced parts of the relevant information providers, transparent elements also constitute the transparent parts of them. As shown in Figure 6.2, the scope of transparent parts varies across different experiences, like experienced parts. As understood from the representation, it is possible for the environment to be partly experienced and partly transparent at a particular moment of the practice. Throughout the study, no instances were encountered where the environment was not partly embodied. Despite how attentive drivers were to their surroundings or how high their awareness was of the elements they perceived in their environment; they conducted the driving partly in an embodied manner.

Being able to maintain a path by not deviating from the road even when inattentive to the road view demonstrates the driver's bodily engagement with the road, which is embodiment. The ability of the driver to move in accordance with the environment without consciously thinking, such as being able to turn corners even without noticing them, that the driver appears to have surrendered themselves to the flow. This relationship between the driver and environment, defined as being carried away by an outside thread in the previous chapter, continues throughout the drive.

While this relationship persists, the driver may also pay attention to their surroundings or be attracted by attention-grabbing elements in the environment. In such cases, their mind may extend to the environment as well. For example, the driver may both look at wayfinding signs on the road and notice a puppy ahead. Even in these situations, the state of being carried away by an outside thread continues. Additionally, during these times, the driver may mistakenly veer onto a previously learned route, as a reemergence of an inside thread, which is another embodiment state.

6.3.2 Quasi-otherness

As outlined above, the simultaneous engagement of the body and mind with the environment indicates that the environment is semi-transparent for the driver. Ihde

(1990) suggests that the level of transparency varies. In the case of engagement with the environment, the transparency of the environment increases as the driver's attention to the surroundings decreases. As the transparency increases, driver-environment relations approach pure embodiment during driving. The state of being carried away by an outside thread during driving is the closest state to pure embodiment because, according to the research findings, it is when the driver's awareness of the environment is lowest.

Quasi-otherness is also a form of engagement that can occur between the driver and navigation device during driving. The navigation device can be considered a quasi-other due to several features. Firstly, the driver may not fully understand the content of the instructions it provides. While navigating in an unfamiliar environment, the device acts as a quasi-other familiar with that environment and suggests wayfinding decisions. Secondly, the timing of instructions is subject to the device's unique timing. Therefore, as long as the device provides wayfinding suggestions, whether through verbal audio messages or a map, it can be said to be engaged with as a quasi-autonomous entity by the driver. Thirdly, the verbal audio messages it provides make it appear as an individual speaking, like a quasi-other.

It has been noted above that there are situations where the transparency level of the environment approaches pure transparency during driving. When comparing the environment and the device in this sense, the study does not claim that the device becomes transparent during the practice. This is because no embodiment relationship was encountered between the driver and the device throughout the study. The reason for this seems to be the limited bodily interaction between these two during the drive, especially since the driver rarely handles the device or operates it using its buttons. This means that material existence of the device is not readily experiential for the driver in in-car navigation. In fact, one of the things the driver engages with when looking at the screen is the body of the device that is its material existence. However, while the driver is perceptually engaged with the device at that moment, the primary experience is not with the perceptually engaged material, but with the meaning it provides. Therefore, the relationship established here is hermeneutic rather than embodied. Thus, the body of the device is transparent only in a hermeneutic sense at this moment.

6.3.3 Working in the background

Above, it was mentioned that while receiving wayfinding-related information, alterity relations between the driver and navigation technology are observed. Additionally, when the device does not provide voice messages and the driver does not look at the screen, the driver may completely forget that they are using a navigation device. During such times, the relation between the driver and the device can be explained by background relations. It is true that the device operates during these times, with, for instance, the dynamic map moving and the texts on the screen constantly changing. However, until the driver looks at them, or hear a voice notification, or remembers that a navigation device is present there, they do not engage with the device, hence, it is absent for them. In its absence, it is background relations that is established between these two.

Background pieces of information presented by the navigation technology constitute its part remaining in the background at that time. While this part of the technology is in the background, another part can be engaged. In this regard, it may be helpful to recall Figure 6.2. As it illustrates Experience period 1, at that moment, the driver perceives a voice message from the device. Meanwhile, information such as the arrow indicating the direction of the next turn or the movement of the driver's representation on the map is not engaged with by the driver. This means that while the voice message is present for the driver, the other information provided by the device is absent. Thus, the device is partially present and partially absent for the driver.

The device being partially present and partially absent simultaneously is analogous to the environment being partially embodied and partially perceived, i.e., partially transparent, and partially present. However, it should be noted that, as observed in this study, this condition of the environment is valid throughout the entire drive. For the device, in contrast, it depends on the situation. It is indeed possible for the device to be completely absent, and this occurs frequently during the drive, sometimes for extended periods. In fact, there are situations where the device operates in the background for the entire duration of the drive. For example, there are instances when the driver activates it not out of necessity but just in case it may be needed. In such a scenario, if the driver mutes the device and never looks at the screen throughout the drive, the relation between them is a background relation during the entire process.

6.3.4 Sharing agency

Since the practice that the study interests is in-car navigation, the scope of the term agency here is playing a role in the fulfillment of navigational tasks and characterizing the experiential nature of the practice. Contribution to the fulfillment of navigational tasks can occur in two ways. The first involves providing information by contributing to both wayfinding decisions and locomotion performed without any decision, either by conveying or processing information. The second entails physically performing locomotion by moving. While the first type of participation is feasible for all information providers, the second seems it could only be performed by the driver. This section will argue that even when the driver appears to be performing an action themselves, agency is shared among three agents.

6.3.4.1 In terms of participation in the practice

Information providers may, in certain instances, be unable to offer navigation-related information. Reasons for this may include, as introduced in the section 5.4 Alterations in Matches, the absence of a map for that environment in the navigation system, the lack of landmarks or wayfinding signs in the vicinity, or the driver's lack of environmental knowledge. Such a situation can be explained by the incapacity of the relevant information provider to supply information at that moment. In this scenario, the information provider cannot contribute to the generation of navigational information. Consequently, during this moment of the practice, it may appear as if it is not acting as an agent. However, as long as there is any relation with the driver, it is also one of the agents. This is because its influence on shaping the practice cannot be denied despite the absence of a contribution to navigational information.

This situation applies even when, for example, the navigation device seems to work in the background. Let's consider a moment where the driver does not receive any visual or auditory message from the device, meaning that it is perceptually absent for the driver. If the driver forgets that there is a navigation device working in the car, the engagement between the two, as mentioned above, can be explained by background relations. However, there are also instances when the driver is aware of the device's presence in the car, despite not receiving any information from it. For example, even at the moments the driver does not receive information from the device, they may continue travelling with a sense of trust in its presence. This means, the presence of the device may result in the characterization of the practice with a sense of trust at those moments. Therefore, it should be considered that the device is an agent in such a scenario.

6.3.4.2 In terms of the role played in making wayfinding decisions

In cases where all three information providers directly provide information related to a navigational task, there are situations where each of them participates in the task to approximately equal extents. This means that in such cases, the information provided by all three is utilized in navigation to roughly similar degrees. In these instances, it can be said that they share agency in approximately equal proportions. However, this is not always the case. Information providers may play role in accomplishing navigational tasks to varying degrees. Insights into the reasons for these variations are elaborated in 5.4 Alterations in Matches.

For instance, even if the environment or navigation technology provides information directly related to the current navigational task, this information may go unnoticed by the driver. In such cases, the information provider presenting this information may not have participated in the navigational task. In some instances, the driver may notice the provided information but choose to disregard it. Wayfinding-related elements noticed but calmly disregarded include the ones that the driver finds unreliable or contradictory, or simply chooses not to use based on preference. When a piece of wayfinding-related information is disregarded at a particular moment, the relevant information provider is less influential in wayfinding decisions compared to others.

Additionally, during the generation of navigational information, there exists information that is prominently noticeable in special occasions. An example of such information is wayfinding-related information to which the driver pays attention during moments of crisis. For instance, during a panic moment, certain elements may capture the driver's attention beyond their control due to the impact of the crisis. In such situations, the information provider presenting these elements may be more effective in wayfinding decisions compared to those mentioned earlier.

The ranking below represents an increase in an information provider's agency from top to bottom.

- When the information it provides completely unnoticed
- When the information it provides noticed but calmly disregarded
- When the information it provides calmly employed
- When the information it provides prominently noticeable in time of crisis

In this subsection, the focus has been on the agency regarding how effective information providers are in influencing wayfinding decisions. However, the above hierarchy applies not only to the wayfinding-related information, but also to the information that does not affect wayfinding decisions. Let's consider the involvement of a conversation among passengers in the car. The driver may not notice this conversation at all, notice it but not care, calmly engage in the conversation, or if the conversation is heated, it may draw their attention excessively.

In this ranking, the agency of the conversation as an environmental element increases progressively in terms of characterizing the practice.

6.3.4.3 In terms of initiative

As outlined in Chapter 3, the driver, environment, and navigation technology are in constant interaction throughout the practice of in-car navigation, influencing each other. Within this interaction, for example, the driver's movements and the environment determine the information provided by the navigation technology; the environment and navigation technology influence the driver's movements; and the driver's actions partially shape the environment, such as when other drivers in traffic adjust their behavior based on the driver's actions. These interactions suggest that agents have the initiative to shape the practice. In addition to this capability, specifically providing wayfinding directions can also be associated to their initiative. In summary, agents participating in in-car navigation practice have agency in determining *what to do*. Indeed, the preceding subsection addressed their influence in this regard. In addition to what to do, the driver also has agency in another aspect: determining who has the initiative regarding what to do, which means delegating the task of making wayfinding decisions.

In the previous subsections, it was mentioned that in some cases, an information provider does not offer information about wayfinding decisions, or the information it offers may not be correct or reliable. Sometimes, this information provider can be the driver themselves. For instance, the driver may have no idea about the route in an unfamiliar environment or may struggle to recall the route even if they previously used it. In such cases, they may largely delegate the decision-making for wayfinding to the environment and/or navigation technology. While the decision to delegate this task lies with the driver, the reason for doing so is their incapacity. Therefore, it cannot be said that they have a high initiative in this regard.

In some cases, even if the driver possesses environmental knowledge, they may choose not to utilize it in making wayfinding decisions. This choice could stem from a lack of confidence, a preference for relying on other information providers, or finding receiving information from them more enjoyable. These are situations where the driver does not provide a considerable amount of information for wayfinding decisions, but it is by choice rather than incapacity. In such situations, where the driver chooses not to provide information, they may be more actively engaged in practice compared to situations where incapacity prevents them from participating in decision-making processes. Therefore, it can be argued that, when comparing the inability to provide information due to incapacity and choosing not to provide information, the driver is more actively involved in the practice in the latter scenario, participating in it through more initiative.

If the information provided by all three information providers is inadequate for making wayfinding decisions, the driver may navigate by making random decisions. This represents a scenario where the driver stands out by at least taking initiative on what to do. Sometimes, however, such a lack of information may push the driver to engage more actively in interpretation, calculation, etc. This implies that the driver takes on more responsibilities in those moments compared to situations where they make random decisions. Sometimes, even when the information is sufficient, the driver may choose to rely on interpretation and calculation instead. This demonstrates the driver's more active involvement in fulfilling navigational tasks, as this behavior is the result of the driver's preference rather than necessity. Making a choice and implementing it indicates a greater role for the driver in those moments in the practice.

The situations described here are presented below in a thread that reflects the increasing agency of the driver.

- Delegating authority in making wayfinding decisions out of necessity
- Taking authority in making wayfinding decisions out of necessity and making decisions randomly
- Taking authority in making wayfinding decisions out of necessity and making decisions using pre-acquired information

- Taking authority in making wayfinding decisions out of necessity and making decisions using dynamically derived information
- Voluntarily delegating authority in making wayfinding decisions
- Taking authority in making wayfinding decisions by preference and making decisions using pre-acquired information
- Taking authority in making wayfinding decisions by preference and making decisions using dynamically derived information

Based on this, the higher the initiative of an information provider in making decisions at a given moment, the greater their agency is at that moment. When the initiative and agency of the environment or navigation device increase, it can also be said that their otherness level also increases. This is because the higher initiative as regards to wayfinding decisions is, the more the information provider is perceived as an entity with its own will. This also implies that as the taken-for-grantedness increases in the relationship between the driver and another information provider during wayfinding, the level of otherness of that information provider also increases.

As to the driver’s initiative in assigning wayfinding tasks to other information providers, the driver's agency is also directly proportional to it. However, if the authority they delegated to other information providers increases, their agency in decision-making decreases at the same time as seen in Figure 6.3.

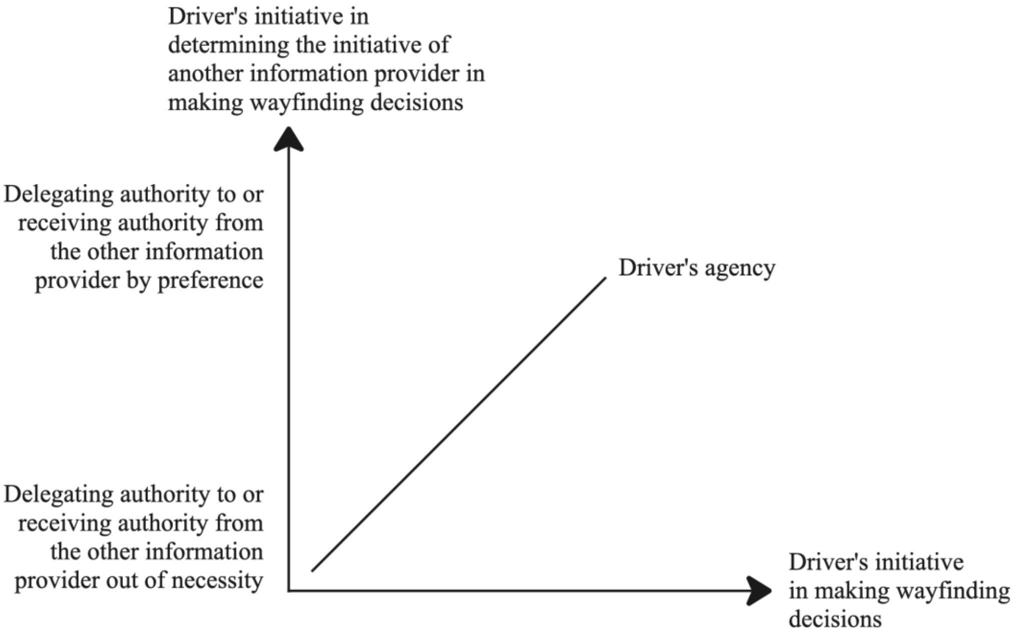


Figure 6.3 Agency of the driver based on their initiative over other information providers in making wayfinding decisions

From the perspective of alterity relations, an increase in the driver's initiative in delegating authority to other information providers or receiving authority from them implies a decrease in the level of their otherness. This is because an increase in this initiative means more control over them; and as this control increases, the perception that the other information providers have their own will, and own lives, weakens.

6.3.4.4 In terms of the role played in locomotion

In situations where locomotion during in-car navigation is carried out based on wayfinding decisions, all agents involved in these decisions, also have agency in locomotion. This means that whereas locomotion may appear to be solely performed by the driver, other agents also have an influence on it. Regarding instances where a locomotion is conducted without a wayfinding decision, this study concludes that both the driver and the environment are agents in locomotion, while the navigation device has no influence in this action. This will be further elaborated below.

In locomotions performed without wayfinding decisions, the driver may appear to be the sole agent at first glance, as stated above. However, the locomotion is facilitated by specific stimuli originating from external sources even in those cases. More specifically, the environment relaying these stimuli is an agent playing a role in such events as well as the driver. These situations are, as discussed in the previous chapter, the moments of embodiment.

In instances of locomotion performed without a wayfinding decision, the environment shares agency with the driver in three ways. That is, it can have three distinct roles in these actions. One of these is to present to the driver a thread in which they are immersed at the moments of being carried of by an outside thread. Here, the thread presented by the environment induces the driver’s movement. Therefore, the environment could be considered as a directive agent in these actions. At these moments, another role of the environment, indeed primarily, is to provide space for mobility. In this space, there are pathways that both enable locomotion, and determine and constrain its direction. In this sense, it is observed that the environment here plays a role as an agent that both facilitates and directs mobility. It is also undeniable that this role, providing space for mobility, is present not only when moving without a decision, but also when wayfinding decisions are taken as well. At the moments when wayfinding decisions are made (as it is possible while being carried away by an outside thread as well), the environment also participates in navigation if it provides references for wayfinding. Briefly, it acts as an agent that provides space for mobility, induces the driver’s movement, and provides references for wayfinding. Based on this, it can assume roles that prioritize bodily relations as well as the roles that emphasize cognitive relations.

To avoid misunderstandings, it is necessary to clarify the following point. The roles of the environment described above are defined separately, but this does not mean that the environment cannot assume one role while also assuming the other. Rather, these roles are observable together. Indeed, it is evident that the environment provides space for navigation practices in all cases. For example, obviously, it provides space both at the moments of decision-making when it provides wayfinding references, and at the moments of embodiment when it presents a thread by which the driver is carried away. It should also be noted as another example that even in situations where the driver moves without awareness under the influence of their internalized knowledge at the moments of reemergence of an inside thread, locomotion is still an action where the environment also plays a determining role. In other words, even at those moments, the driver is not only under the influence of the internalized knowledge but also guided by the environment. Although they may be moving without awareness at such moments, not hitting a wall, or being able to turn when approaching corners, indicates that the space provided by the environment still determines the experience. This also shows that there is a relationship between the environment and the driver even in moments when awareness is interrupted. This relationship between the environment and driver continues without interruption even when awareness is disrupted. This is because this relationship is the bodily engagement between the two that will be discussed in the next section.

This finding is one of the most crucial ones for understanding the nature of driver-environment relations during driving in this study. Because to understand how navigation technologies that intervene in navigation practices change the relationship between the driver and environment, it is necessary to define how these two engage with each other in unmediated practices. The following section will address this relationship in terms of the boundaries between the environment and driver.

To summarize this issue from the driver's perspective, at the moments of decision-making, the driver participates in the practice both with their existing knowledge and information, and the information they derive simultaneously. Hence, at those moments, they are one of the agents of decision making in addition to being the agent who moves to perform locomotion. However, in embodiment situations, the driver is solely move in the environment in the absence of a decision. In embodiment situations, the driver lacks the characteristic of being a thinking agent, thus narrowing the scope of their participation in practice.

As for the participation of navigation technology to the practice in the case of locomotion without wayfinding, it does not play a role in embodied relations where a wayfinding decision is not made. Rather, it does get involved in wayfinding process, as it is its purpose. The following generalization can be made based on this. Navigation technologies addressed in this study are involved in environment-driver relations established through mind, rather than in bodily relations between them. In other words, these technologies appear to participate in the cognitive relationships between the driver and environment; however, they do not seem to intervene in their embodied relationships. Figure 6.4 shows the tasks performed by the three agents in in-car navigation practices.

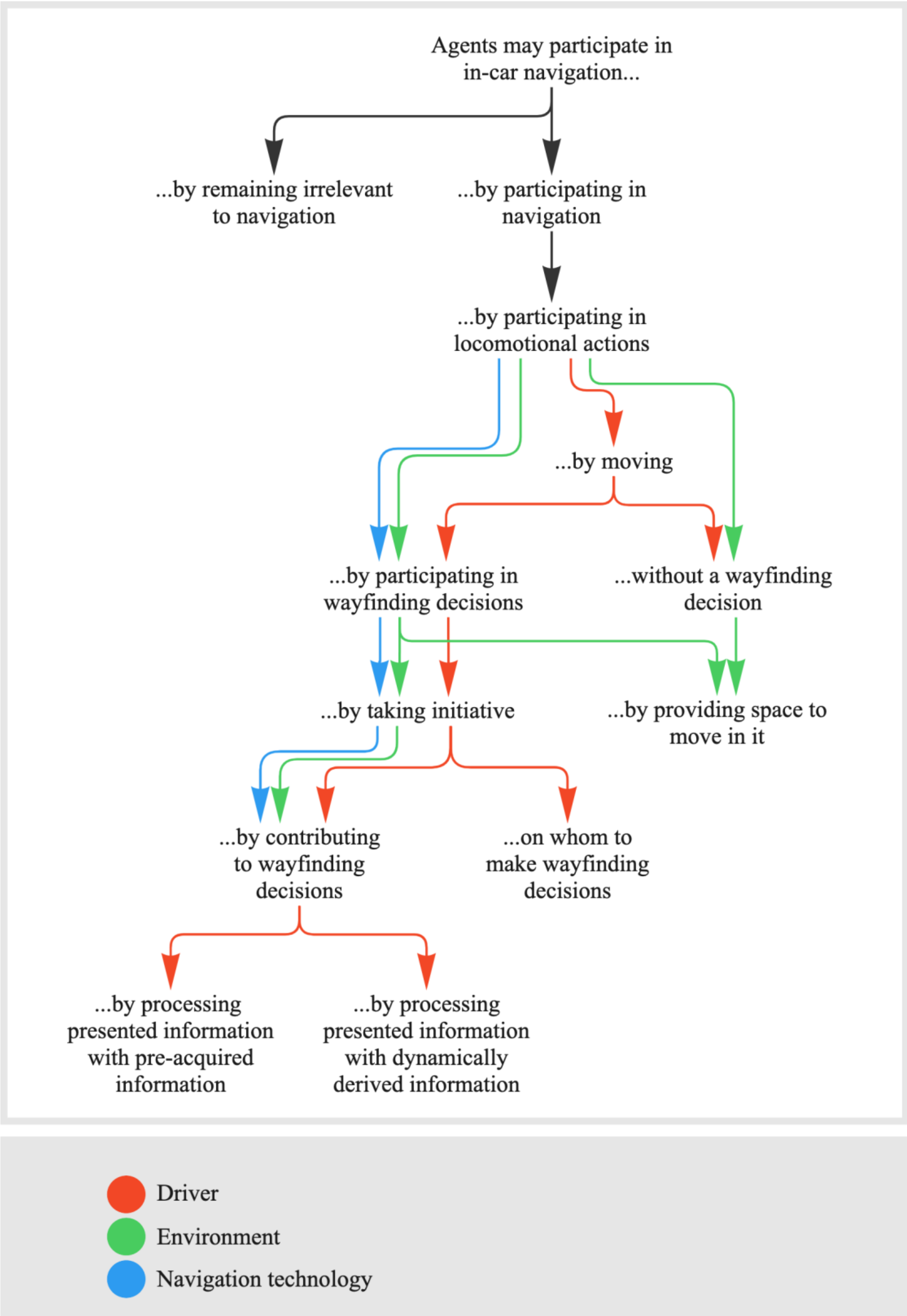


Figure 6.4 Tasks agents may perform during in-car navigation

6.4 Boundaries of the Agents in In-Car Navigation

As outlined in the section 2.3 Basics of Boundaries of Self, boundaries, which are variable and sometimes ambiguous, of human and materials involving a practice can be discussed based on extendibility of the body and mind, and shared agency. Accordingly, this section will examine the boundaries of information providers participating in in-car navigation through the lens of these concepts.

6.4.1 In terms of the scope of environment and navigation technology

The breadth of the environment and navigation technology for the driver, contingent on the combination of elements extended by the driver's mind, varies across each experience period throughout the practice. Experienced parts of the information providers for the driver broadens or contracts based on how much of the elements they present are extended to by the driver's mind. In experiences where the number of these elements increases, the boundaries of information providers expand for the driver, while in experiences where it decreases, they contract. For instance, in one experience period, the driver is aware of the road view, surrounding buildings, plants, other vehicles, pedestrians, honking sounds, and audible notifications from the navigation device. In contrast, in another period, the driver solely focuses on the screen of the navigation device, noticing only the honking sounds, without visually perceiving other surrounding elements. In the first scenario, the environment appears wider, whereas in the second one, it seems narrower. When comparing these two experience periods regarding boundaries of the navigation device, in the first period, only the sound of the device is heard, while in the second, visual pieces of information on the screen are also included in the field composition. This indicates that the device's boundaries are broader in the second scenario.

This discussion on boundaries centers on the scope of the environment and navigation technology as perceived by the driver, emphasizing their breadth in in-car navigation. The section will proceed by address the concept of boundaries in terms of alterations observed in the boundaries that separate the driver from the environment and navigation technology during the practice.

6.4.2 Boundaries between the driver and environment

In the context of this study, the most notable relations between the driver and environment during in-car navigation are embodiment relations. When the driver embodies the environment to some extent, it becomes semi-transparent to them. As the transparency of the environment increases, the boundaries between the driver and environment blur. Blurred boundaries essentially indicate the onset of the extension of the body through the environment, and the environment's disappearance from the perspective of the driver. This, as described above, explains situations where the environment narrows from the driver's viewpoint. This explanation also applies to the moments of being carried away by an outside thread.

In the scenario of being carried away by an outside thread, the driver becomes immersed in the surroundings, merging with them. This suggests that the driver does not function as a separate entity from the environment at that moment. Thus, it implies the blending of boundaries between the environment and driver, signifying their unity at that moment. According to this study, the most distinct example of this unity is that, even in the most absentminded moments, the driver can continue to maintain a *bodily harmony* with physical entities in the environment. In other words, despite not consciously deliberating, they can navigate without colliding with obstacles, adjust speed in response to traffic, and respond to signals like traffic lights. In this case, these elements are not objects of the experience anymore but rather subjects that contribute to shaping locomotion within their coherence with the driver. Thus, they are not the objects of the experience, but elements participating in the unity of the driver and environment which is the subject of the experience.

Upon analyzing the information obtained from driving sessions, it becomes evident that driving fundamentally entails achieving a bodily harmony, which requires the embodiment of the environment, from beginning to end. Throughout the act of driving, the driver seamlessly adapts to changes in traffic and environmental dynamics, with their mobility forming threads where adjustments occur instinctively. As long as everything goes smoothly, the driver can navigate without consciously focusing on these aspects. In that case, the elements of the environment are ready-to-hand for the driver. Instances where the driver directs attention to specific elements in the environment indicate moments, for instance, when not everything proceeds smoothly, or when particular objectives come to the forefront, or when some element captures the driver’s attention. For example, if the driver encounters a deep pothole, or starts searching for wayfinding signboards, or when someone walking on the sidewalk catches the driver’s eye, their attention extends to these elements, making them present-at-hand at those moments.

As outlined previously, when bodily harmony, or embodiment, between the driver and the environment is disrupted, the relevant parts of the environment become present-at-hand. However, the environment never becomes entirely present. For instance, when the driver carefully examines wayfinding signboards to understand where to turn, it is true that they are present-at-hand, yet the driver remains unaware of some other elements with the environment. This means that even if signboards are present-at-hand, other aspects of the environment, such as the movement of vehicles, remain ready-to-hand. Accordingly, in such moments, the boundaries between the driver and the environment partially blur while partially remain the same.

Still, as previously mentioned, when everything proceeds smoothly, the driver can also travel in a state of great absentmindedness, almost forgetting that they are on a journey. Participants in the study was travelling with this level of absentmindedness just before exclaiming in surprise, "Who pushed me?", "They were the ones speeding up," or "It turned me itself." as mentioned in Chapter 5. These moments of absentmindedness represent the times when the environment's transparent field is at its widest, approaching pure transparency. It is during these moments that the most extensive unity between the driver and the environment occurs.

Regarding the reemergence of an inside thread, at such times, the knowledge previously embodied by the driver reappears in their body and transforms into action. In other words, the driver moves based on the information encoded in their body without consciously contemplating how to navigate the environment. However, it is essential to note that the unity of the driver and environment described above still applies during this period; that is, the driver both implements the internalized thread and embodies the environment while traveling. Therefore, being carried away by an outside thread also occurs during the reemergence of an inside thread. The relationship between these two conditions will be revisited at the end of this subsection. Before that, it is necessary to provide further information about the internalization of a thread.

Throughout the study, examples of the internalization of a thread presented by the environment were examined. The research revealed that what is internalized is not merely environmental elements or their relationships, such as individual details of the environment. Instead, what is internalized is a cohesive entirety related to the environment, where individual environmental details are not discernible. This entirety represents a unified and independent quality that transcends individual elements. During the internalization of a thread, environmental elements are not encoded as separate entities. For example, the driver is not consciously aware of transitioning from a tree-lined road to a stone-walled building because they have not learned these elements as individual entities. Instead, what they have learned is the experiential relationship between them (such as the thread of encountering one after the other).

What is learned being experiential signifies that this learning is practice-based. The fact that the elements are not individually noticed stems from the learning being bodily rather than mental. This is precisely why participants, in cases of the reemergence of an inside thread, could not articulate how they accomplished navigational tasks correctly. To elaborate further, due to their lack of awareness of the environmental elements, they lacked landmark knowledge. Moreover, since they were unaware of their movements within the environment, they also lacked route knowledge. They did not even feel familiar with their surroundings. In essence, it seems that they did not know about the environment. However, they somehow know about navigating, as a skill, within those areas. In other words, they had developed navigation skills from their experiences in navigating those environments.

This form of learning being skill-based sets it apart from acquisition of landmark knowledge, route knowledge, and survey knowledge. For instance, unlike the internalization of a thread as mentioned above, people can talk about landmarks, articulate routes, provide directions to each other with this kind of knowledge, which means that they can think about these concepts and verbalize them.

The difference between these two can be further elucidated as follows: Landmark knowledge, route knowledge, and survey knowledge are acquired through the experience of landmarks, routes, or areas (here, experience doesn't solely refer to physically traversing a road; it also includes receiving directions about them, learning them from maps, or seeing the route on a display, which are different ways of experiencing them). Hence, here the environment is the object of learning. In such a learning scenario, the driver is the subject, and the related pieces of environmental information are the object; and the driver’s mind extends to these objects. The boundaries between the driver and environment are clear-cut in this form of learning, as these pieces of information stand distinctly in the field composition, as elements separate from the driver. On the other hand, in the case of internalization of a thread, the object of learning is the practice related to it. This internalization, being embodiment, necessitates the partial (or near complete) dissolution of boundaries between the driver and environment, as explained before. This means that the subject here not the driver, but the unity of the driver and environment. That is why it is emphasized above that internalizing a thread requires embodying an outside thread. Table 6.2 summarizes the difference between these two types of learning in this subsection.

Table 6.2 The difference between acquisition of environmental knowledge and internalization of a thread

Acquisition of landmark knowledge, route knowledge and survey knowledge	Internalization of a thread
The subject of learning is the driver.	The subject of learning is the unity of the driver and environment.
The object of learning is the environment.	The object of learning is the practice.
What is extended to the environment is the mind.	What is extended to the environment is the body.
The related environmental elements are experienced, thus, present.	Environment is embodied, thus, transparent (at least partially).
The driver comes to know about the environment.	The driver develops skill.
The knowledge is verbal.	The knowledge is tacit.

6.4.3 The impact of technological mediation on boundaries

6.4.3.1 Boundaries between the driver and navigation technology

It was mentioned in the preceding section that no embodiment relationship was observed between the driver and device during the entire study. As a result, it consistently maintained its distinct boundaries with the driver. As elucidated in the previous section, the limited bodily interaction between the driver and device during the drive appears to account for this. The establishment of alterity relations and hermeneutic relations between the driver and the device during their engagement was also discussed above. In these relations, the device remains perceptible to the driver in some way. Particularly in alterity relations, as the device's level of otherness increases, its boundaries with the driver become clearer. This is because the closer the device is to being an other, the more distinct it appears as a separate entity from the driver's perspective. Within the scope of hermeneutic relations between these two agents, it could be argued that the boundaries are somewhat blurred. This is because during these moments, the meaning of the content provided by the device is experienced rather than the physical presence it presents. This means, in hermeneutic relations, the physical presence of the device is what enables the driver to experience the meaning rather than being directly experienced.

6.4.3.2 Interference of the navigation technology in the boundaries between the driver and environment

Given this information, it can be argued how the navigation technology practically influences boundaries during the mediation of in-car navigation. The introduction could begin by raising a question posed in the relevant literature, namely whether the use of this technology leads to disengagement between the driver and environment. The study seeks to address this question from two perspectives: engagement established through bodily interaction and engagement established through the mind between the driver and the environment. Firstly, the continuity of the unity of the driver and environment during driving indicates that the device does not have an effect that would disrupt this unity completely. It is not surprising, as the driver does not interfere in the bodily engagement between the driver and environment since its use requires minimal bodily interaction. Yet, as the driver engages with the device through the mind to a large extent, it is debatable whether it influences the relationship established through the mind between the driver and the environment. In this regard, an initial observation could be articulated as follows. The device works not to prevent the extension of the mind to the environment, but rather to connect it to the environment by providing information about it. Also, during the hermeneutic experience of the provided environmental information, material existence of the device is largely withdrawn from between the driver and environment. Therefore, the study does not support the idea that the device causes disengagement between the driver and the environment in this regard.

However, if the information provided by the navigation technology draws the driver's attention to certain environmental details, it may also detach their attention from some other environmental information. For instance, a driver who is appreciating a seascape or examining the decor on a distant building wall at a certain moment of the drive may shift their focus from the element they were just interested in to the upcoming turn when the device's voice notification refers to the next turn. Considering this, it is not a matter of the device disconnecting the driver's mind from the environment, but rather influencing which environmental elements the mind extends to. In other words, the device alters the scope of information the driver receives from the environment, thus changing what the driver knows about the environment. That is, it shapes *what is known* by the driver about the environment; consequently, *what it is* from their perspective.

The effect of the device's mediation of the engagement between the driver and environment established through the mind also partially affects the bodily relationship between the two. To elaborate further, the alteration of environmental elements extended by the mind by the device leads to partial disruptions in the embodied unity of driver and environment. For example, some environmental elements may be transparent to the driver before the device relays information about them, but they become experienced due to the device drawing attention to that information. For instance, on a straight road where the driver may not pay attention to an intersection ahead, if they hear a message from the device instructing them, for example, to continue straight at the intersection, the intersection becomes an element noticed by the driver. Such a scenario represents a situation where the device partially disrupts the unity of the driver and environment, as the initially blurred boundaries between the driver and intersection become clear when the device draws attention to it. Because at that moment, the intersection becomes detached from the driver, and becomes the object of the experience.

The device may also potentially render certain environmental elements transparent while directing attention to others. For instance, when the driver ceases to focus on the decor of the distant building upon hearing a voice notification about an upcoming turn, the building may become transparent in their perception. At that moment, the building ceases to be the object of experience and becomes integrated into the driver-environment relationship, which means its boundaries with the driver blur. Indeed, in such instances observed in driving sessions, it is understood that the experience with the elements in question ended when the drivers later admitted to forgetting them. However, determining whether the element became transparent or absent when the experience ended is not feasible with the methods employed in this study. Consequently, it remains unclear whether the element was absent due to the driver looking elsewhere or was transparent because it went unnoticed within the field of view. Thus, this element remains in the grey area, introduced in the subsection 6.2.2.3 Information in the grey area, where it is uncertain whether it was absent or transparent. In such circumstances, it is challenging to make a claim about whether the element is participated in the unity of the driver and environment.

Another relationship that appears to influence the driver's interaction with the environment is the taken-for-grantedness between the driver and the device. The comfort afforded by using the device might lead the driver not to pay sufficient attention to their surroundings. In fact, two participants among those who used navigation technology less than the others believed that extensive use of the device would reduce environmental awareness. While this belief is merely a personal assumption of these participants and lacks empirical evidence, it is a common view. However, this study does not support the claim that taken-for-grantedness has a negative impact on environmental awareness. Moreover, during such a relationship, when the agency of the device in making wayfinding decisions increases, the driver may even find more opportunities to attend to environmental elements that do not contribute to wayfinding. Nevertheless, the study does not provide evidence on this matter as no difference was observed between participants who largely assigned wayfinding tasks to the device during the drives and others.

The study does not provide evidence regarding the impact of using navigation technology on environmental awareness, nor does it offer findings on acquisition of landmark knowledge, route knowledge, or survey knowledge. However, it leans towards the view that the use of this technology may not negatively affect the internalization of threads during practice. This is because internalization necessitates the embodiment of the environment, and this embodiment occurs inevitably during driving, regardless of whether a navigation device is being used or not. Therefore, the use of the device does not hinder the driver’s bodily connection to the environment. Hence, it is not surprising that when a driving practice on a specific route is repeated enough times, the driver internalizes the threads offered by that practice, regardless of whether they use a device or not.

Nevertheless, whether the use of the device intervenes in the duration of moments when the environment is extensively embodied remains open to debate. Therefore, whether it supports or hinders the skill development mentioned above is also a matter of debate. For instance, the presence of this technology may reduce the need for the driver to focus on the environment and thereby expand the scope and duration of the embodiment, thus supporting the acquisition of tacit knowledge. Alternatively, as an information provider that shortens experience periods with its voice notifications, it may also frequently interrupt moments of expanded embodiment, thus undermining the acquisition of tacit knowledge. However, the study has not reached a conclusion on this matter. At least, throughout the study, no evidence has been found to suggest that it reduces moments when the environment is extensively embodied.

In summary, according to the results of the study, navigation technology does not significantly hinder the relationship established through the mind or body between the driver and environment. Particularly, there is no noticeable negative impact on the bodily interaction between the two. Indeed, considering the inherent nature of human existence, complete bodily detachment from the environment seems unlikely. Instead, while technological mediation may sever specific aspects of the driver-environment relationship, it fosters alternative connections between them. In this regard, navigation technology provides an alternative model of the environment to be directed towards, even if it steers the driver away from certain environmental elements.

6.4.3.3 About the engagements modified and afforded by the navigation technology

One of the criticisms regarding the potential disengagement between the driver and environment induced by navigation technologies revolves around the perception that such disengagement weakens driving safety. Yet, this remains a topic open to debate. Within the driving practice, while there may be moments where the mind recedes into the background, there is never a moment when bodily activity becomes entirely dormant. As previously mentioned, even if the mind disengages from the environment, the body continues to interact with it. This seems to underscore the possibility of safe driving even during periods of cognitive lapse.

The issues raised above concerning the mediation of environmental experience through navigation technologies represent practical concerns. Epistemological drawbacks related to this matter can also be posited. For example, during mediation, the perceived manifold of the environment diverges considerably from the actual environment. Typically, in an unmediated engagement, the human relates to the real environment primarily interacting with its physical existence, that is perceiving it physically. For instance, they see concrete elements, hear voices, sense air temperature etc. These *unfiltered* experiences represent the most authentic encounters with the environment which means that what is experienced here is manifolds closest to the real environment. However, when navigation technologies intervene, they provide a digital model drawing attention away from the physical existence of this phenomenon. Thus, the experience mediated through this digital representation, in comparison to unmediated experiences, distances the human from the real environment more.

The interactive nature of navigation technologies introduces another epistemological challenge. Given that technology mediates each navigation practice in a distinct manner specifically to that practice, experiences of different humans, even within the same environment, diverge. This decreases the possibility of a shared environmental experience to exist. In fact, unmediated environmental experiences are already unique inherently. However, the distinctions between experiences mediated by these interactive technologies are inevitably greater since interferences of these technologies to experiences, too, are distinct from each other.

6.5 Summary

The findings presented in this chapter can be summarized as follows.

- During in-car navigation, when a new piece of information appears in the field composition, it ends the current experience and starts a new one. This makes the navigation process a thread, with intervals between these interruptions by new information. Thus, each alteration in the relationships among the information providers results in a new experience period, suggesting that the entire practice can be viewed as a chain of experience periods, as well as a chain of matches between the information providers.
- The state identified in this study as being carried away by an outside thread involves an experience where the thread presented by the environment is embodied to some extent, resulting in its semi-transparency. This transparency signifies the dissolution of boundaries between the driver and environment. When elements in the environment are embodied, the driver and them participate in the practice at those moments not as separate entities, but as a whole. This embodied unity is the subject of the navigational experiences during those moments.
- Throughout the driving practice, the environment remains semi-transparent at every moment. This means that it is partially experienced and partially embodied at each moment of the practice. There are instances where the

environment is embodied to a large extent, where the driver navigates almost unconsciously. The environment approaches a state of pure transparency in these instances. Despite the diminished awareness during such moments, the driver can still navigate safely on the road. This implies that driving is a practice where the driver establishes a bodily harmony with the surroundings. Even if the driver is unaware, their ability to navigate on the road is associated to the bodily harmony between the driver and environment.

- During the embodiment of the environment, pieces of information may be encoded in the body as tacit knowledge. In such cases, the driver can learn to navigate within a given environment, even when their awareness of it is significantly reduced. This type of learning differs from the acquisition of knowledge related to landmarks, routes, and areas. It is a process of skill development related to navigation practice in that environment rather than being acquisition of knowledge related to the environment itself.
- Navigation devices primarily assume the cognitive tasks during navigation, with minimal bodily interaction. As a result, it has not been observed to be embodied, which means that moments of its semi-transparency are not encountered, throughout the study. It can be argued that it is engaged as a quasi-other rather than being semi-transparent. As the device becomes more distinct from the driver as a quasi-other, its boundaries with the driver become more defined. This occurs because the device appears as an entity separated from the driver when it more closely resembles an other.
- In the hermeneutic relations between the driver and the navigation device, boundaries may appear somewhat blurred. For example, when the driver looks at the map displayed on the screen, what is experienced is the meaning conveyed by the map rather than the device's material existence.
- During driving, background relations exist between the driver and device when no auditory notifications are provided, and the driver does not look at it. In such instances, the device remains absent for the driver. However, when a verbal notification is heard, the device becomes experienced to that extent.

If the driver does not turn to look at the screen, the visual existence of the device continues to be absent for them. Thus, the device is partially experienced and partially absent in such situations.

- Within the scope of this study, agency encompasses both contributing to navigation and shaping the practice without such a contribution. Contributing to navigation involves participating in the decision-making in wayfinding process or engaging in locomotion without wayfinding decisions. All information providers involved in the practice possess agency throughout the practice. Additionally, they all have initiative in wayfinding, regarding what to do. Furthermore, apart from determining what to do, the driver also exercises initiative in determining which information provider should have the initiative of determining what to do.
- The higher an information provider's initiative at a given moment, the greater their agency is during that period. As the initiative and agency of the environment or navigation device increases, their level of otherness also rises. This is because a higher initiative in making wayfinding decisions implies a stronger perception of the information provider as an entity with its own will. Similarly, an increase in taken-for-grantedness in the driver's relationship with another information provider during wayfinding corresponds to a higher level of otherness for that provider.
- The level of control the driver has in assigning navigation tasks to other information providers correlates directly with their agency. Yet, when more authority is given to another information provider, the driver's control over decision-making during wayfinding diminishes. As regards to alterity relations, when the driver takes more initiative in delegating or receiving authority, it suggests a reduction in otherness of the relevant information provider. This is because taking more initiative in this matter implies more influence over it, which weakens the perception of its autonomy from the driver as an other.

- In the case of locomotion not based on a wayfinding decision, the movement appears to be solely performed by the driver, yet the subject of this experience is the unity of the driver and environment. In such situations, the driver moves through the environment without thinking, leading to a narrowing of the scope of their participation in the practice, and their agency.
- The scope of the environment and navigation technology for the driver, shaped by the elements extended by the driver's mind, fluctuates across each experience period during the practice. The breadth of experienced information providers expands or contracts based on the driver’s conscious engagement with the information they present, affecting their perceived boundaries.
- The environment becomes semi-transparent to the driver as it is embodied. Increasing transparency corresponds to blurred boundaries between the driver and the environment, indicating the extension of the body through the environment and the environment's disappearance from the driver's perspective. This situation explains cases where the environment narrows for the driver.
- The relationship established through the mind or body between the driver and the environment is not significantly impeded by the navigation technology. Specifically, there is no apparent adverse effect on bodily interaction between them. Given the human existence, a complete separation of the body from the environment appears unlikely. Technological intervention, instead, might disrupt certain aspects of the driver-environment relationship while promoting alternative links between them, offering a different representation of the environment for the driver to interact with, even if it diverts attention from specific elements the real environment presents.

This chapter has begun by illustrating how the combination of pieces of information in the field composition undergoes continuous changes as the driver, environment and navigation technology match in various ways during in-car navigation. Subsequently, it has examined the states in which the pieces of information presented by these information providers participate in the practice as experienced, transparent, and absent. Following this, it has discussed the participation of information providers in the practice. It has also deliberated on how the boundaries between information providers change in their different modes of participation in the practice. Finally, it has presented views on how navigation technology intervenes in these boundaries. In light of all these discussions and those presented in the previous chapters, the subsequent chapter will conclude the study.

CHAPTER 7

CONCLUSION

This chapter will answer the research questions based on the research findings at the beginning. Then, it will present a general evaluation of the research. Finally, it will conclude by addressing the limitations encountered throughout the study and providing recommendations for further work.

7.1 Research Questions Revisited

7.1.1 Q1. How do driver, environment and navigation technology participate in in-car navigation?

The driver, environment, and navigation technology are the three agents of in-car navigation. The driver participates in the practice by utilizing previously acquired knowledge and derivating new information during the practice. They are also the agent executing movements physically. The environment functions as an agent by providing space for movement, prompting locomotion, and providing guidance for wayfinding. In this regard, it can play roles that emphasize physical interactions as well as roles that prioritize interactions established through mind. Providing space for mobility and inducing movement indicates its bodily relations with the driver, while offering wayfinding directions and cues signifies the relations established through mind between them. Navigation technology assists navigation during the drive through visual and auditory notifications. Its function is to establish a relationship with the driver through the mind, like how the environment provides wayfinding directions and cues. Considering the participation of these three agents in the practice, it is possible to define each of them as an information provider.

Generation of navigational information occurs through the aggregation of pieces of information from the driver, environment, and navigation technology during the drive. Each instance of navigational information generation involves the amalgamation of varying pieces of information from these three information providers. Consequently, throughout the practice, these three agents continuously match in various ways. Thus, the practice of in-car navigation constitutes a series of matches between the driver, environment, and navigation technology, where information exchange occurs among these three.

In the decision-making processes of wayfinding, the utilization of road-related and landmark-related information is essentially involved. According to relevant literature, landmarks are spatial elements that reference a particular environment. However, the findings of this study suggest that, in addition to such elements, ambient conditions, notifications by the navigation device, and remembered experiences all have the potential to serve as sources of information aiding drivers in recognizing relevant areas, thereby serving as references indicating specific environments. Given that this description aligns with the function described in the literature for landmarks, these elements can also be considered as landmarks.

The degree of aid in navigation offered by each agent during driving may fluctuate throughout the practice. Certain situations that either decrease or eliminate the support of each provider in the practice have been identified in the study. Still, the study did not establish a predetermined hierarchy regarding their contribution to navigation. Put differently, the research did not arrive at a conclusion indicating that one agent inherently tends to contribute more to navigation or is prior to the other agents in the practice.

One of the factors that diminish the contribution of navigation technology to the generation of navigational information is the driver's occasional lack of trust in the technology. The distrust can stem from reasonable motives or excessive skepticism.

Regardless of the cause, this lack of trust reduces the driver's benefit from the navigation technology and occupies their mind with the evaluation of the device's reliability. To address this issue, navigation applications could provide a self-rating in relation to their reliability. This could be achieved by allowing users to assess the reliability of these applications in various regions based on their experiences. This would likely prevent users from unnecessarily doubting the instructions provided by the technology or overly relying on it in areas where the information it gives may be less accurate.

In addition to the idea that each application could establish its own standards for reliability ratings, there is potential to develop an application that compares various navigation applications based on standardized reliability criteria. Such an application would inform users about which navigation applications are more reliable in various environments and situations.

7.1.2 Q2. What type of engagements does the driver establish with the environment and navigation technology during in-car navigation?

Driving is a practice which involves an immersion of the driver in the environment from start to finish, thus, results in a physical harmony between the two. Throughout the drive, the driver, sometimes even without awareness, moves in harmony with the flow of traffic and other environmental elements. In other words, they can travel without veering off the road or colliding with anything, even without being aware of it. The ability to do this without deliberate thought is a result of the embodiment relation between the driver and environment. During these moments, for instance, not veering off the road or avoiding collisions with other vehicles indicates the driver's engagement with these elements. Besides, the lack of awareness signifies that they are embodied, which means transparent, elements at that moment. There are even moments when the driver travels on the road almost entirely unaware of their surroundings. These moments represent instances when the environment approaches pure transparency.

In addition to moments where the driver nearly fully embodies the environment, during certain segments of the drive, their mind extends to some elements in the surroundings. For instance, when encountering a driving-related issue, making a wayfinding decision, or whenever an environmental element irrelevant to navigation captures the driver's attention, the driver becomes attentive to the surroundings. At such instances, the environment becomes present to the extent that it is perceived by the driver. However, it never achieves complete presence. This is because the driver's movement within the environment, or even mere existence within it, inherently entails partially embodying the surroundings.

Due to the limited bodily interaction provided by the navigation device during driving, it has not been observed to be embodied throughout the study. Still, alterity relations, background relations, and hermeneutic relations are established between the driver and device. Regarding alterity relations, the device can be considered as a quasi-other during driving for various reasons. Firstly, while navigating, especially through unfamiliar environments, the device appears like a quasi-other familiar with that environment, offering suggestions for wayfinding decisions. Secondly, it has its own unique timing mechanism for the instructions it gives. Consequently, as long as it furnishes wayfinding recommendations, whether through verbal audio prompts or the map display, it can be perceived as being interacted with as a quasi-autonomous entity by the driver. Thirdly, the verbal audio information it relays creates an impression of an individual speaking, akin to a quasi-other.

The increasing initiative of the navigation device in making wayfinding decisions implies that it is experienced as an entity with its own will and life to some extent. In this regard, it is possible for the device to be perceived as a quasi-other as its initiative increases. However, the higher the driver's initiative in granting initiative to the device, the stronger the perception that the device is a controllable artifact. Therefore, in such a scenario, contrary to the previous situation, it can be argued that even though the device's initiative increases, its level of otherness would diminish.

In instances where the device remains silent without providing voice messages and the driver does not visually attend to it, it operates quietly in the background. In such circumstances, the interaction between the driver and device can be characterized by background relations. Until the driver directs their attention to the device or receives a voice notification, they do not actively engage with it, rendering it effectively absent from their awareness. If the driver hears a notification from the device but does not look at the screen, the voice message becomes present for the driver, while other pieces of information provided by the device at that moment remains absent. Consequently, there are moments during driving where the device is partially present and partially absent for the driver.

The device's simultaneous partial presence and partial absence resemble the environment's state of being partially embodied and partially perceived, exhibiting partial transparency and partial presence. Yet, this condition of the environment persists throughout the entire drive whereas, for the device, it varies depending on the circumstances. It is indeed conceivable for the device to be entirely absent, as a scenario that frequently occurs during the drive, even sometimes for prolonged durations. There are also instances where the device operates in the background for the entirety of the drive.

Driver’s relations between the map and other information displayed on the screen fall within the scope of hermeneutic relations. Even though the driver is perceptually involved with the device while observing the information on the screen, what they experience is the meaning of the content, not the screen. That is the driver certainly sees the device at that moment, but what they see is hermeneutically transparent to them. Rather, they reach the meaning through this transparent entity.

7.1.3 Q3. How do the boundaries between the driver, environment and navigation technology vary during in-car navigation?

The extent of the environment and navigation technology available to the driver, determined by the combination of elements extended by the driver's mind, fluctuates across different experience periods during the practice. The experienced portions of information providers expand or contract depending on the degree to which the elements they provide are perceived by the driver.

Within the scope of the study, the predominant relations between the driver and environment during in-car navigation are embodiment relations. Through the embodiment of environmental elements, their boundaries with the driver blur. This entails the extension of the body through those elements, causing them to vanish from the driver's perspective.

The extension of the driver's body towards the environment brings about a unity of the driver and the environment as a subject. Within this unity, the driver does not operate as a distinct entity separate from the environment. Instances where the driver can travel without much or any conscious awareness of their surroundings can be explained by the fact that, at that moment, the subject is not the driver alone but the unity of the driver and environment. This is because, during such instances, the driver is connected to their surroundings through their body, not through their mind. It is this unity that enables the driver to safely navigate the road without the need for active thought.

Embodied experiences where the subject is the unity of the driver and environment, which are navigational experiences, can be internalized by the driver as tacit knowledge. This practice-based internalization involves development of skills in navigating within that environment. It is a form of learning, but distinct from the acquisition of landmark knowledge, route knowledge, and survey knowledge.

In the acquisition of landmark, route, and survey knowledge, the driver is subject, and the relevant pieces of environmental information are the objects of learning. This type of acquisition requires the extension of the mind towards those pieces of environmental information, i.e., the driver experiencing those elements. Therefore, the boundaries between the driver and this information are clear in this type of knowledge acquisition. Conversely, in practice-based internalization, the object of learning is the practice itself, and the subject is the unity of the driver and environment, where the boundaries between the two are not clear. Thus, in this case, it is the body that extends towards the environment. This comparison highlights that knowledge related to landmarks, routes, and areas is acquired through mental processes, whereas practice-based internalization is encoding relevant information within the body.

Presumably because practice-based internalization is carried out by the unity of the driver and environment as the subject, the application of internalized knowledge requires the reintegration of that specific driver and environment, i.e., the reformation of the context in which learning occurred. Consequently, outside of this context, the driver cannot apply this knowledge, or even think about it, let alone expressing it verbally whereas knowledge acquired about landmarks, routes, and areas is possible to be articulated by the driver. This difference can also be explained by the tacit nature of the first type of knowledge and the verbal nature of the second type. The reason for this is that the former is acquired through the body, while the latter, through the mind.

As for the navigation technology, when the driver engages with it during driving, the relations between them can be characterized as alterity relations or hermeneutical relations. During alterity relations, the device is experienced by the driver to a large extent, which means the boundaries between them are clearer than they are in embodiment relations between the driver and environment. As the device's degree of otherness increases, its boundaries from the driver become more apparent. Within the context of hermeneutic relations between the driver and navigation technology, the boundaries could be argued to be somewhat obscured since the meaning of the content conveyed by device is perceived rather than its material existence. This implies that, while experiencing meaning, the material existence of the device is hermeneutically transparent in this type of relations. In other words, at such instances, the body of the device is not perceived as a clearly defined entity by the driver.

7.1.4 Q4. How do navigation technologies interfere in the boundaries between the driver and environment during in-car navigation?

Findings on the intervention of in-car navigation technologies within the boundaries between the driver and environment shed light on whether it disconnects the two entities. The relevant literature has investigated whether the use of this technology leads to disengagement between the driver and environment. However, studies conducted in this regard generally focus on the driver-environment engagements established through mind only. This study approaches driver-environment relationships from two perspectives: engagements established through the body and engagements established through the mind. Accordingly, it examines the role of navigation technologies in the relations between these two from both viewpoints.

According to the findings of the study, navigation technology does not significantly impede the relationship established through either the body or mind between the driver and the environment. This is because one of the most critical factors shaping the design decisions of in-car navigation technology is its use within the context of driving. This technology is designed to ensure that it never obstructs or takes precedence over the driving activity.

Specifically, no discernible adverse effect on the physical interaction between the two has been observed throughout the research. Given the way of being of human, indeed, complete physical detachment of the driver from the environment appears improbable. Rather, while the mediation of in-car navigation by navigation technologies may sever specific facets of the driver-environment relationship, it fosters alternative connections between them. In this context, navigation technology presents an alternative framework of the environment to be navigated, even if it redirects the driver away from certain environmental elements.

It can be argued that the customization options provided by navigation technology further diversify the alternative driver-environment connections that this technology facilitates. For instance, users can save their favorite locations in the system, thereby creating a digital world model composed of related places. Additionally, as noted in 5.5 Alterations in the uses of navigation technology, users can create customized routes by specifying stops between the points of departure and destination. Alongside such features, additional customization options could potentially create new user-environment relations.

One possible way of customization related to driver-environment relations could involve providing users with the option to ignore certain types of roads when selecting alternative routes between two locations. Indeed, among the participants, there were those who preferred to avoid steep roads, narrow alleyways, and poorly maintained secondary roads. The option to exclude such roads could provide such users with their preferred user-environment relationship.

Another design consideration related to customization options that could impact driver-environment relations involves giving users more choices regarding the types of information they receive from the navigation technology about their surroundings. For example, drivers could opt to receive only instructions related to turns while rejecting lane guidance. When they have the chance to select which types of environmental information they receive and which they do not, they can prioritize certain interactions with their environment while deprioritizing others. This feature could enhance the variety of relationships drivers can establish with their surroundings.

As previously mentioned, navigation technology does not substantially hinder the relationship that the driver establishes with the environment. Still, it is important to criticize this technology from the perspective that it may weaken driver-environment engagements. The primary criticism in this regard could be that it reduces driving safety by diminishing these engagements. However, the study has not reached a conclusion supporting this view. On the contrary, it interprets that mediation by this technology is not prone to have such an effect. This interpretation is justified by the study as follows. In the context of driving, even if attention and awareness of the environment recede into the background, bodily engagement never completely ceases. It means, although there might be instances where the mind disengages from the environment, the body maintains its interaction with it. On the other hand, what this technology predominantly intervenes in the driver-environment engagements is the relations established through the mind. Based on this, the study is more inclined towards the view that navigation technology has no significant negative impact on driving safety.

How navigation technology alters the experience of the environment is also worth discussing. The study examines the impact of this technology on how the environment appears to the driver from two perspectives. Firstly, during mediation, the real environment and its perceived manifold may be significantly different from each other in comparison to how the environment is perceived in an unmediated navigation. In an unmediated interaction with the environment, the unfiltered experiences represent the most authentic engagements with it, meaning that the way it appears to the human is closer to the real environment than it is in a mediated interaction. When navigation technologies intervene, they filter the experience through a digital model of the environment. This filter amplifies the difference between the real environment and how it is perceived by the human. Consequently, experiences that this representation of the environment mediates seem to distance individuals further from the real environment compared to unmediated experiences.

Secondly, when comparing the differences between the mediated experiences of different individuals with those between unmediated experiences, the former may be much greater than the latter. This is because of the interactive nature of navigation technologies. Considering that technology mediates each navigation practice uniquely tailored to that practice, the environmental experiences of different individuals diverge even on the same route. Accordingly, it diminishes the likelihood of a shared environmental experience to exist. In fact, unmediated environmental experiences are naturally unique as well. However, such experiences, for instance, as in the case of adoption of commonly known landmarks by individuals, seem to be more conducive to aligning individuals' environmental experiences. This is because in unmediated experiences, at least, there is no interactive filter that would amplify the differences between the experiences of different individuals.

7.2 Overview of the Study

Based on the relevant literature, the study has defined navigation as a process where wayfinding and locomotion intertwine. However, it has drawn attention to instances where locomotion activities occur without wayfinding. Whether locomotion independent of wayfinding can be considered navigation is debatable according to the definition adopted in the study. Nonetheless, the study finds it worthwhile to consider this activity in studies related to the navigation experience, regardless of whether it falls within the scope of navigation, as it occurs during navigation practice.

One of the key differences between this study and previous research on whether technological mediation disengages humans from the environment during navigation is its consideration of bodily relations in driver-environment engagement. In this sense, it offers a more comprehensive perspective in studies concerning environmental experience. Additionally, the study not only examines the impact of navigation-related information on the experiences during in-car navigation, but also considers information irrelevant to navigation since it influences the experiences as well. Because, according to the perspective highlighted by the study, all elements engaged with during an experience period, whether they serve the purpose of the practice or not, play a role in shaping the experience. Such comprehensive approaches also appear applicable to other studies on human experience.

Defining the agents of practice as *information providers* in the study, regardless of the definition of in-car navigation, is a result of the (post)phenomenological approach. This perspective seems applicable to practices beyond in-car navigation as well. Similarly, it is possible to consider any other practice as *an information exchange between the agents*, or a *chain of matches between the agents*, or a *chain of experience periods*. This perspective developed by the study as a (post)phenomenological method seems possible be adopted in other studies on human experience.

The study has presented findings on the technological mediation of in-car navigation, yet some of the results are related to driving practices independently of navigation. Particularly noteworthy among these findings is the embodiment in driver-environment engagement during driving, which may end up with a type of skill development. Therefore, these findings are outcomes that can be tested by not only the studies on navigation but also other driving-related research.

Regarding the position of the study in the domain of design research, it focused on the experience of design outputs from a human experience perspective as stated in Chapter 1. In this context, it emphasizes the importance of not only how users experience the product/system in question but also how they experience the things they interact with through that product/system.

7.3 Limitations and Potential Directions for Further Research

The study encountered a limitation in providing a truly naturalistic environment for driving sessions. Although driver participated in the study appeared to engage naturally with driving and navigation applications during their drives, their eagerness to verbally share information during the think-aloud protocol indicated their awareness of being in a research setting. Generally, participants showed the highest level of awareness of being in a research setting during the initial minutes of the drives. However, as the drives progressed, they began to behave more naturally despite continuing thinking-aloud. Therefore, it can be argued that the longer the duration of the drives, the more they met the requirements of naturalistic driving. However, due to limitations related to the information processing capacity of the video recording equipment, it was not possible to extend all drives sufficiently. For this reason, the study suggests that further research in this area be conducted with longer-duration drives.

The researcher was one of the drivers in the study who used the navigation device extremely and showed the least interest in their surroundings during driving. It can be said that this extreme behavior has increased the comprehensiveness of the data obtained from the drives. However, this could also be a reason for the heterogeneous distribution in the depth of discussions related to the findings. For example, while the study has revealed a considerable number of findings on embodied locomotion performed without awareness, it has proposed relatively fewer discussions related to hermeneutical relations, suggesting the potential influence of the researcher's personal navigation experiences on the data obtained. Therefore, it is recommended that similar autoethnographic studies be replicated by researchers with different navigation habits.

In the discussions presented in the study, it was suggested that embodiment of an environment during navigation could result in skill development in navigating there. However, the study did not provide any findings regarding whether the navigation technology has an impact on this skill development. The study's inability to clarify this issue stems from the inadequacy of its methodology to provide insight in this matter. Methods involving repeated driving sessions spread over longer periods with the same users, for instance, appear more suitable for observing skill development processes. This study recommends further research that employs such methods to explore potential effects of this technology on acquisition of tacit knowledge related to how to find one’s way in environments where they repeatedly navigate.

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APPENDICES

A. Ethics Committee Approval[4]

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

DUMLUPINAR BULVARI 06800
ÇANKAYA ANKARA/TURKEY
T: +90 312 210 22 91
F: +90 312 210 79 59
ueam@metu.edu.tr
www.ueam.metu.edu.tr

Sayı: 28620816/ 01 ARALIK 2021

Konu : Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi : İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Prof.Dr. Gülay HASDOĞAN

Danışmanlığını yürüttüğünüz Elif Büyükkeçeci'nin "Navigasyon teknolojilerinin self'in sınırlarını şekillendirmesi" başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülmüş ve **455-ODTU-2021** protokol numarası ile onaylanmıştır.

Saygılarımızla bilgilerinize sunarız.

[redacted]

Prof.Dr. Mine MISIRLISOY
İAEK Başkanı

[4] The thesis title mentioned in the document is the tentative title proposed in 2021.

B. Consent Form for POND Sessions in the Original Language

Araç içi navigasyon teknolojisi kullanıcı deneyimi saha araştırması
açıklama metni ve gönüllü katılım formu

Bu araştırma, Orta Doğu Teknik Üniversitesi Endüstriyel Tasarım Bölümü'nde, Prof. Dr. Gülay Hasdoğan danışmanlığında Elif Büyükkeçeci tarafından yürütülmektedir. Bu form sizi araştırma hakkında bilgilendirmek için hazırlanmıştır.

Araştırmanın amacı nedir?

Araştırmanın amacı, sürücülerin araç içi navigasyon uygulaması kullanımı sırasında çevre ve navigasyon teknolojisi deneyimlerini tanımlamaktır.

Bize nasıl yardımcı olmanızı isteyeceğiz?

Araştırmaya katılım tamamen gönüllülük temelinde olmalıdır. Araştırmanın sürüş seanslarında sizden beklenen, birlikte belirleyeceğimiz kalkış ve varış noktaları arasında navigasyon teknolojisi desteğiyle sürüşler yapmanızdır. Her sürüş sonrasında ilgili sürüş ve daha önceki navigasyon deneyimleriniz üzerine bir röportaja katılmanız beklenmektedir. Sürüş ve röportaj seansları sırasında onayınıza bağlı olarak video ve/veya ses kaydı alınacaktır (bu konuda onayınızın olmaması durumunda sürüşlerinizde kayıt alınmayacaktır).

Sizden topladığımız bilgileri nasıl kullanacağız?

Çalışma kapsamında, katılımcılardan kimlik veya kurum belirleyici hiçbir bilgi istenmemektedir. Araştırma sırasında yapılan kayıtlar ve katılımcılara ait diğer bilgiler tamamıyla gizli tutulacak, sadece araştırmacı tarafından değerlendirilecektir. Katılımcılardan elde edilecek bilgiler toplu halde değerlendirilecek ve bilimsel yayınlarda kullanılacaktır.

Araştırmaya katılmanızın getirdiği riskler nelerdir?

Çalışma sırasında, araç kullanımınız esnasında navigasyon uygulamasını takip etmekten rahatsızlık hissedebilirsiniz. Bu ya da başka bir durumda istediğiniz zaman sebep göstermeksizin prosedürü durdurabilir ve çalışmadan herhangi bir kaybınız olmaksızın çekilebilirsiniz.

- ❖ *Araç kullanımı ve/veya navigasyon uygulaması kullanımı konusunda kendinizi rahat hissetmiyorsanız araştırmaya katılmanız uygun değildir.*

Araştırmayla ilgili daha fazla bilgi almak isterseniz:

Araştırmayla ilgili soru ve yorumlarınızı çalışma öncesinde, sırasında ve sonrasında araştırma yürütücüsü Elif Büyükkeçeci'ye iletebilirsiniz (E-posta: [redacted]).

"Yukarıdaki bilgileri okudum ve bu çalışmaya tamamen gönüllü olarak katılıyorum."
(Formu, doldurup imzaladıktan sonra uygulayıcıya geri veriniz.)

Ad-Soyad　　　　Tarih　　　　İmza

C. Consent Form for POND Sessions Translated to English

Explanation regarding the field research on experience of in-car navigation technologies and voluntary participation form

This research is conducted by Elif Büyükkeçeci under the supervision of Prof. Dr. Gülay Hasdoğan at the Department of Industrial Design, Middle East Technical University. This form is prepared to inform you about the research.

What is the aim of the research?

The aim of the research is to describe the experiences of drivers with the environment and navigation technology during the use of in-car navigation technologies.

What do we expect from you?

Participation in the research is on voluntary basis. What is expected from you during the driving sessions of the research is to drive with the support of navigation technology between departure and destination points that we will determine together. After each drive, you are expected to participate in an interview regarding the respective drive and your previous navigation experiences. Video and/or audio recordings will be made during the driving and interview sessions depending on your consent (if you do not give consent, no recording will be made during your sessions).

How will we use the information we collect from you?

During the study, participants will not be requested to provide any identifying personal or institutional information. The records made during the research and other information about the participants will be kept confidential and will only be evaluated by the researcher. The information obtained from the participants will be evaluated collectively and used in scientific publications.

What are the risks of participating in the research?

During the study, you may feel uncomfortable following the navigation technology while driving. In this or any other situation, you can stop the procedure at any time without giving a reason and withdraw from the study.

- ❖ *If you do not feel comfortable with driving and/or using navigation technologies, it is not suitable for you to participate in the research.*

If you would like to get more information about the research:

You can forward your questions and comments about the research to the researcher Elif Büyükkeçeci before, during, and after the study ([redacted]).

"I have read the above information and I am participating in this study entirely voluntarily." (After filling out and signing the form, please return it to the researcher.)

Name-Surname	Date	Signature

D. Survey in the Original Language

Araç içi navigasyon teknolojisi kullanıcı anketi

Bu araştırma ODTÜ Endüstriyel Tasarım Bölümü Doktora Programı'nda yürütülmektedir. Araştırmanın amacı sürücülerin araç içi navigasyon teknolojilerini kullanmaları sırasında çevre ve navigasyon teknolojisi deneyimlerini tanımlamaktır. Araştırmanın katılımcı kitlesini, **şehir içi ve/veya şehirler arası yolculuklarında sürüş yapmaları sırasında araç içi navigasyon teknolojisini düzenli olarak kullanan kişiler** oluşturmakta. Bu şartları sağlıyorsanız sayfanın devamındaki ankete katılmanızı rica ederiz. Araştırmaya katılımınız tamamen gönüllülük temelinde olmalı.

Anketin tamamlanması yaklaşık 9 dakikanızı alacak. Anket, genel olarak kişisel rahatsızlık verecek sorular içermemektedir. Soruları yanıtlarken kararsızlık yaşamanız veya bilgi vermekten kaçınmanız hâlinde **söz konusu soruları yanıtsız bırakabilirsiniz**.

Anket sorularına verdiğiniz cevaplar tamamıyla gizli tutulacak, sadece araştırmacı tarafından değerlendirilecek. Katılımcılardan elde edilecek bilgiler toplu halde değerlendirilecek ve bilimsel yayınlarda kullanılacak. Araştırmanın devam eden aşamalarına katılabileceğinizi düşünüyorsanız, gerektiğinde size ulaşabilmemiz için **ilgili alanlara iletişim bilgilerinizi girmenizi rica ederiz**.

Anket sonunda, çalışma hakkındaki soru ve yorumlarınız için araştırma yürütücüsü Elif Büyükkeçeci ile iletişim kurabilirsiniz (E-posta: [redacted]).

Değerli zamanınız için şimdiden teşekkür ederiz.

* 1.

☐ Yukarıdaki açıklamaları okudum ve ankete gönüllü olarak katılıyorum.

Demografik bilgiler

Aşağıdaki sorular kapsamında kendinizle ilgili demografik bilgileri bizimle paylaşmanızı bekliyoruz.

2. Cinsiyetiniz:
   - Kadın
   - Erkek
   - Diğer
   - Bu soruya cevap vermek istemiyorum.

3. Yaşınız:
   - 18-26
   - 27-38
   - 39-49
   - 50+

4. Eğitim durumunuz (Lütfen en son mezun olduğunuzu programı dikkate alınız):
   - İlkokul/Ortaokul
   - Lise
   - Üniversite
   - Lisansüstü

5. Mesleğiniz ve işiniz:

   …………………………………………………

Sürüş deneyimi ve navigasyon teknolojisi kullanımı

Aşağıdaki sorular kapsamında sürüş deneyiminiz ve navigasyon teknolojisi kullanımızla ilgili genel bilgileri bizimle paylaşmanızı bekliyoruz.

6. Kaç yıldır sürücü belgeniz var?
   - 0-4
   - 5-9
   - 10+

7. Kaç yıldır aktif olarak araç kullanıyorsunuz?
   - 0-4

- 5-9
- 10+

8. Sürücülük becerilerinizin sizce hangi seviyede olduğunu 1 ve 10 arasında bir derece ile belirtiniz (1 ‘en düşük’, 10 ‘en yüksek’ anlamına gelecek şekilde).
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10

9. Kaç yıldır düzenli olarak araç-içi navigasyon teknolojisi kullanıyorsunuz?
   - 0-1
   - 2-3
   - 4-5
   - 6+

10. Navigasyon uygulamalarını araçla yol bulma dışında hangi durumlarda ve/veya hangi amaçlarla kullanırsınız (Birden fazla maddeyi işaretleyebilirsiniz)?
   - Yürüyerek bir yere giderken
   - Birine yol tarifi verirken
   - Kendi konumumu görmek için
   - Birine konum bilgilerimi gönderirken
   - Birinin/bir yerin konum bilgilerini öğrenmek için
   - Diğer (Lütfen belirtin)
     ………………………………………………

11. <u>Daha önce hiç gitmediğiniz ve nasıl gideceğinizi bilmediğiniz bir yere</u> aracınızla kendiniz giderken bu teknolojiyi ne sıklıkla kullanırsınız?
   - Hiçbir zaman
   - Nadiren
   - Bazen
   - Sık sık
   - Her zaman

12. Daha önce bu teknoloji yardımıyla, aracınızla ya da yürüyerek, kendiniz gittiğiniz bir yere aracınızla tekrar gideceğinizde bu teknolojiyi ne sıklıkla kullanırsınız?

- Hiçbir zaman
- Nadiren
- Bazen
- Sık sık
- Her zaman

13. Daha önce sizi başkasının götürdüğü ya da toplu taşıma ile gittiğiniz bir yere aracınızla kendiniz ilk kez gideceğinizde bu teknolojiyi ne sıklıkla kullanırsınız?

- Hiçbir zaman
- Nadiren
- Bazen
- Sık sık
- Her zaman

14. Araç içi navigasyon uygulamalarını sürüşlerinizde hangi amaçlarla kullanırsınız? Birden fazla maddeyi işaretleyebilirsiniz.

- Yola çıkmadan önce alternatif yolları görmek için
- Yola çıkmadan önce yol bulmaya yönelik yönlendirmeleri görmek için
- Yola çıkmadan önce mesafe bilgisine sahip olmak için
- Yola çıkmadan önce alternatif güzergahlardaki trafik yoğunluğu ile ilgili bilgi sahibi olmak için
- Yola çıkmadan önce yolculuğun ne kadar süreceği konusunda fikir sahibi olmak için
- Sürüş sırasında an be an yol tarifi almak için
- Sürüş sırasında o güzergahtaki trafik yoğunluğu ile ilgili anlık bilgi almak için
- Sürüş sırasında alternatif yol önerilerini almak için
- Sürüş sırasında gideceğim yere ne zaman varacağım konusunda fikir sahibi olmak için
- Sürüş sırasında yolun geri kalanına ait anlık mesafe bilgisi almak için
- Yola çıkmadan önce ya da sürüş sırasında güzergahım üzerindeki dinlenme tesisleri, restoranlar, benzin istasyonları, park yerleri gibi duraklama yerlerini görebilmek için
- Diğer (Lütfen belirtin): ……………………………………………………

Sürüş öncesinde ve sırasında çevre bilgisi ve teknoloji bilgisi kullanımı

Bu bölümdeki soruları, kendi deneyiminize dayanarak yanıtlamanızı bekliyoruz.

15. Yolculuk sırasında sıradaki dönüşe kalan mesafeyi sesli yönlendirmelerden ya da haritadan takip ederim.
   - Hiçbir zaman/Asla
   - Nadiren/Düşük ihtimalle
   - Bazen/Belki
   - Sık sık/Büyük ihtimalle
   - Her zaman/Kesinlikle
   - Bu konuda nasıl davrandığımın farkında değilim.

16. Bu teknolojiyi kullanarak sürüş yaparken yakında bir dönüş olmasa da yoldaki kıvrımları ve kırılmaları ekrandan takip ederim.
   - Hiçbir zaman/Asla
   - Nadiren/Düşük ihtimalle
   - Bazen/Belki
   - Sık sık/Büyük ihtimalle
   - Her zaman/Kesinlikle
   - Bu konuda nasıl davrandığımın farkında değilim.

17. Bu teknolojiyi hiç bilmediğim bir yolda kullanırken o sırada hangi yoldan/yerleşim alanından geçmekte olduğumu uygulama ekranından bilirim.
   - Hiçbir zaman/Asla
   - Nadiren/Düşük ihtimalle
   - Bazen/Belki
   - Sık sık/Büyük ihtimalle
   - Her zaman/Kesinlikle
   - İlgili anları hatırlamıyorum.

18. Bu teknolojiyi hiç bilmediğim bir yolda kullanırken az sonra hangi yoldan/yerleşim alanından geçecek olduğumu uygulama ekranından öğrenirim.
   - Hiçbir zaman/Asla
   - Nadiren/Düşük ihtimalle
   - Bazen/Belki
   - Sık sık/Büyük ihtimalle
   - Her zaman/Kesinlikle
   - İlgili anları hatırlamıyorum.

19. Bu teknoloji desteği ile <u>hiç bilmediğim</u> bir yolda giderken yol üstündeki tabelalarda farklı bir yönlendirme olsa da <u>navigatörün yönlendirmesini takip ederim.</u>

- o Hiçbir zaman/Asla
- o Nadiren/Düşük ihtimalle
- o Bazen/Belki
- o Sık sık/Büyük ihtimalle
- o Her zaman/Kesinlikle

20. Bu teknolojiyi kullandığım sürece yolumu bulmak için tabelalara bakmaya gerek duymam.

- o Hiçbir zaman/Asla
- o Nadiren/Düşük ihtimalle
- o Bazen/Belki
- o Sık sık/Büyük ihtimalle
- o Her zaman/Kesinlikle

21. Bu teknolojiyi hiç bilmediğim bir yolda kullanırken hangi yoldan/yerleşim alanından geçmekte olduğumu tabelalardan bilirim.

- o Hiçbir zaman/Asla
- o Nadiren/Düşük ihtimalle
- o Bazen/Belki
- o Sık sık/Büyük ihtimalle
- o Her zaman/Kesinlikle
- o İlgili anları hatırlamıyorum.

22. Bu teknolojiyi daha önce geçtiğim bir yolda kullanırken hangi yoldan/yerleşim alanından geçmekte olduğumu <u>mekân tanımlayan çevre öğelerinden</u> (meydanlar, parklar, tüneller vb.) anlarım.

- o Hiçbir zaman/Asla
- o Nadiren/Düşük ihtimalle
- o Bazen/Belki
- o Sık sık/Büyük ihtimalle
- o Her zaman/Kesinlikle
- o İlgili anları hatırlamıyorum.

23. Bu teknolojiyi daha önce geçtiğim bir yolda kullanırken hangi yoldan/yerleşim alanından geçmekte olduğumu <u>devamlılığa sahip çevre öğelerinden</u> (yol boyu

ağaçlandırma, yol boyu dağ/deniz manzarası, yol boyu uygulanmış süslemeler vb.) anlarım.

- o Hiçbir zaman/Asla
- o Nadiren/Düşük ihtimalle
- o Bazen/Belki
- o Sık sık/Büyük ihtimalle
- o Her zaman/Kesinlikle
- o İlgili anları hatırlamıyorum.

24. Bu teknolojiyi daha önce geçtiğim bir yolda kullanırken hangi yoldan/yerleşim alanından geçmekte olduğumu etraftaki <u>noktasal çevre öğelerinden</u> (dikkat çekici binalar, heykeller vb.) anlarım.

- o Hiçbir zaman/Asla
- o Nadiren/Düşük ihtimalle
- o Bazen/Belki
- o Sık sık/Büyük ihtimalle
- o Her zaman/Kesinlikle
- o İlgili anları hatırlamıyorum.

25. Bu teknolojiyi kullanmam sırasında sıradaki dönüşlerime karar vermek için yoldaki tabelalara da bakarım.

- o Hiçbir zaman/Asla
- o Nadiren/Düşük ihtimalle
- o Bazen/Belki
- o Sık sık/Büyük ihtimalle
- o Her zaman/Kesinlikle
- o İlgili anları hatırlamıyorum.

26. Gideceğim yol üstündeki yönlendirme bilgileri yeterli ise daha önce hiç gitmediğim bir yere bile araç içi navigasyon teknolojisi kullanmadan gidebilirim.

- o Hiçbir zaman/Asla
- o Nadiren/Düşük ihtimalle
- o Bazen/Belki
- o Sık sık/Büyük ihtimalle
- o Her zaman/Kesinlikle

27. Bu teknoloji desteği ile <u>hiç bilmediğim</u> bir yolda giderken yol üstündeki tabelalar navigatörün yönlendirmelerinden farklı bilgi veriyorsa <u>tabelalara göre hareket ederim.</u>

- Hiçbir zaman/Asla
- Nadiren/Düşük ihtimalle
- Bazen/Belki
- Sık sık/Büyük ihtimalle
- Her zaman/Kesinlikle

28. Sürüş sırasında bu teknolojiyi kullanıyor olsam da yol üzerindeki <u>yol tarifi tabelalarını</u> fark ederim.
    - Hiçbir zaman/Asla
    - Nadiren/Düşük ihtimalle
    - Bazen/Belki
    - Sık sık/Büyük ihtimalle
    - Her zaman/Kesinlikle

29. Sürüş sırasında bu teknolojiyi kullanıyor olsam da yol üzerindeki <u>güvenlik tabelalarını ve trafik lambalarını</u> fark ederim.
    - Hiçbir zaman/Asla
    - Nadiren/Düşük ihtimalle
    - Bazen/Belki
    - Sık sık/Büyük ihtimalle
    - Her zaman/Kesinlikle

30. Sürüş sırasında bu teknolojiyi kullanıyor olsam da yol üzerindeki <u>kasisleri ve/veya diğer tümsekler ile çukurları</u> fark ederim.
    - Hiçbir zaman/Asla
    - Nadiren/Düşük ihtimalle
    - Bazen/Belki
    - Sık sık/Büyük ihtimalle
    - Her zaman/Kesinlikle

31. Sürüş sırasında bu teknolojiyi kullanıyor olsam da <u>hafif inişler ve/veya yokuşlar</u>ı fark ederim.
    - Hiçbir zaman/Asla
    - Nadiren/Düşük ihtimalle
    - Bazen/Belki
    - Sık sık/Büyük ihtimalle
    - Her zaman/Kesinlikle

32. Sürüş sırasında bu teknolojiyi kullanıyor olsam da yol üzerindeki dikkat çekici binaları, heykelleri fark ederim.

- Hiçbir zaman/Asla
- Nadiren/Düşük ihtimalle
- Bazen/Belki
- Sık sık/Büyük ihtimalle
- Her zaman/Kesinlikle

33. Sürüş sırasında bu teknolojiyi kullanıyor olsam da yolun bir bölümü boyunca uygulanmış süslemeleri fark ederim.

- Hiçbir zaman/Asla
- Nadiren/Düşük ihtimalle
- Bazen/Belki
- Sık sık/Büyük ihtimalle
- Her zaman/Kesinlikle

34. Sürüş sırasında bu teknolojiyi kullanıyor olsam da yol kenarında yürüyen insanları, hayvanları fark ederim.

- Hiçbir zaman/Asla
- Nadiren/Düşük ihtimalle
- Bazen/Belki
- Sık sık/Büyük ihtimalle
- Her zaman/Kesinlikle

35. Sürüş sırasında bu teknolojiyi kullanıyor olsam da aniden yoluma çıkan/çıkabilecek yayaları, hayvanları fark ederim.

- Hiçbir zaman/Asla
- Nadiren/Düşük ihtimalle
- Bazen/Belki
- Sık sık/Büyük ihtimalle
- Her zaman/Kesinlikle

36. Sürüş sırasında bu teknolojiyi kullanıyor olsam da yolun genel olarak dağ/deniz manzaralı mı, ağaçlı mı, çiçekli mi vs. olduğunu fark ederim.

- Hiçbir zaman/Asla
- Nadiren/Düşük ihtimalle
- Bazen/Belki
- Sık sık/Büyük ihtimalle
- Her zaman/Kesinlikle

37. Bu teknolojiyi hiç bilmediğim bir yolda da kullansam kaç meydandan, tünelden, köprüden, viyadükten vs. geçtiğimi yolculuk bittiğinde biliyor olurum ya da aşağı yukarı tahmin edebilirim.

- o Hiçbir zaman/Asla
- o Nadiren/Düşük ihtimalle
- o Bazen/Belki
- o Sık sık/Büyük ihtimalle
- o Her zaman/Kesinlikle

38. Bu teknolojiyi hiç bilmediğim bir yolda da kullansam yolculuk bittikten sonra navigasyon uygulamasının desteği olmadan yolu başkasına tarif edebilirim.

- o Hiçbir zaman/Asla
- o Nadiren/Düşük ihtimalle
- o Bazen/Belki
- o Sık sık/Büyük ihtimalle
- o Her zaman/Kesinlikle

İletişim bilgileri

Sorularımızı buraya kadar yanıtladığınız için teşekkür ederiz. bölümdeki soruları, kendi deneyiminize dayanarak yanıtlamanızı bekliyoruz. Deneyimleriniz hakkında daha detaylı bilgi almak için araştırmanın ilerleyen aşamalarında sizi katılımcı olarak aramızda görmek isteriz. **İlerleyen aşamalara katılabileceğinizi düşünüyorsanız gerektiğinde size ulaşabilmemiz için iletişim bilgilerinizi aşağıda bizimle paylaşmanızı rica ederiz** (Bilgilerinizi paylaşıp paylaşmamanız tamamen sizin tercihinize bağlı. Bu bilgileri paylaşmanız hâlinde araştırmanın devamına katılıp katılmamanız konusunda da sizin tercihiniz gözetilecek)**.**

Araştırma hakkında soru ve yorumlarınızı araştırma yürütücüsü Elif Büyükkeçeci'ye iletebilirsiniz (E-posta:[redacted]).

39. Adınız-soyadınız (Dilerseniz sadece rumuz paylaşabilirsiniz):
…………………………………………………

40. Yaşadığınız il-ilçe:
…………………………………………………

41. Telefon numaranız:
………………………………………………………

42. E-posta adresiniz:
………………………………………………………

E. Survey Translated to English

In-car navigation technologies user survey

This research is being conducted within the PhD Program of Industrial Design Department at Middle East Technical University (METU). The aim of the research is to describe drivers' experiences with environmental and navigation technology during the use of in-vehicle navigation technologies. The participants of the research consist **of individuals who regularly use in-vehicle navigation technology while driving in urban and/or intercity travels**. If you meet these criteria, we kindly ask you to participate in the survey provided on the following page. Your participation in the research should be entirely voluntary.

Completing the survey will take approximately 9 minutes of your time. The survey does not contain questions that would cause personal discomfort. If you feel uncertain or prefer not to provide information for any questions, **you may leave those questions unanswered.**

The responses to the survey questions will be kept completely confidential and will only be evaluated by the researcher. The information obtained from the participants will be analyzed collectively and used in scientific publications. If you believe you may participate in the ongoing stages of the research, we kindly request that **you provide your contact information in the relevant sections** so that we may reach out to you if necessary.

t the end of the survey, you may contact the research coordinator Elif Büyükkeçeci for any questions or comments regarding the study (Email: [redacted]).

We thank you in advance for your valuable time.

* 1.

☐ I have read the above statements and voluntarily agree to participate in the survey.

Demographic information

We kindly ask you to share demographic information about yourself regarding the following questions.

2. Gender:

- Female
- Male
- Other
- I prefer not to answer this question.

3. Age:

- 18-26
- 27-38
- 39-49
- 50+

4. Educational background (Please consider the program you last graduated from):

- Primary/Secondary school
- High School
- University
- Postgraduate

5. Occupation and job:

……………………………………………………

Driving experience and the use of navigation technologies

We kindly ask you to share general information about your driving experience and the use of navigation technology regarding the following questions.

6. How many years have you had your driver's license?

- 0-4

- 5-9
- 10+

7. How many years have you been actively driving a vehicle?

- 0-4
- 5-9
- 10+

8. Please rate your driving skills on a scale of 1 to 10 (1 being the lowest, 10 being the highest).

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

9. How many years have you been regularly using in-car navigation technologies?

- 0-1
- 2-3
- 4-5
- 6+

10. In what other situations and/or for what purposes do you use navigation technologies besides navigating by car? (You can select multiple options)

- While walking to a destination
- Providing directions to someone else
- To check my own location
- Sending my location information to someone
- To learn about the location of someone/somewhere else
- Other (Please specify)
  …………………………………………………

11. How often do you use this technology when driving yourself to <u>a place you've never been to before and do not know how to get there</u>?

- Never
- Rarely
- Sometimes
- Often
- Always

12. How often do you use this technology when you return to <u>a destination you've previously visited either by car or on foot</u>?

- Never
- Rarely
- Sometimes
- Often
- Always

13. How often do you use this technology when driving yourself <u>to a destination you have previously visited, where you were either driven by someone else or traveled by public transportation.</u>

- Never
- Rarely
- Sometimes
- Often
- Always

14. For what purposes do you use in-car navigation applications during your drives? (You can select multiple options)

- To see alternative routes before starting a journey
- To see wayfinding directions before starting a a journey
- To learn about the distance before starting a journey
- To be informed about traffic congestion on alternative routes before starting a journey
- To have an idea of the duration of a journey before setting out
- To receive real-time navigation guidance during a drive
- To receive real-time information about traffic congestion on the route during a drive
- To receive alternative route suggestions during a drive
- To have an idea of the estimated time of arrival during a drive

- To receive real-time distance information for the remaining part of the journey during a drive
- To see facilities such as rest areas, restaurants, gas stations, parking lots, etc., along my route before or during a drive
- Other (Please specify): …………………………………………………

The use of information coming from the environment and technology before and during a drive

We expect you to answer the questions in this section based on your own experience.

15. During a journey, I track the distance to the next turn using voice directions or the dynamic map.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely
- I am not aware of how I behave in this regard.

16. While driving using this technology, I track the curves and bends on the road from the screen even if there is no upcoming turn.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely
- I am not aware of how I behave in this regard.

17. While using this technology on a road I am completely unfamiliar with, I know which road/settlement I am passing through from the screen at that moment.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely

- I do not recall such moments.

18. While using this technology on a road I am completely unfamiliar with, I learn which road/settlement I will pass through shortly from the screen.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely
- I do not recall such moments.

19. While driving on an unfamiliar road with the support of this technology, <u>I follow the directions of the navigator</u> even if there is a different direction indicated on wayfinding signboards.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely

20. While using this technology, I do not need to look at wayfinding signboards to find my way.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely

21. While using this technology on a road I am completely unfamiliar with, I know which road/settlement I am passing through from wayfinding signboards at that moment.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely

- I do not recall such moments.

22. While using this technology on a road I've traveled before, I understand which road/settlement I am passing through by recognizing <u>spatial elements</u> (such as squares, parks, tunnels, etc.).

  - Never/Not at all
  - Rarely/Low chance
  - Sometimes/Maybe
  - Often/High chance
  - Always/Absolutely
  - I do not recall such moments.

23. While using this technology on a road I've traveled before, I understand which road/settlement I am passing through based on <u>continuous environmental features</u> (such as roadside trees, continuous mountain/sea views, road decorations, etc.).

  - Never/Not at all
  - Rarely/Low chance
  - Sometimes/Maybe
  - Often/High chance
  - Always/Absolutely
  - I do not recall such moments.

24. While using this technology on a road I've traveled before, I determine which road/settlement I am passing through based on prominent <u>singular environmental features</u> (such as notable buildings, sculptures, etc.).

  - Never/Not at all
  - Rarely/Low chance
  - Sometimes/Maybe
  - Often/High chance
  - Always/Absolutely
  - I do not recall such moments.

25. While using this technology, I also look at wayfinding signboards to make decisions about the upcoming turns.

  - Never/Not at all
  - Rarely/Low chance
  - Sometimes/Maybe
  - Often/High chance

- Always/Absolutely
- I do not recall such moments.

26. If I know/think that wayfinding information on the route I will take is sufficient, I can go to a destination I've never been before without using in-car navigation technology.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely

27. If the wayfinding signboards on a completely unfamiliar road provide different information than the navigator's directions, I would follow the information on the boards.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely

28. Even if I am using this technology, I still notice the wayfinding signboards on the road during the drive.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely

29. Even if I am using this technology, I still notice the safety signs and traffic lights on the road during the drive.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely

30. Even if I am using this technology, I still notice speed bumps and other bumps or potholes on the road during the drive.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely

31. Even if I am using this technology, I still notice slight descents and inclines on the road during the drive.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely

32. Even if I am using this technology, I still notice prominent buildings and statues along the road during the drive.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely

33. Even if I am using this technology, I still notice decorations applied along some parts of the road during the drive.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely

34. Even if I am using this technology, I still notice humans and animals walking along the roadside during the drive.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe

- Often/High chance
- Always/Absolutely

35. Even if I am using this technology, I still notice humans and animals that might suddenly appear in my path during the drive.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely

36. Even if I am using this technology, I still notice whether the road offers views of mountains/seas, is lined with trees, flowers, etc. during the drive.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely

37. Even if I use this technology on a completely unfamiliar road, I would know or could roughly estimate the number of squares, tunnels, bridges, viaducts, etc., I passed through when the journey ends.

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely

38. Even if I use this technology on a completely unfamiliar road, I can describe the route to someone else after the journey without the support of the navigation application.

Hiçbir zaman/Asla

- Never/Not at all
- Rarely/Low chance
- Sometimes/Maybe
- Often/High chance
- Always/Absolutely

Contact information

Thank you for answering our questions up to this point. We kindly ask you to respond to the questions in this section based on your own experience. We would appreciate hearing more detailed information about your experiences, and we would like to see you participate as a contributor in the later stages of the research. **If you believe you may participate in the subsequent stages, we kindly request that you share your contact information below so that we may reach out to you if necessary** (Sharing your information is entirely optional, and your decision regarding participation in the continuation of the research will be respected).

For any questions or comments about the research, you can contact the researcher, Elif Büyükkeçeci (Email: [redacted]).

39. Name-surname (You can choose to share only your nickname):

…………………………………………………

40. City-district:

…………………………………………………

41. Phone number:

…………………………………………………

42. E-mail address:

…………………………………………………

F. Quotes in the Original Language

[1] Bu yol ağaçlarla çevrili bir yol, yol gösteren bir tabela yok. Nereye dönmem gerektiğini bana söyleyecek dikkat çekici bir şey bile yok çevrede. Bu yüzden, geçmişte dönüşü kaçıracağım zamanlar olurdu; ama bir gün ileride bir zeytin ağacı fark ettim, yol kenarında sık ağaçların arasında zar zor seçiliyordu; işte o benim dönüş noktam oldu. Artık zeytin ağacını gördüğümde dönüş yapıyorum.

[2] Bizim mahallede çok yaşlı bir köpek var. Her zaman yürüyüş yolunun belli bir noktasında yatar, oradan hiç ayrılmaz. Bir gün bir arkadaşım ve ben yürüyüşe çıkmaya karar verdik. Nerede buluşalım diye sordum, o da bir an farkında olmadan, köpeğin orada buluşalım, dedi. O günden beri yürüyüşe çıktığımızda köpekte buluşuyoruz.

[3] Benim aslında gözlerim iyi görmüyor, bu mesafeden tabelalardaki yazıları okuyamıyorum. Ama buranın sola dönmem gereken nokta olduğunu ezberledim. O tabelaları gördüğümde, yakında sola dönmem gerektiğini anlıyorum. Bu arada, bu yolda daha önceki yolculuklarımdan biliyorum, tabelalar aslında sağı gösteriyor, ha ha. Ama onların işaret ettiği yer şehre giriş tabii, köyü göstermiyor onlar.

[4] O çakıllı yola girdiğimde biliyorum ki tali yolun girişine ancak birkaç kilometre falan uzaktayım. Çakıllı kısım bitince biraz daha ilerliyorum ve önümde bir kavşak var. Oradan dönüp tali yola giriyorum.

[5] Bir yol var, sık sık kullanıyorum ama hâlâ bilmiyorum, orada bir yer var, altı yüz metre sonra dön, dediği bir yer cihazın. Tam bildirimi duyuyorum, yolun sağında istinat duvarı başlıyor. O yüzden artık o bildirimi aldığımda duvara varmak üzere olduğumu biliyorum. Dönüş, bu arada, duvarın tam sonunda. O yolda birçok tabela var aslında ve muhtemelen o dönüşte de bir tane vardır; ama zaten orada döneceğimi bildiğim için bakmaya gerek bile duymuyorum, ha ha. Ya da daha doğrusu, bildirimi aldığımda rahatladığım için tabelalara dikkat etmeyi unutuyorum. Bu yüzden, hâlâ ne yazdığını bile bilmem o tabelalarda.

[6] İşte orada bak! Orada, köşede duruyor! Oraya çivili bildirimi görmüyor musun sen?

[7] Bir gün bir arkadaşımla birlikte şehirlerarası bir yoldan işe gidiyordum. Yol ıslakmış, tamam mı, yolda düzenli olarak sulanan bir arsa varmış; ancak o zaman bilmiyordum bunu. Arsanın yanından dönerken araba kaydı, bir an direksiyon hakimiyetimi kaybettim. Kaza yapıyordum neredeyse. Hemen, korku, şaşkınlık, arkadaşıma baktım, "Azrail buradaydı" demişim sessizce ve başladım ağlamaya! İkimiz için de çok korkutucuydu. Artık oradan ne zaman geçsem o anı tekrar yaşıyorum ve tabii artık o dönüşte navigasyon yardımına falan gerek duymuyorum yani.

[8] Aa, bu yol arkadaşlarla yemek yemek için durduğumuz yol değil mi ya? Acıkmaya başladım vallahi. Dönüşte şuralarda duralım mı ya?

[9] Ben çocukken babam burada durup, burası Hansel'le Gretel'in ormanı, derdi; ben de inanırdım, ha ha. Buralarda biraz dolaşırdık. Burası benim için hâlâ Hansel'le Gretel'in ormanıdır.

[10] Sen bu cihazı gerçekten her zaman böyle tam kapasite mi kullanıyorsun? Son damlasına kadar kullandın!

[11] Buralar kırsal bir yerler, buralarda harita güncel olmayabilir.

[12] Yol hem dar hem bakımsız, olsa olsa bir köye falan çıkıyordur o zaman.

[13] Cihaz düz bir yol gösteriyor, bu yüzden, şehri boylu boyunca geçen ana yoldayız, diye düşünüyorum.

[14] Bu yolda trafik olmaz genelde. Şimdi ileride bir sıkışıklık görünüyor, yol kapalıdır. Bence bir sonraki yol ayrımından dönmeliyiz.

[15] Şu anda burada ilk kez bulunuyorum. Fakat son zamanlarda benzer bir yerde cihaz çelişkili bilgiler verdi ve beni yanlış yollara soktu. Kırsal yerlerde böyle sorunlar olabiliyor gibi ve şimdi de benzer bir risk var gibi duruyor. Bu yüzden tabelaları takip ederek bulacağım yolu.

[16] Bu semte daha önce hiç gelmedim; ama hep arka sokaklarda güzel restoranlar olduğunu duyuyorum. O zaman yakınlarda benzin istasyonu da vardır. O zaman, benzin almak için bu yönden devam ediyorum.

[17] Bunlar restorana gelenlerindir. Bu konvoyun sonundadır restoran da.

[18] Pazar çantalarıyla yürüyen insanlar görüyor musun? Ne taraftan geliyorlarsa market oradadır. Görevimiz pazar çantalarını takip etmek, tamam mı?

[19] Uzunlar mı açık? Yoo, değil. E' niye selektör yaptı? Radar mı var yolda? Onu mu diyor? Önümüzde bir radar olabilir vallahi. O zaman şuradan dönüyorum, devam etmeyeceğim.

[20] Ay tamamen dalgınlıkla oldu' Dönerken fark etmedim. Ay bu dönen ben değildim, ha ha! Sanki biri döndürdü beni? Biri mi itti beni acaba? Beni kim itti ki? Ha ha!

[21] Onlar hızlandı ya, ben hızlanmadım vallahi.

[22] Bu yola ne zaman girdik? Nasıl girdik yani?

[23] Ben kıvrımı fark etmedim vallahi, beni kendisi döndürdü.

[24] Müzik bayağı hareketliydi. Onun etkisiyle fark etmeden gaza yüklenmişim. Sonra cihaz bir dönüş bildirimi verdi; ama o anda doğru şeride geçemezdim artık. Çünkü hızlanmışım bayağı ve dönüş yakındı. O yüzden, dönüşü yapmadan devam etmek zorunda kaldım.

[25] Öyle yapmam gerekiyor gibi geldi.

[26] Dalgınlıkla yaptım vallahi.

[27] O yola girdiğimin farkında değildim.

[28] Aa, ben bu yolu bilmiyordum ama az önce tünele yaklaştığımı anladım! E' nasıl anladım ki? Bu yollardan hep navigasyon cihazının desteğiyle geçiyorum ben, kendim buralarda hayatta yolumu bulamam, nerede olduğumu bile blmiyorum aslında! Ama az önce cihazın bildirim vermeden anladım tünele gireceğimi. Hem de doğru yola girmişim kendi kendime! Şöyle oldu. O yolda olduğumu bilmeden ilerlerken bir anda sanki çevremdeki tanıdık bir değişiklikle derin bir uykudan uyandım. Etrafımı saran büyük ağaçlar birden kayboldu, onların yerini kuru otlar aldı. Çevredeki yeşillikler birden sarardı, gibi geldi. Bu sararmayla uyandım. Bu uyanma tünele girmek üzere olduğum hissiyle birlikte geldi. Sonra hemen devamında gerçekten de bir baktım, tünelin girişi karşımda.

[29] Ben yolları asla öğrenmem, ha ha! Oraya giderken hep navigasyon desteğiyle giderim. Ama son zamanlarda cihaz, o yolda her zaman verdiği rotayı değil de farklı bir rotayı vermeye başladı. O yüzden eskiden bildirim verdiği yerde artık bildirim veriyor. Ama son zamanlarda o rotayı en azından belirli bir yerinde kendim gidebildiğimi fark ettim. Yolun o bölümünde hangi dönüşten döneceğimi, nasıl olduysa artık, anlayabiliyormuşum meğer. Çok ilginç ya, çünkü hâlâ hiç bilmiyorum rotayı. O döneceğimi anladığım yerden önce kaç dönüş olduğunu bilmiyorum, o dönüşten sonra rotanın nasıl olduğunu bilmiyorum, yolu kimseye tarif edemem, çizemem bile... Çünkü yolu bilmiyorum basbayağı! Ama geçen hafta o yolu kullanırken, bir an için kendimi, ay bu kavşak burada olacak ya, derken buldum. Tam o sırada da tepenin etrafından dönerken bir baktım, kavşak birden karşıma çıktı! Hâlâ bilmiyorum nasıl anlayabildiğimi! İçimdeki bir his gibiydi, ha ha! Of tepe demedim mi işte yaa? Aa, bir dakika! Orada bir tepe olduğunun bile farkında değildim, şimdi fark ettim! Tepeyi bildiğimi şimdi fark ettim! O kavşağı o tepeyle eşleştirmişim bak demek ki! Bunu daha önce fark etmemiş olmam çok garip değil mi ya, ha ha ha!

CURRICULUM VITAE

Surname, Name: Büyükkeçeci, Elif

EDUCATION

Degree	Institution	Year of Graduation
MS	Izmir University of Economics (IUE) Design Studies, Izmir	2017
BS	IUE Industrial Design, Izmir	2013
High School	Sekine Evren Anadolu High School, Manisa	2008

WORK EXPERIENCE

Occupation	Institution	Year
Research Assistant	IUE Interior Architecture and Environmental Design	2016-2022
Teaching Assistant	IUE Faculty of Fine Arts and Design	2015-2016

FOREIGN LANGUAGES

Advanced English

PUBLICATIONS

1. Aktaş, B. M., Tok, T., Gürtekin, B., Kaygan, H., Dilek, Ö., Özçelik, A., … & Büyükkeçeci, E. (2022). Human-Thing Relations in Design: A Framework Based on Postphenomenology and Material Engagement Theory.

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YAZARIN / AUTHOR

Soyadı / Surname : Büyükkeçeci
Adı / Name : Elif
Bölümü / Department : Industrial Design

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