JOINT CHANGE-DETECTION: HOW THE INTERPLAY BETWEEN SCENE CONTEXT AND OBJECT DETECTION IS AFFECTED BY TASK SETTING

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JOINT CHANGE-DETECTION: HOW THE INTERPLAY BETWEEN SCENE CONTEXT AND OBJECT DETECTION IS AFFECTED BY TASK SETTING

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ABSTRACT

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In this paper, we study the effects of social setting on change-detection performance: First, we investigate how detection of changing (i.e., repeatedly appearing and disappearing) objects in scene images is influenced by the scene context. If a changing object's identity is in conflict with its surrounding context (e.g. a boat on a highway), that is a semantically-inconsistent change; if there is no such conflict (e.g., a boat in a lake), that is a semantically-consistent change. We found, in line with previous studies in the literature, that inconsistent changes were detected more often (more accurately) and faster than the consistent ones, probably because attention was attracted towards inconsistent objects earlier than the consistent ones. Second, we investigate how joint-action settings (i.e., cooperative and competitive) affect performance on the change-detection task. Based on social facilitation literature, which indicates simple tasks are performed better and complex tasks are performed worse in the presence of others, we expect that detecting inconsistent changes (a simple task) are even more often and faster, whereas detecting consistent changes (a complex task) are even less often and more slowly in the presence of a cooperating or competing co-actor, as compared to individual condition. However, we did not find such a differential effect. Instead, our results showed that cooperating subjects performed similarly to the individual subjects; competing subjects, though detected the inconsistent changes more often than the consistent ones, were less accurate but faster on both types of change relative to the individual subjects.

Keywords: Change Blindness, Change Detection, Semantic Consistency, Joint Action, Social Facilitation

ÖZ

ORTAK DEĞİŞİM-SAPTAMA: MANZARA KONTEKSTİ VE NESNE SAPTAMA ARASINDAKİ ETKİLEŞİMİN FARKLI GÖREV ORTAMLARINDA İNCELENMESİ

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Bu çalışmada sosyal ortamın değişim saptama üzerindeki etkisini araştırdık. İlk olarak, manzara resimlerindeki değişen (sürekli olarak kaybolup görünen) nesnelerin saptanmasının manzara kontekstinden nasıl etkilendiğini inceledik. Değişen nesnenin kimliği ile içinde bulunduğu kontekst arasında bir çelişki varsa (örneğin, otoyolda bir tekne), buna semantik olarak tutarsız değişiklik diyoruz; eğer böyle bir çelişki yoksa (örneğin, gölde bir tekne), buna ise semantik olarak tutarlı değişiklik diyoruz. Literatürdeki diğer çalışmalarla benzer şekilde, tutarsız değişikliklerin tutarlı değişikliklere nazaran daha sık (doğru) ve daha hızlı saptandığını bulduk; bu bulgu, tutarsız nesnelerin dikkati tutarlı olanlara nazaran daha erken çekmesinden kaynaklanıyor olabilir. İkinci olarak, ortak-hareket ortamlarının (yardımcı ve rakip ortamları) değişim saptama performansını nasıl etkilediğini inceledik. Başka insanların önündeyken basit görevlerin daha kolay, karmaşık görevlerin ise daha zorlaştığını belirten Sosyal Kolaylaştırma literatüründen yola çıkarak, yardımcı veya rakip bir eşle beraberken, tutarlı değişikliklerin (karmaşık görev) daha az ve daha yavaş, tutarsız olanların (basit görev) ise daha sık ve daha hızlı saptanacağını (bireysel olma durumuna nazaran) tahmin ettik. Fakat, sonuçlarımız gösterdi ki böyle ayrımsal bir etki bulamadık. Yardımlaşan katılımcılar ile bireysel katılımcıların performansı birbirine çok benzer çıktı. Rakip katılımcılar ise, her ne kadar tutarsız değişiklikleri tutarlı olanlara nazaran daha sık saptadılarsa da, bu iki tür değişiklikte, bireysel katılımcılara nazaran, daha az fakat daha hızlı saptama yaptılar.

Anahtar Sözcükler: Değişim Körlüğü, Değişim Saptama, Semantik Tutarlılık, Ortak Hareket, Sosyal Kolaylaştırma

To My Family

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
METU	Middle East Technical University
ms	milliseconds
RT	Reaction Time(s)
SD	Standard Deviation
SE	Standard Error

CHAPTER 1

INTRODUCTION

In our daily lives, we are bombarded continuously with information coming from an astonishingly rich and complex visual world around us. We encounter various scenes with the objects constituting them having numerous characteristics like size, shape, color, texture, etc. Everything we see, in this sense, consists of a different combination of those characteristics. Given this complexity, the important question arises: To what extent do we mentally represent this outside visual world? In other words, do we form perfect/complete internal representations of the external world, or are those representations limited (Ludwig, 2006; Viger, 2006)?

Considering the fact that we can survive, adapt to our environments, and succeed in so many fields of our lives, it seems obvious that we at least form and maintain representations of our visual world *in a sufficient way*. On the other hand, when we look at the literature on perception and cognition, there are several findings indicating that these sufficient representations do not reach perfectness.

Part of the evidence regarding this non-perfectness comes from the physiology of vision. The retina of each eye consists of several different layers of cells. When the image of the visual world lands on the retina, it is first processed by the photo-receptor cells, which convert the light into neural activity. The number of these photo-receptor cells is said to be around 100 million for each retina (Rodieck, 1998). The information in the photo-receptors is then sent to the other retinal layers for further processing; these other layers are the horizontal cells, bipolar cells, amacrine cells, and the ganglion cells, respectively. The number of the ganglion cells is about 1 million (Rodieck, 1998; Wässle, 2004). The information in the ganglion cells is then sent to the brain via the optic nerve. In short, visual processing at the sensory level starts with 100 million photo-receptor cells and the information is reduced to 1 million ganglion cells before it is sent to the brain. That is, we lose 99% of the incoming information before it reaches the brain. This reduction of information, however, does not occur disorderly. Due to the organization of the retinal layers (Callaway, 2005; Wässle, 2004), we still manage to form a *fair* sensory representation of the external world, though it is not perfect.

In order to make sense of this raw sensory representation, our perceptual and cognitive systems must *interpret* it. For instance, when we encounter a kitchen, which is a highly complex scene consisting of a lot of different objects in it, we can immediately identify it as a kitchen (Bar, 2009). But can we also identify every object in it at once? In other words, can we form a conscious representation of it such that we recognize and become aware of every detail in this kitchen the moment we see it? Or, do we recognize only a few objects in it at a glance, leaving the others outside of our consciousness? These questions lead us to other kinds of evidence regarding the non-perfectness of our internal representations of the external world.

An intriguing demonstration that our conscious representations of the visual world around us are quite limited, incomplete, and formed in piecemeal fashion comes from an experiment conducted by Simons and Chabris (1999). In this experiment, participants were shown a video of two teams of people, with each team passing a basketball among each other. Participants were told to keep mental count of the passes one of those two teams made. Halfway through the video, a strange thing happened; a person wearing a full gorilla costume walked past these two teams, appearing in full view of the camera. After the video ended, participants were asked several questions like “Did you notice anything/anybody unusual on the video?”. Nearly 50% of the participants reported not having seen this strange event.

This phenomenon is called “inattentional blindness” (Simons & Chabris, 1999) because while the participants’ attention is busy with an event (e.g., counting the passes), a strange and unexpected event (e.g., a person in a gorilla costume), which appears in full view of the camera and consequently must have landed on the retina of the participant, goes unnoticed; that is, their preoccupied attention system leaves the participants “blind” to the unexpected event occurring in the same scene.

Why cannot we be aware of and recognize all things in our visual field? A plausible answer is that our visual cognitive system has limited capacity (Cavanagh, 2011), therefore, we must be selective in what we attend to. Attention, in the visual domain, can be defined as the set of processes which enables people to mobilize resources for cognitive/perceptual processing of the selected portions of the retinal image more fully than the nonselected portions (Palmer, 1999). This selection does not occur at random; instead, it depends mostly on our motivations, goals, expectations, needs, etc. Once we attend to something, it generally reaches our consciousness (Baars, Franklin, & Ramsoy, 2013; Jacob, Jacobs, & Silvanto, 2015; Prinz, 2012). Yet unattended objects may still be processed at some *non-conscious* level and can later attract our attention (Mack & Rock, 1998).

Consistent with these ideas, there is another powerful phenomenon showing the incompleteness of our representations of the external world. This phenomenon is called “change blindness” (Simons & Levin, 1997; Rensink, O'Regan, & Clark, 1997) – which is the topic of this thesis. It shows that people have a poor ability to detect changes occurring in displays, even when those changes are gross. This phenomenon has been established by employing a variety of techniques, which will be described at length in the following chapter; but for now, only one of those techniques called "flicker paradigm" will be introduced briefly, because this technique is the medium through which we will investigate change blindness in this thesis. In the flicker paradigm subjects are shown two repeatedly alternating pictures which are identical except some element (an object or feature) that changes, with a brief interval (usually a blank screen) placed between the presentation of those pictures. Subjects are instructed to press a button as soon as they see the change. The typical finding is that subjects take quite a long time to detect the changes.

One research question that has been frequently tested by using the flicker paradigm is whether the semantic (contextual) congruency of the changing object affects the detection performance (e.g., Hollingworth & Henderson, 2000; LaPointe & Milliken, 2016). For example, when a farmyard image containing a live chicken repeatedly alternates with the same farmyard image without the live chicken in it, this is a "semantically-congruent" change, because live chickens are typically found in farmyards. On the other hand, when a kitchen image containing a live chicken repeatedly alternates with the same kitchen image without the live chicken in it, this is a "semantically-incongruent change", because kitchens are not the typical places for live chickens. The typical finding is that semantically-incongruent changes are detected faster and more accurately than the semantically-congruent ones. A possible explanation offered in the literature is that attention is drawn to the incongruent objects earlier than the congruent ones because the incongruent objects conflict with the scene context (Hollingworth & Henderson, 2000). One of the aims of this thesis is to replicate this finding.

Attention, besides the visual domain, can encompass a variety of different inputs from other domains that we deal with in our lives (Baars, 1988). Other people around us, for instance, can be considered as one such input type (from the social domain) to our attentional system. Since we humans are social beings, and most of the time we encounter, communicate, and interact with other people, the presence of them is an important source for attention (Klein, Shepherd, & Platt, 2009).

Furthermore, when we attend to two things at the same time, our attention is considered *divided* between those things. This divided attention situation is what the capacity theory of attention, proposed by Kahneman (1973), concentrates on. It basically says our attentional capacity is limited and when we engage in two things simultaneously, whether both from the same domain or from different domains, allocation of our attention between those things occurs in strategic ways, depending on the priority of one thing over the other, the difficulty level of those things, etc. (Britton & Tesser, 1982; Pashler, 1999; Tyler, Hertel, McCallum, & Ellis, 1979; Huang & Pashler, 2005; Smith, 1982; Roge, Kielbasa, & Muzet, 2002).

In line with these arguments, we can say that when we engage in a task and the presence of other people around matters to us while we do it, our attention should be divided between that task and those people (Baron, Moore, & Sanders, 1978; Frischen, Loach, & Tipper, 2009). Indeed, there are two related research areas on this issue. One is social facilitation (Zajonc, 1965; Guerin, 1993; Aiello & Douthitt, 2001) and the other is joint action (Sebanz, Bekkering, & Knoblich, 2006; Knoblich, Butterfill, & Sebanz, 2011).

Social facilitation is the phenomenon that when an individual performs a cognitive or motor activity before an audience or with an independent co-actor, his/her performance will be different from when s/he does it alone. Typically, the presence of an audience or co-actor increases the individual performance when the task is simple or well-practiced but impairs it when the task is complex or less-practiced (Aiello & Douthitt, 2001).

Joint action, on the other hand, is a more recent research area. It occurs when co-actors engage in a task together by interacting with one another, rather than acting independently of each other on the same task (Sebanz, Bekkering, & Knoblich, 2006). In joint action settings, co-actors generally share each other's mental representations. For instance, one study showed that in a visual joint action task, co-actors took each other's 'perspective' into account, even though that was not required (Böckler, Knoblich, & Sebanz, 2011).

Our aim in this thesis is to bring together these different strands of research: the research on change blindness on the one hand and the research on social facilitation and joint action on the other hand. For this purpose, we want to observe how performance in a change-detection task consisting of semantically congruent and incongruent images will be affected by the social conditions of the participants, whether they perform the task alone or with a partner. The results of this study will give us further knowledge about how attention allocation between the demands of a task and the demands of social conditions will influence individual performance.

Chapter 2 of this thesis will give a literature review on change blindness, social facilitation and joint action. In the change blindness part, we will describe various paradigms used to induce change blindness, some factors that affect change blindness (e.g., semantic congruency of the changing object), and some theoretical accounts of change blindness. In the social facilitation and joint action part, we will mention some important studies in which a social facilitation effect was observed; specifically, we will cover different methods employed to induce social facilitation, different social settings (e.g., audience and co-action) inducing social facilitation, and major theoretical explanations of social facilitation. We will also present an account of joint action and its cognitive and behavioral effects. In chapter 3, we will list our hypotheses for this thesis by explaining the rationale behind those hypotheses. Chapter 4 will cover the methodology we employed in this thesis. In chapter 5, the results of the experiment we conducted for this thesis will be analyzed. Finally, chapter 6 will provide a discussion.

CHAPTER 2

LITERATURE REVIEW

The first part of this section covers change blindness studies and change detection paradigms. The second part covers the research on social facilitation and joint action.

2.1. Change Blindness

In typical studies of visual memory, individuals are shown hundreds (Shepard, 1967) or even thousands (Standing, Conezio, & Haber, 1970; Standing, 1973) of pictures, and then are given some recognition test hours or days later. In this recognition test, they try to identify which pictures they have been shown and which they have not. The general conclusion of these studies is that people can recognize the pictures they have seen before at a very high rate, around 90%. However, several studies indicate that memory for the pictures does not retain the precise visual form of the picture (Pezdek et al., 1988). For example, Standing, Conezio, and Haber (1970) reversed the orientation of half of the actual pictures in the test phase, but the subjects did not become aware of that. These studies suggest that although we do not recognize a picture we have seen in its *exact* visual form, we can extract the gist (meaning) of it and use that gist for recognition (Nickerson, 1965).

The main purpose of the studies described above was to test how many different pictures people could retain in their memories; therefore, the pictures used in these studies were chosen to be distinctive. More recent studies in visual cognition, on the other hand, have concentrated on how much detailed the visual images are represented at perceptual and cognitive levels; therefore, the main interest in these studies is to see how well individuals can notice the changes made in visual displays (Simons, 2000). The common finding of these studies is that people are not good at detecting changes occurring in displays. The various phenomena showing such detection failures have been categorized under the name of "change blindness" (Simons & Levin, 1997). Change blindness has been observed by using different paradigms.

2.1.1. Change Blindness through Saccadic Eye Movements

Saccades are rapid movements (jumps) of the eyes from one location to the other. Their function is to bring objects of interest to the fovea, a part of the retina where visual acuity is very high. Planning and executing a saccade takes around 150-200 ms; the movement itself is typically around 30 ms. The eyes fixate an object of interest between saccades for 300 ms on overage in order for the visual system to process the information in that location (Palmer, 1999). During a saccade, the retinal image is blurred and we never perceive that blurred vision.

People generally do not notice changes if they occur during saccades (Currie, McConkie, Carlson-Radvansky, & Irwin, 2000; Henderson & Hollingworth, 1999a). For instance, McConkie and Zola (1979) were interested in how much of the visual information was integrated across fixations in reading. They presented their subjects texts that consisted of alternating cases with each letter (e.g., tHe FlOrIdA). During some saccades subjects made, every letter in the words switched case (e.g., rEd becomes ReD). The striking result was that subjects did not become aware of these changes. The authors concluded that information integration across fixations were not dependent on the exact visual form of the words.

Furthermore, Grimes (1996) investigated change detection performance of his subjects by using full-colored scene images. He told his subjects to study the images for a later recognition test. He also informed them that something in the images might occasionally change and they should press a button when they saw a change. Eye movements of the subjects were monitored so that a change in a picture could be made during a saccade. The remarkable result was that most of the subjects failed to notice that the different colored hats switched between the two men in the image. Another surprising result was that only half of the subjects detected it when the two men switched heads.

2.1.2. Change Blindness through Eyeblinks

In addition to saccades, eyeblinks, which are very fast closures and reopenings of the eyes, can also induce change blindness. O'Regan, Deubel, Clark, and Rensink (2000) showed their subjects several scene images. The subjects were told that there would be a change at some moment in every image while they were examining it, and that they should press a button immediately when they saw it. The kinds of the changes were addition-deletion of an object (or a feature), position shift of an object, and color change in an object. The changes in the pictures occurred every time the subjects blinked. The subjects, of course, were not told that their eye blinks would cause a change in the pictures. The researchers found that the probability of change detection dropped as the distance of the eye from the change location increased. But the most interesting result was that even when the subjects were fixating the change location at the time of their eye blinks, they missed the change in 40% of the cases.

2.1.3. Change Blindness through the Flicker Paradigm

Similar to saccades and eyeblinks, blanking out a picture very briefly and then exposing its modified version can also impair people's change detection performance. This method is called "flicker paradigm" because of the rapid appearance-disappearance of the pictures (Rensink, O'Regan, & Clark, 1997). The flicker paradigm was developed by Rensink et al. (1997), and has since been employed in various studies in visual cognition (Aginsky & Tarr, 2000; Shore & Klein, 2000; McCarley et al., 2004; Beck, Angelone, & Levin, 2004; Youmans, Figueroa, & Kramarova, 2011). For instance, in Rensink et al.'s (1997) study, participants were shown different scene images, such that every image continuously flickered until the participants responded. During this flicker, an image (shown for 240 ms) and its modified version (shown for 240 ms) repeatedly alternated with each other, with an 80 ms blank screen inserted between the alternations. For every picture, a single change – color, position shift, or appearance/disappearance – was made to an object or an area. The researchers also manipulated the interest levels of the changing elements in order to see the effects of higher-level factors. For this, five naïve observers were shown the scene images used in the study. They were asked to give a brief verbal description of those images. The objects or areas mentioned by at least three observers were deemed as "central interests" (e.g., the helicopter in the background), and those not mentioned by any of the observers were deemed as "marginal interests" (e.g., the railing behind the people).

The researchers found that it took the subjects several seconds (sometimes nearly a minute) to detect the changes. They also found that changes in central interests were detected faster than changes in marginal interests, possibly because attention is drawn earlier to central interest changes.

To make sure that the changes were actually quite easy to see when there was no flicker, they repeated the experiment but this time removed the blank screen between the alternations. The results showed that the subjects immediately detected the changes when there was no blank interval. There was also no difference in detection speeds between the central interest changes and marginal interest changes.

Furthermore, Rensink, O'Regan, and Clark (2000) investigated the nature of the interruptions, namely, the blank screens between the alternating images, by manipulating the duration and brightness of the blank intervals. In duration, they used 0 (no interruption), 40, 80, 160, and 320 ms intervals. The results showed that detection speed decreased as durations rose from 0 to 80 ms interval. There was no difference in performance between 80 and 160 ms intervals. But the detection deteriorated at 320 ms interval as compared to the 160 ms interval. In brightness, the researchers used black, gray, and white blank screens. The results yielded no significant effect of brightness on performance.

2.1.4. Change Blindness through Motion Picture Films

Besides changes in static images, motion pictures (movies) can also induce change detection failures. Levin and Simons (1997) created a brief video (nearly 1 minute) of a conversation between two women. Every time the camera angle shifted to somewhere else in the scene, the researchers made an intentional editing mistake in the movie. For instance, one woman was wearing a scarf in one shot, but it disappeared in the next shot, and reappeared in the shot after it. Another intentional change was the color of the plates on the table; initially, the plates were red, but they became white in the next shot, and then became red again in the following shot. Also, the food in one plate shifted to the other plate when the camera angle was changed. There were 9 types of changes in total. Subjects were told to watch this movie by paying close attention to it. After the movie, subjects were asked if they had noticed any changes in the clothes, items, and item positions in the movie. Only 1 subject (out of 10) noticed a change (out of the 9 changes). These subjects watched the same video again and they were also warned to look for changes while watching it. But they still failed to detect most of the changes; on average, they detected 2 of the 9 changes. That is, re-watching the video with the instruction to look for changes did help a little.

In this study, all the changes were made in the peripheral objects (e.g., scarfs, plates, food). We know from studies using the flicker paradigm (e.g., Rensink et al., 1997) that peripheral changes are missed more often or detected more slowly than central changes. To test the effect of central changes in motion pictures, Simons (1996) made one intentional change which was to a central object in the movie. The movie started with a woman pouring cola from a bottle into a cup on the table. Then, the camera showed another woman approaching. When the camera returned to the table again, the bottle was gone, and instead of it, there was a cardboard box about the same size as the bottle. Of the 10 subjects, none could detect this change, although most of them referred to the bottle in their descriptions of the video. The fact that the subjects mentioned the bottle suggests that the bottle was central to the scene and that the subjects paid attention to it. But the subjects' failure to notice the cardboard box suggests that the box might not be the central object when the camera returned to the table. A possible explanation is that people can only notice changes when they attend to a target object both before and after the change occurs (Simons & Mitroff, 2001; Simons, 2000).

2.1.5. Change Blindness in Real-World Settings

Instead of passively observing a movie, what happens when we are actively a part of an ongoing activity in which a central change occurs? Simons and Levin (1998) conducted a field experiment in which they employed a real-world change detection task. In this experiment, the subject, who was a pedestrian, was approached by the experimenter. The experimenter asked the subject for directions to some place. During the conversation, two men carrying a door passed between the subject and the experimenter. During this interruption, the experimenter was substituted by another experimenter, who was one of those two men passing. 50% of the subjects did not notice the experimenter they had been talking to had been interchanged, even though they interacted with the two experimenters. Those two experimenters were similar such that they were young (approximately 30 years old), white males, and with short dark hair. But they differed in height (one was 5 cm shorter than the other), in clothing, and in voice.

The 50% of the subjects who failed to notice the change were all older than the experimenter, and the other 50% of the subjects, who became aware of the change, were all younger than or at the same age with the experimenters. This effect was not due to aging because most of the older subjects were not that much old. A plausible explanation might, according to Simons and Levin (1998), be that people encode the members of their own social group in a different way than they encode members of another social group. A person from one's own social group ("in-group") might be encoded in terms of the features that can differentiate individuals within that social group. In contrast, a person belonging to another social group ("out-group") might be encoded only in terms of his/her group membership information, and his/her differentiating features might be ignored (Rothbart & John, 1985). Accordingly, in this experiment, older subjects (usually faculty or staff) might have encoded the experimenter(s) as s student asking for directions, so they might not need to encode the differentiating features of the experimenters. However, younger subjects (all of them students) might have encoded the differentiating features of the experimenter(s), so they noticed the switch of the experimenters. To test this possibility, Simons and Levin (1998) dressed these experimenters as construction workers so that they looked like out-group members to the younger subjects. With this modification, only 33% of the new younger subjects became aware of the experimenter switch. This was a huge drop, considering the earlier version of this experiment where all of the younger subjects noticed the change.

2.2. Theoretical Accounts of Change Blindness

Although most people have a firm belief that they can easily detect changes occurring in visual displays (Levin, Momen, Drivdahl, & Simons, 2000; Levin, Drivdahl, Momen, & Beck, 2002; Beck, Levin, & Angelone, 2007), the studies on change blindness show that people are indeed poor at detecting changes (Simons & Levin, 1997). Why do we fail in these circumstances? One view is that our internal representations of the external scenes are sparse and incomplete (O'Regan, 1992), and we can become aware of a change only when we focus our attention on it (Rensink et al., 1997; Rensink, 2000). More specifically, when there is no disruption (saccades, blinks, blank screens, or other kinds of disruptions), we can immediately notice the change because the retinal transients accompanying the change attracts our attention to the place where the change occurs. However, when there is a disruption separating the pre-change and post-change scenes, these low-level transients are of no use; thus, attention will not automatically be led to the place of change, and the change detection likelihood will be low. Change detection in the presence of disruptions, according to this view, occurs only when our focal attention coincides with the location of the change. Rensink et al. (1997) tested the influence of guided attention on flicker task performance. Right before each trial, they gave their subjects a verbal cue indicating the part of the scene to be changed. By this way, the subjects could more efficiently direct their attention to the relevant part of the scene. The results showed that change blindness attenuated in the cue condition as compared to the no-cue condition, suggesting that attention plays a role in change blindness. Furthermore, the finding that central interest changes are detected faster than marginal interest changes (Rensink et al., 1997; O'Regan, 2001) can also be interpreted in favor of the attention view, such that central changes, which are more important to the gist of the scene, receive preferential attention as compared to the marginal interest changes, which are less important to the gist of the scene.

Other views regarding why we experience change blindness argue that change blindness findings do not necessarily imply that our internal representations are sparse (Simons & Ambinder, 2005). For instance, it may be that our internal representations are initially rich, but they rapidly decay or become overwritten by the post-change scene before the perception of change is accomplished (Becker, Pashler, & Anstis, 2000; Simons & Rensink, 2005). Or, it may be that our conscious representations of the scenes are abstract and incomplete, whereas our nonconscious representations might be quite rich and detailed; thus, we might not easily access to our nonconscious representations, which make us fail to detect changes (Simons, 2000). Another account is that our internal representations might be richer than we think, but we may still be blind to changes because we might fail to compare the pre-change and post-change scenes (Simons, Chabris, Schnur, & Levin, 2002). Or, even if we can compare the scenes, our comparison processes might be slow, causing us to miss the changes (Hollingworth, 2003; Simons & Rensink, 2005).

2.3. Philosophical Implications of Change Blindness

The change blindness phenomenon raises a possible paradox: If we encode a given complex scene sparsely as the change blindness findings suggest, how or why do we have the *impression* that our visual experience is rich?

One answer is the so-called "inattentional amnesia" view (Wolfe, 1999). It basically says that our impression of visual richness results from a very short-lived but high-resolution *icon* formed in our minds upon seeing the scene. It is because of this image-like icon that we have the impression of visual richness. But because of its ephemeral nature, we can attend to only a small portion of this icon at a moment and forget the rest of it later on, when the percept enters into our working or short-term memory. Thus, according to this view, we consciously perceive everything in detailed but forget most of it right away.

Another idea, which is more radical, is that visual experience does not involve forming an internal representation of the external world. Instead, it involves employing certain skills to interact with the external world. In this view, the external world acts like an "external memory", where outside visual information is actively sought for by means of eye movements and attention in order to probe and interact with the environment (O'Regan & Noë, 2001). According to this "embodied cognition" view, we have the impression of visual richness because we know we can access everything in our environment; all we need to do to access something in the environment is to direct our eyes or attention to it. Change blindness, according to this account, occurs because when we attend to some area of the scene, we do not at that moment have access to the part of the scene that changes.

2.4. Some Factors Affecting Change Blindness

Although change blindness might be influenced by various factors, we will mention only some of them here: Developmental constraints, expertise, and semantic-consistency of the changing items.

2.4.1. The Development of Change Blindness

Are children susceptible to change blindness like adults? Fletcher-Watson, Collis, Findlay, and Leekam (2009) were interested in this question. They used the stimulus set developed by Rensink et al. (1997) and employed the flicker paradigm to three groups of children (6-8-year-olds, 8-10-year-olds, and 10-12-year-olds) and to a group of adults (19-22 years of age). The results indicated that change detection performance (both in accuracy and reaction times) improved with age and reached adult levels at the age 11. Another interesting finding of this study was that central-interest (high semantic importance) changes were detected more accurately and quickly than marginal-interest (low semantic importance) changes by all of the subjects. According to these researchers, this suggests that children have the same attentional biases/priorities as adults.

2.4.2. Change Blindness in Expertise-related Images

Being an expert in an area attenuates the degree of change blindness if the presented images are within the domain of that expertise area. For example, Beck, Martin, Smitherman, and Gaschen (2013) tested the change-detection performance of radiology experts and novices by using the flicker paradigm. Their stimuli consisted of radiograph images and regular real-world images. Changes in radiograph images were made by using pre- and post-treatment radiographic examinations of the patients (e.g., the pre-change image shows a fracture in a bone, and the post-change image shows the same bone healed). Changes in real-world images were similar to those used in classic change blindness studies. The results showed that radiology experts detected the changes in radiographs faster and more accurately than the novices. These experts also performed better on the radiography trials than they did on the real-world trials. Moreover, in the real-world trials, there was no performance difference between the experts and novices. That is, expertise improved performance only in the domain-specific trials, not in the domain-general trials. These findings, according to Beck et al. (2013), suggests that experts have more efficient attention allocation for the stimuli from their domain and use their visual working memory more effectively by retrieving the relevant cues from their long-term memory.

Another example of the influence of expertise on change blindness comes from a study by Werner and Thies (2000). They compared the change detection performance of American football experts to that of novices. They presented their subjects, by employing the flicker paradigm, American football images and football-unrelated images. A semantically important change occurred in the images. The results showed that American football experts had a significant performance advantage over novices: The experts detected changes in football scenes faster and more accurately than novices. Furthermore, for the football-unrelated images, the performance of the experts and novices did not differ, showing that the advantage of expertise prevail only in the domain-specific stimuli. Werner and Thies's (2000) interpretation of these findings is that experts have detailed expectations about their domain; this leads them to attend to and encode the relevant and important visual parts of the images from their domain more efficiently than novices.

2.4.3. Semantic Consistency of the Changing Item with the Scene

To what extent is an object in a scene consistent with the context of that scene? A plausible criterion might be the a priori probability of that object being in that scene, given the rest of the scene and the observer's past experience with such scenes (Loftus & Mackworth, 1978). With this logic, high-probability objects (e.g., a tractor in a farm scene) can be deemed as semantically-consistent objects, and low-probability objects (e.g., an octopus in a farm scene) can be deemed as semantically-inconsistent objects.

The question of whether objects that are semantically consistent with their surrounding scene are detected and/or identified more efficiently than the objects that are semantically inconsistent with the scene has been investigated many times in the literature (Henderson, Weeks, & Hollingworth, 1999; Neider & Zelinsky, 2006; Palmer, 1975; Brockmole & Henderson, 2008; Gordon, 2004; Hollingworth & Henderson, 2000; LaPointe & Milliken 2016). The findings revealed different effects, sometimes in favor of the inconsistent objects and sometimes in favor of the consistent objects. The reason why such opposite findings were obtained across the studies might be that the paradigms used in these studies and thus their task demands were different (LaPointe, Lupianez, & Milliken, 2013; LaPointe & Milliken 2017). For example, in visual search paradigms, where participants are first given a target object label and then instructed to find that target in a scene, the task demand is to identify that object because participants cannot spot the correct object without first identifying it. The general finding of these studies is that a target object consistent with its background is identified more efficiently than a target object inconsistent with its background (Palmer, 1975; Neider & Zelinsky, 2006; Henderson, Weeks, & Hollingworth, 1999). A possible explanation is that the gist of a given scene and prior knowledge regarding that scene can aid identification of the target object by constraining its classification. Moreover, context can help in finding the target object by restricting attentional processes, and thus produce superior performance for the target object which is semantically consistent with the scene it is in (Palmer, 1975; LaPointe et al., 2013).

On the other hand, if the task demand is not to identify a given object but just to detect it (e.g., a change-detection task), then the opposite effect is obtained; that is, objects inconsistent with their scene context are detected faster and more accurately than those consistent with their context (Brockmole & Henderson, 2008; Gordon, 2004, 2006; Hollingworth & Henderson, 2000; Hollingworth, Williams, & Henderson, 2001; LaPointe et al., 2013; LaPointe & Milliken 2017; Mack, Clarke, Erol, & Bert, 2017; LaPointe & Milliken 2016).

For instance, Hollingworth and Henderson (2000) presented their subjects different scene images by using the flicker paradigm (Rensink et al., 1997). In half of the trials (change trials), an image (shown for 240 ms) and its changed version (shown for 240 ms) repeatedly alternated, with the 80 ms blank screen between those alternations. In the other half of the trials (no-change trials), the procedure was the same except the alternating images were the same. This alternation continued until the subjects pressed a button. The subjects were instructed to press a button if they notice a change and press another button if they cannot notice a change. The critical manipulation in this study was that half of the images contained an object that was semantically congruent with its background and the other half contained an object that was semantically incongruent with the background. Each critical object was swapped across two backgrounds. For example, a fire hydrant was placed in a street scene (a congruent case), and the same fire hydrant was placed in a living room (an incongruent case). In some of the change trials, the critical object was deleted and then added repeatedly; in other change trials, the critical object's orientation was repeatedly changed (mirror-reversed). The critical finding of the study was that the semantically incongruent changes were detected earlier than the semantically congruent changes.

Why are the inconsistent (incongruent) objects detected faster? The visual cognition literature has provided ample evidence that when people encounter a scene, they first extract the context information within 120 ms (Biederman, 1981; Castelhano & Henderson, 2008; Fei-Fei, Iyer, Koch, & Perona, 2007; Henderson & Hollingworth, 1999b; Intraub, 1981; Oliva & Schyns, 1997; Potter, 1975; 1976; Sampanes, Tseng, & Bridgeman, 2008). Then, they begin to process the objects in the scene (Chun & Jiang, 1998; Navon, 1977; Schyns & Oliva, 1994). However, if there is a conflict between the object and the scene context surrounding it, that conflict attracts the attention to that object so that attention can process it further. Thus, semantically inconsistent objects draw attention earlier than the semantically consistent ones. This view, called "attention attraction hypothesis", was proposed by Hollingworth and Henderson (2000), and it has gained empirical support (LaPointe & Milliken, 2016). LaPointe and Milliken (2016) monitored their subjects' eye movements while they were engaged in a change detection task (flicker paradigm). They found that the first saccade following the onset of the picture was directed closer to inconsistent target objects than to consistent target objects. Furthermore, the subjects fixated the inconsistent targets earlier than the consistent ones.

2.5. Social Facilitation and Joint Action

In various tasks, people perform differently when they are with others relative to when they are alone (Sellaro, 2013). This section is devoted to this issue. We will first summarize the literature on social facilitation, wherein individual performance is affected by the presence of other people depending on the task complexity, and then we will give a summary of the joint action literature which shows that sharing a task with another person affects the individual performance. Besides, in this thesis, we aim to test change blindness in joint action settings.

2.5.1. Social Facilitation

Social facilitation is the phenomenon that individual performance on a task is influenced by the real or implied presence of others. Specifically, as compared to performing a task alone, performing a task in front of an audience or near another person doing the same task independently (co-action) lead to performance improvement if the task is simple or well-learned but to performance impairment if the task is complex or less-learned (Aiello & Douthitt, 2001).

2.5.2. Examples of Social Facilitation Studies

Some examples of the tasks which can be categorized as simple or complex and which induced social facilitation effects in the literature are as follows: pseudo-recognition task (Zajonc & Sales, 1966; Cottrell, Wack, Sekerak, & Rittle, 1968), maze learning task (Hunt & Hillery, 1973; Rajecki, Ickes, Corcoran, & Lenerz, 1977), dressing task (Markus, 1978), copying task (Sanders, Baron, & Moore, 1978; Taylor & Rechtschaffen, 1959), and paired-associates learning task (Cottrell, Rittle, & Wack, 1967; Feinberg & Aiello, 2006).

An interesting example of the social facilitation effect obtained in the audience setting is Markus' (1978) study. In this study, the subjects dressed and undressed their own clothes (a simple task) and also dressed and undressed some laboratory clothes (a complex task) either in front of an audience (a person watching) or alone. The dependent measure was the time it took the subjects to dress and undress. The data showed that dressing/undressing one's own clothes took less time in the presence of others than alone (performance improvement); on the other hand, dressing/undressing the laboratory clothes took more time in the presence of others than alone (performance impairment).

Social facilitation can also occur in co-action settings. For instance, Hunt and Hillery (1973) measured their subjects' performance on a maze learning task. The maze was either a simple one (two alternatives at each level) or a complex one (four alternatives at each level). The results showed that on the complex maze, co-acting subjects made more errors than single subjects (performance impairment); in contrast, on the simple maze, co-acting subjects made less errors than single subjects (performance improvement).

2.5.3. The History and Theoretical Accounts of Social Facilitation

Studies of social facilitation go back to the late 19th century. Triplett (1898) observed that bicycle racers were faster when they were racing against other bicycle racers as compared to when they were racing alone (against a clock). Triplett then conducted an experiment on children and found that most of the children turned a fishing reel faster when they were next to another child who was also turning a reel as compared to the children who did the same task alone. Later, other researchers became interested in the effect of the presence of others on individual performance by employing numerous different tasks (see Guerin, 1993, for a review).

Allport (1920) had coined the term "social facilitation" to refer to such phenomena. However, the studies conducted did not always show facilitation effects. Some studies indicated that the presence of others improved the individual performance, while the others showed that it deteriorated the individual performance. Then, Zajonc (1965) attempted to solve this inconsistency. He proposed that the conflicting results could be reconciled if the task difficulty was taken into account as a critical factor. He proposed the presence of others increases the drive (arousal/alertness) level of the individual; this increased drive then heightens the emission of dominant responses and restricts the emission of sub-ordinate responses. If the task at hand is a simple or well-learned one, the dominant response is probably the correct one; and consequently, the presence of others will enhance the emission of those correct responses, thereby improving the performance. On the other hand, if the task is difficult/complex or less-learned, the dominant response is probably the wrong one; and consequently, the presence of other people will increase the emission of those incorrect responses, thereby impairing the performance.

A few years later, Zajonc's view was questioned by some researchers. Henchy and Glass (1968), for instance, proposed the evaluation-apprehension hypothesis. They claimed that the mere presence of others is not sufficient for social facilitation to occur; instead, the increase in drive level and thus social facilitation occur only when the individual is concerned about how others will evaluate him/her (see also Martens & Landers, 1972).

In the 70s and 80s, researchers began to highlight the importance of attention on social facilitation (Baron, Moore, & Sanders, 1978; Sanders & Baron 1975; Sanders, Baron, & Moore, 1978). According to the distraction-conflict hypothesis proposed by Baron et al. (1978), the presence of others is a source of distraction, preventing the individual from completely focusing his/her attention on the task at hand. This distraction causes a conflict, as to how attention will be allocated between the task and the social stimuli. This conflict increases the individual's drive level. This increased drive will impair performance on complex tasks and improve performance on simple tasks. Furthermore, if the distraction is highly disruptive or the number of distractions is increased, then even the simple task performance can be impaired.

Afterwards, Baron (1986) proposed the overload hypothesis, which is a modified version of the distraction-conflict hypothesis. Derived from the attentional theories (Kahneman, 1973; Cohen, 1978), the overload hypothesis states that the distraction caused by the presence of others might not increase the drive level of the individual, but rather lead to cognitive overload. This cognitive overload then restricts the focus of attention. On simple or well-learned tasks, which have a few central/relevant cues, the cognitive overload causes individuals to focus their attention on those cues and leave out the peripheral/irrelevant cues, resulting in performance improvement. However, on complex or less-learned tasks, which are composed of a lot more cues that must be processed for adequate performance, individuals might neglect some crucial cues because of the restricted focus of attention, which results in performance impairment.

2.5.4. Joint Action

Like social facilitation, joint action is a situation wherein the presence of others influences individual performance. Yet, the difference of joint action from social facilitation is that rather than in front of an audience or with passive/independent co-actors, the individual engages in a task together with a partner, interacting with him/her. As Sebanz, Bekkering, and Knoblich (2006) put it, joint action is "…any form of social interaction whereby two or more individuals coordinate their actions in space and time to bring about a change in the environment" (p. 70). In our daily lives, we frequently engage in various kinds of joint actions with people to attain common goals; for instance, we cook with a friend, play team sports, dance with a partner, and have conversations with people (Clark, 1996; Loehr, Sebanz, & Knoblich, 2013). By engaging in joint actions, people can share a task with other people, learn from those people's actions, predict their behaviors as well as the consequences of those behaviors, and coordinate their actions with people (Sebanz et al., 2006).

One task that has been extensively employed to study joint action is the Simon task (Simon & Rudell, 1967; Simon & Small, 1969). In a typical Simon task, subjects are shown, e.g., a square, which appears either on the right or on the left of the screen at a time. The subjects are instructed to press a left button or a right button depending on a non-spatial characteristic of that square (e.g., its color). The usual finding is that the subjects respond more slowly in trials in which the spatial location of the square does not match the location of the required response than in trials in which they match; for instance, if a participant should press the right button when the square is red and the left button when it is green, his responses are slower when the red square is presented on the left of the screen (an incongruent trial) as compared to when the red square is presented on the right of the screen (a congruent trial). This effect, called Simon effect, can be explained by the conflict that takes place at the response selection stage; that is, slower response times for the incongruent trials are due to the conflict between the automatically activated response that spatially matches the stimulus and the response that is selected on the basis of the relevant characteristic of the stimulus (De Jong, Liang, & Lauber, 1994).

The joint Simon task is the social version of the Simon task in which two people share the complementary parts of the Simon task; for instance, the person sitting on the right responds only to green squares and the person sitting on the left responds only to the red squares. That is, a subject can perform his/her part without taking into account his/her partner's part. However, studies showed that a response selection conflict was still observed in the incongruent trials (Sebanz, Knoblich & Prinz, 2003). Moreover, a control condition showed that the conflict did not occur when a person simply sat at the side of the individual participant. Thus, these findings indicate that in joint action situations participants do not ignore their co-actors. Participants represent their co-actor's actions, and consequently, a response selection conflict occurs, just like in the condition where one participant is in charge of both actions (Knoblich, Butterfill & Sebanz, 2011).

There are two kinds of joint action: emergent joint action and planned joint action (Knoblich et al., 2011). Emergent joint action occurs when individuals have no plan to act together but still act in similar ways because of their shared perception-action couplings. Whereas in planned joint action, people plan their own actions to achieve the same goal. These two kinds of joint action do not always have to be mutually exclusive; actually, many forms of joint action probably necessitate both emergent and planned coordination (Knoblich et al., 2011).

2.5.5. Competition and Cooperation

In our study, we will investigate joint change detection in two different social settings: Competition and Cooperation. Both competition and cooperation are essential to human social life (Reboul, 2010). However, people may be more inclined to cooperation than to competition (Tomasello et al., 2012). For example, in joint action studies, participants have a tendency to perceive the task setting as cooperative, even though they are not explicitly told so (Iani et al., 2011).

For example, one study tested the impact of competitive and cooperative relations between the partners by employing the joint Simon task (Hommel, Colzato, & van den Wildenberg, 2009). These researchers found that when participants were confronted with a friendly and cooperative partner, the expected joint Simon effect was observed. However, when participants were confronted with an intimidating and competitive partner, the joint Simon effect disappeared. The researchers concluded that individuals can separately represent their actions and their partner's actions, but are only inclined to link/incorporate these representations if their personal relationship with their partners is a positive one.

Another study investigated the influence of joint action and the nature of social condition on time perception (Usal, 2016). In this study, participants performed a Simon task alone, in cooperation with, or in competition with another person. The critical dependent measure was how long the participants estimated the time elapsed during their Simon task performance. The results showed that estimation of time was longest in the individual condition, shorter in the cooperative condition, and shortest in the competitive condition. Usal (2016) concluded that joint social settings demand more attentional resources than the individual setting, allowing less attentional resources for estimation of time, and thus result in shorter time estimations.

Moreover, Tollner-Burngasser, Riley, and Nelson (2010) were interested in how cooperation would affect change-detection performance. These researchers employed the flicker paradigm and used icons (squares of different colors) as their stimuli. There were change and no-change conditions. In the change condition, a position change was made for a square. The subjects engaged in the flicker task either individually or in three-person teams. In one team condition, subjects were allowed to communicate with each other, whereas in the other condition, they were not. These researchers found that communicating teams were faster and more accurate in detecting changes as compared to individuals and non-communicating teams.

2.5.6. The Present Study

In this thesis, we are interested in how change-detection performance in the flicker paradigm is affected by the semantic consistency of the changing item with its surrounding scene (Hollingworth & Henderson, 2000; LaPointe & Milliken 2016). Furthermore, we will look at how this change detection performance will be affected by cooperative and competitive settings. To our knowledge, there is no study conducted so far which directly investigated the interaction of semantic consistency in the flicker paradigm with individual, competitive, and cooperative settings. Although there is just one relevant study (described just above) that explored the flicker task performance in cooperative settings (Tollner-Burngasser, Riley, & Nelson, 2010), that study was neither about the semantic consistency effect nor there was a competitive setting in it; besides, the stimuli used in that study were simple, abstract icons, whereas the stimuli in our study are complex scene images like those used in the classical change-detection studies. Therefore, our study will be the first to investigate semantic consistency effect in the flicker paradigm together with different joint action settings.

CHAPTER 3

HYPOTHESES

In this thesis, our aim is to bring together two areas of research: 1) Change detection 2) Joint action and social facilitation. We have formulated two main hypotheses regarding these research areas.

The first hypothesis of this study is that participants' change detection performance will be affected by the semantic consistency of the changing object. We expect participants to be more accurate and faster in detecting the objects which are semantically inconsistent with the surrounding scene than in detecting the objects which are semantically consistent with the surrounding scene, probably because attention is drawn to the inconsistent objects earlier than to the consistent objects (Hollingworth & Henderson, 2000; LaPointe & Milliken, 2016). We expect this effect to occur in all of our social task settings, namely, the Individual setting and the two Dual settings (Cooperative and Competitive).

The second hypothesis is that the social task setting will affect change detection performance. Specifically, we expect that the inconsistent-change advantage will be more evident in the Dual settings as compared to the Individual setting and also that the consistent-change disadvantage will be more evident in the Dual settings as compared to the Individual setting. The rationale of this prediction comes from the social facilitation literature (Aiello & Douthitt, 2001), which indicates that simple tasks are performed better and complex tasks are performed worse in the presence of other people. Accordingly, we reasoned that our inconsistent-change trials might be regarded as simple trials and our consistent-change trials might be regarded as complex trials because detection of semantically-inconsistent changes occur faster and more accurately than detection of semantically-consistent ones. That is, we expect a two-fold social facilitation effect in our dual settings.

Our second hypothesis can be further rationalized by basing it on the overload hypothesis (Baron, 1986). If the presence of a cooperative or competitive co-actor demands more attentional resources than the individual case, then the limited attentional capacity must be used *economically*: In complex tasks, which have many central cues, attention might neglect some of these cues, which results in performance impairment. In simple tasks, which have few central cues or in which some central cues are more salient than the others, attention will focus on these cues, leaving out the less central ones, which results in performance improvement. In our case, consistent-change trials might be deemed as complex trials because all objects in these trials are semantically consistent with their surrounding scene; that is, there are many central cues in these trials. Therefore, in the dual settings, participants are more likely to miss changes in the consistent objects. Inconsistent-object trials, on the other hand, might be deemed as simple trials because in these trials only one object is semantically inconsistent with the surrounding scene; that is, that object might be more central to the scene than the other objects. Therefore, in the dual settings, participants are more likely to detect changes in the inconsistent objects.

To sum up, we expect the cooperating and competing subjects will be faster and more accurate than the single subjects in detecting the semantically-inconsistent changes, whereas the single subjects will be faster and more accurate than the cooperating and competing subjects in detecting the semantically-consistent changes. However, we do not have a directional hypothesis regarding the performance difference between the cooperative and competitive settings.

CHAPTER 4

METHODOLOGY

4.1. Participants

Fifty-three participants (28 males, mean age=27.02, SD=4.43) were tested in three different groups. Participants in the Individual Setting (n=17, 12 males, mean age: 29.76, SD=5.82) were tested individually, whereas participants in the Cooperative Setting (n=18, 10 males, mean age: 26.44, SD=3.45) and Competitive Setting (n=18, 6 males, mean age: 25.00, SD=2.00) were tested in dyads. Every dyad consisted of participants from the same gender. Participants were enrolled through e-mail or in-person invitation. They were graduate students from various departments of Middle East Technical University (METU). All participants had normal or corrected-to-normal vision and were right-handed. They attended the experiments voluntarily without any rewards.

Ethics approval was obtained from METU Human Studies Ethical Committee (see Appendix F) before the experiments were conducted.

4.2. Stimuli

The stimulus set used by LaPointe and Milliken (2016) were used in this study[1]. That stimulus set consisted of images which were created from photographs taken in Brisbane, Australia. There were 126 pairs of images in total. Every pair consisted of a background-with-target image (*A*) and a background-alone image (*A'*). The background-alone images were photographs of various typical scenes which differed in several aspects such as context, lighting conditions, number of objects, and complexity. The background-with-target images were formed in a graphics software

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[1] I would like to thank Mitchell LaPointe for he kindly shared his stimulus set with me.

by superimposing a target object from a different photograph onto a copy of the background-alone image. There were 63 target objects in total. Each target object was placed on two different backgrounds, one on a semantically-consistent background and one on a semantically-inconsistent background. In total, 63 pairs of images were presented in the consistent condition and 63 pairs of images were presented in the inconsistent condition (see Figure 1 for an example of a consistent image pair and Figure 2 for an example of an inconsistent image pair).

In the consistent condition, target objects were situated in background scenes that had a context in which the target object could typically be found. In this condition, target objects appeared to be fitting naturally to the background scene and they also seemed to occupy physically possible places in the background scene (e.g., a no-smoking sign in a cafeteria). In the inconsistent condition, target objects were situated in background scenes that had a context in which the target object could typically not be found. In this condition, target objects appeared not to be fitting naturally to the background scene, yet they still seemed to occupy physically possible places in the background scene (e.g., a no-smoking sign in a living room). Moreover, the spatial locations of the target objects were somewhat alike across the two context conditions. That is, there was no significant difference between these conditions in terms of the average target-object eccentricity from the center of the screen.

Figure 1: An image pair belonging to the Consistent condition.

Figure 2: An image pair belonging to the Inconsistent condition.

Furthermore, since placing the target objects, which were taken from separate photographs, onto the background scenes via a graphics editor might create perceptual salience differences – in addition to the intended semantic (contextual) differences – across the consistency conditions, LaPointe and Milliken (2016) used an algorithm developed by Zhang et al. (2008) to check if there was such a confounding. This algorithm calculates local, rather than global, salience statistic for each image in terms of the color and intensity values of the rectangular region surrounding the target object. These calculations were made for the relevant region of each image pair (i.e., when the target object was absent and when it was present). The analysis yielded no significant differences in salience values between the two consistency conditions (see LaPointe & Milliken, 2016, for details).

Having described above the properties of the stimulus set we obtained from LaPointe and Milliken (2016), we must note that, as compared to their study, there are some differences in the way we presented the stimuli to our participants. The important differences between their design and ours will be noted in the current sub-section as well as in the Procedure sub-section below.

As noted before, LaPointe and Milliken’s (2016) stimulus set consisted of 126 image pairs (63 consistent image pairs and 63 inconsistent image pairs). Every image pair in this original stimulus set had one background-alone image and one background-with-target image. That is, every trial in their study was a Change trial; therefore, participants always looked for a change. When they pressed the button to indicate that they saw the change, then the experimenters asked the participants to say aloud what the changing element was.

In our study, however, we did not require our participants to name the critical element, in order to make the experimental procedure simpler. But in this case, there would be no way for us to be sure if participants would really detect the changes and not respond haphazardly. In order to obviate this concern, we arranged some trials as NoChange trials; with this modification, we had a fair criterion of performance and also participants had the impression that accuracy of their responses could be evaluated. Another reason for the inclusion of NoChange trials in our study was our interest in them: Perceptual and decision processes in knowing there will always be a change might be quite different from those in not knowing when (i.e., in which trial) there will be a change. Deciding that there is no change in a trial should be a result of an exhaustive searching process; therefore, people may terminate their searching at some point even if they are not absolutely sure of their decision. Since we were interested in all of these processes, we still had to use a Change/NoChange paradigm.

Consequently, we modified the original stimulus set so that some trials became NoChange trials. We picked randomly 84 image pairs (42 consistent pairs and 42 inconsistent pairs) from LaPointe and Milliken's (2016) stimulus set and took them as stimuli for our Change trials. Then, we calculated the mean 'eccentricity-from-the-center-of-the-screen' value of the target objects, both for the consistent images and for the inconsistent images. The analysis yielded no significant target eccentricity differences between the consistent images and the inconsistent images. Of the remaining 42 image pairs (21 consistent pairs and 21 inconsistent pairs), we took only the background-with-target image (A) of every image pair as stimuli for our NoChange trials.

In our study, stimuli were presented through a desktop computer with a 17" CRT monitor at a screen resolution of 1920 x 1080 pixels. The contrast and brightness levels of the monitor were set to 70% each. The experiment was designed using E-Studio 2.0, an experiment design tool which is a part of the E-Prime 2.0 software package.

4.3. Procedure

Although LaPointe and Milliken (2016) presented to their participants all the stimuli in one block and intermixed the presentation of the images in the consistent and inconsistent conditions within that block, we did not follow this procedure. Instead, we chose to present the images in separate blocks, with every image presented in the block it belonged to. That is, all images in the consistent condition were presented in one block and all images in the inconsistent condition were presented in another block. The reason for this modification is that we are interested in the relation between task difficulty and individual/social conditions. Likewise, most of the social facilitation studies were also made exposing participants to simple and complex task conditions separately, in a blocked way. In our study, the simple-complex task distinction, as we noted in the Hypotheses section above, was made in the way that inconsistent-change trials belong to the simple task block and consistent-change trials belong to the complex task block.

We presented these blocks in a counterbalanced order. That is, half of the participants saw first the images belonging to the consistent condition and then the images belonging to the inconsistent condition, whereas the other half of the participants saw first the images belonging to the inconsistent condition and then the images belonging to the consistent condition. In each block, there were 60 trials -40 Change trials and 20 NoChange trials- making the total number of trials 120 across these two blocks. Since we had 126 image pairs in total, we used the remaining 6 trials for the practice session. In this practice session, where the participants got accustomed to the procedure of the experiment, we had a stimulus sample (4 Change Trials – 2 Consistent Change trials and 2 Inconsistent Change trials –, and 2 NoChange trials – 1 Consistent NoChange trial and 1 Inconsistent NoChange trial) representing all the conditions in the actual experimental session. The presentation order of the stimuli in the practice session was fixed. However, the stimuli in each actual experimental block were randomly presented; every participant saw a different order of presentation which was determined randomly each time the experiment began to run on the computer.

We also counterbalanced the response keys across the participants. We will give the details of this arrangement in the subsequent "Individual Setting" and "Dual Settings" parts below.

Every trial began with a fixation cross appearing at the center of the screen for 1 second. Immediately after the termination of the fixation cross, the background-with-target image (A) appeared for 250 ms, followed by a blank (white) screen for 250 ms, followed by the background-alone image (A') – or again by the image (A) if it was a NoChange trial – for 250 ms, followed by another blank (white) screen for 250 ms. This sequence (namely, the flicker) was presented repeatedly until the participant responded (see Figure 3). When the participant made a response, a blank white screen appeared on the screen for 500 ms, before the next trial began.

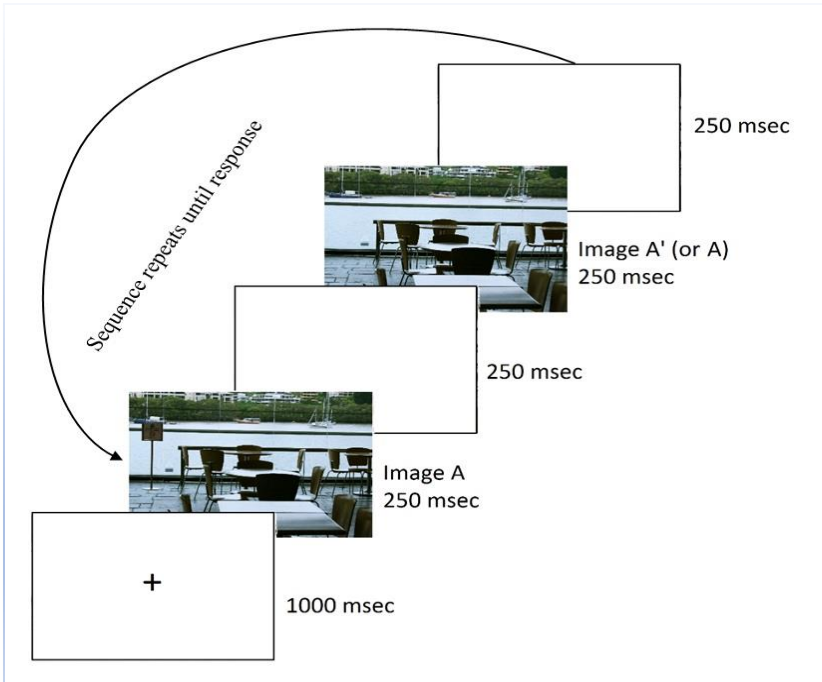

Figure 3: Illustration of a trial. The flicker sequence A'-A is a change trial; the flicker sequence A-A is a no-change trial.

Note that to present the flicker continuously we benefited from a code written by Brauch (2016), which we modified slightly so it fitted our experimental concerns.

In our study, all the participants were tested in the cognitive science laboratory of Informatics Institute at METU, which was a quiet and well-lit room with computers, desks, and chairs in it. After signing an informed consent form (see Appendix A), participants were seated in front of a desktop computer with a QWERTY keyboard to begin the experiment.

Individual Setting

The participant was taken to the lab and seated in front of a desktop computer to begin the experiment (see Figure 4). S/he was tested individually, with no one else – except the experimenter – around in the lab.

The arrangement of the response keys in this condition was as follows: We put a red sticker on the "1" button and a green sticker on the "5" button, which were part of the number pad located at the right side of the keyboard (see Figure 4 again). Half of the participants were instructed to press the green-colored button if they saw a change and the red-colored button if they could not see a change; the other half were instructed to press the green-colored button if they could not see a change and red-colored button if they saw a change.

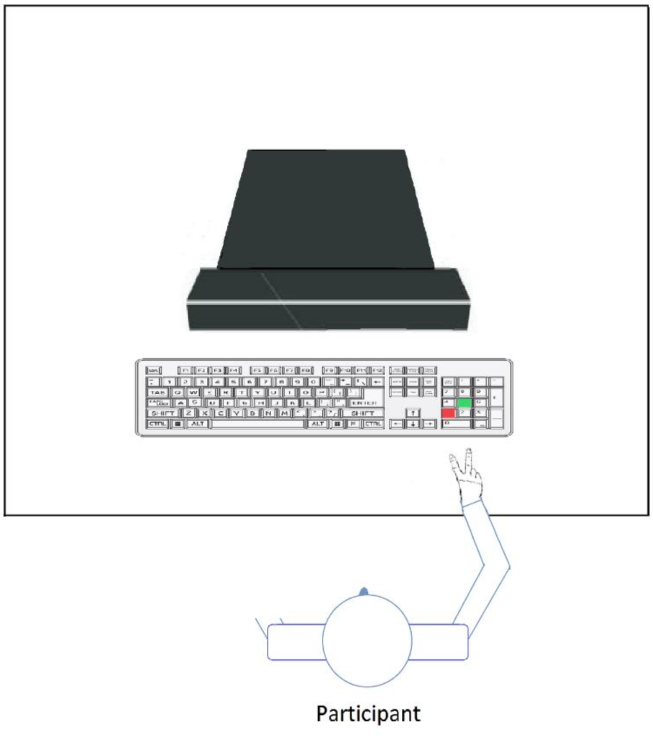

Figure 4: Sitting position of the participant and his/her response buttons in the Individual Setting condition.

The participant was instructed by the experimenter in the following way:

"You are going to see [some] photographs. Every photograph will flicker continuously unless you make a response. During this flicker period, some of the photographs will undergo a change. That is, one element in some photographs will disappear and then reappear repeatedly in sync with the flicker. Other photographs, on the other hand, will not undergo a change during the flicker period. That is, they will be the same in every sense as the flicker goes on. If you see a change in a photograph, you should press the red (or green) colored key. If you cannot see a change in a photograph, you should press the green (or red) colored key. You should make your decisions – Change or NoChange – as fast and accurately as possible. You are going to receive a (+) point for each correct response you make and a (-) point for each incorrect response you make. First, you are going to have a short practice phase, where you will be familiar with the procedure, and then you are going to have two actual experimental phases. I will be in this room during the experiment, sitting there doing some paperwork. Now I will run the experiment if you are ready." (see Figure 5 for the transcribed form of this instruction)

"Fotoğraflar göreceksiniz. Her bir fotoğraf, siz tuşa basmadıkça, sürekli bir şekilde pırpır edecek. Bu pırpır süresince, bazı fotoğraflarda bir değişiklik olacak. Yani, bazı fotoğraflardaki bir öge bu prıpırla eş zamanlı olarak sürekli bir şekilde kaybolup tekrar görünecek. Öte yandan, bazı fotoğraflarda ise, bu pırpır esnasında, hiç bir değişiklik olmayacak. Yani, o fotoğraflar her anlamda aynı kalmaya devam edecek. Değişiklik gördüğünüz fotoğraflarda kırmızı (veya yeşil) renkli tuşa basmalısınız. Değişiklik göremediğiniz fotoğraflarda ise yeşil (veya kırmızı) renkli tuşa basmalısınız. Kararlarınızı - değişiklik var ya da değişiklik yok olarak - elinizden geldiğince hızlı ve doğru bir şekilde vermeye çalışın. Her doğru saptamanız için bir (+) puan, her yanlış saptamanız için ise bir (-) puan alacaksınız. İlk olarak, sizi deneyin prosedürüne alıştırmak adına, kısa bir alıştırma safhası yapacaksınız. Ondan sonra ise iki tane asıl deneysel safha olacak. Deney esnasında ben bu odada olacağım, şurada oturup kendi işlerimle ilgileneceğim. Eğer hazırsanız, deneyi başlatabilirim."

Figure 5: The transcribed form of the instruction given to the participants in the Individual Setting condition.

With this information provided, the participant began the experiment.

Dual Settings

There were two Dual Setting conditions: Dual-cooperative setting and Dual-competitive setting. In these conditions, participants were seated on two chairs side by side in front of a desktop computer (see Figure 6). Who would sit on the left and who would sit on the right was determined incidentally. Participants were asked if they were comfortable with their sitting positions; if they were not comfortable, necessary arrangements were made so that they could see the screen clearly and reach their response buttons comfortably.

The participant sitting on the right side used the same response keys (i.e., number buttons "1" and "5") as the ones described in the Individual Setting part above. For the participant sitting on the left side, we put a red sticker on the "z" button and a green sticker on the "s" button, which were at the left side of the keyboard (see Figure 6 again).

Half of the dyads were instructed to press the green-colored button if they saw a change and the red-colored button if they could not see a change; the other half were instructed to press the green-colored button if they could not see a change and red-colored button if they saw a change.

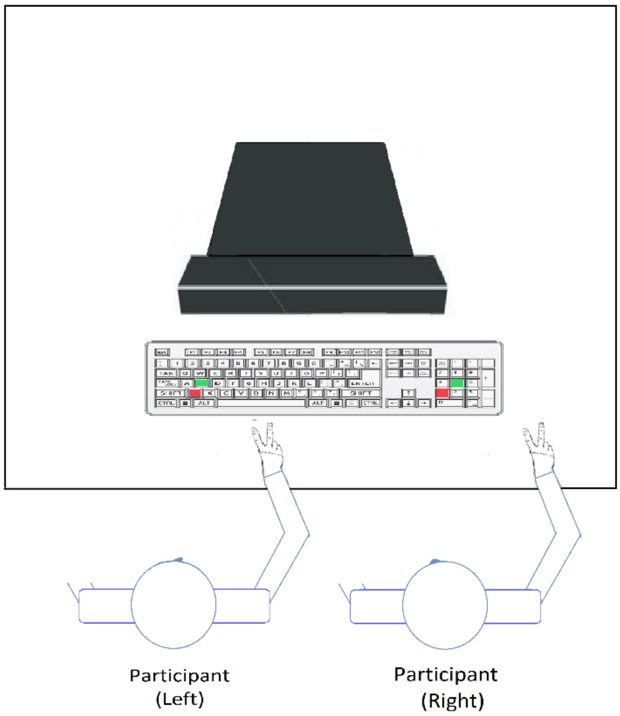

Figure 6: Sitting positions of the participants and their relevant response buttons in the Dual Setting conditions.

The dyad in the Cooperative Dual Setting condition was instructed by the experimenter in the same way as in the Individual Setting condition except the following additional instructions:

"… Furthermore, you two are a TEAM! That is, your points are going to be evaluated as a team and compared to other teams. Accordingly, it does not matter which of you press a response button [first]. You are also free to talk to each other…" (see Figure 7 below for the transcribed form of this additional instruction)

"... Ayrıca, siz ikiniz bir TAKIMsınız! Yani, puanlarınız bir takım olarak değerlendirilecek ve sonra başka takımlarla karşılaştırılacak. Dolayısıyla, ilk olarak kimin tuşa bastığının bir önemi yok. Birbirinizle de konuşabilirsiniz..."

Figure 7: The transcribed form of the additional instruction given to the dyads in the Cooperative Dual Setting condition.

The dyad in the Competitive Dual Setting condition was instructed by the experimenter in the same way as in the Individual Setting condition except the following additional instructions:

"… Furthermore, you two are RIVALS of each other! That is, your points are going to be evaluated individually and compared against each other. Accordingly, it is crucial which of you press a response button first…" (see Figure 8 below for the transcribed form of this additional instruction)

> "... Ayrıca, siz ikiniz birbirinize RAKİPsiniz! Yani, puanlarınız bireysel olarak değerlendirilecek ve sonra birbirinizle karşılaştırılacak. Dolayısıyla, ilk olarak kimin tuşa bastığının kritik bir önemi var..."

Figure 8: The transcribed form of the additional instruction given to the dyads in the Competitive Dual Setting condition.

With this information provided, the dyad began the experiment.

After the experiment was over and the questionnaires were filled out (see sub-section 4.4. below), all participants were debriefed (see Appendix E) .

4.4. Questionnaires

All the participants were given questionnaires right after they were finished with each block (i.e., Consistent block and Inconsistent block) of the experiment as well as at the end of the experiment. The questionnaires were administered in order to estimate the participants' emotional mode during the experiment. The reason why we measured participants' feelings was that we wanted to see whether or to what extent the task difficulty (i.e., simple, complex) and task setting (i.e., individual, cooperation, competition) would influence their emotional mood during the experiment. The questionnaires were anonymized for all the participants; additionally, the participants in dyads were discouraged from seeing each other's answers. Every question had five choices, with the farthermost one on the right being the most positive and the farthermost one on the left being the most negative.

The first questionnaire given to the participants was developed as a "manipulation check" of the Consistency conditions. As noted before, we hypothesized the inconsistent-change trials to be the simple/easy trials and the consistent-change trials to be the complex/difficult trials. Similarly, we wanted to see whether this hypothesized task difficulty would also be reflected in participants' own ratings of the blocks they performed. Right after each block was over, we gave the participants one question about the perceived difficulty of the block they had just finished. These two block-specific questions were the same except the word indicating the block number they referred to. These questions, in a combined form, were as follows: "You have just completed the first/second phase of the experiment. How difficult do you think this phase was?" with choices ranging from "Very difficult" to "Very easy" (see Figures 9 and 10 below). As we noted before, we counterbalanced the presentation order of the blocks among all the participants; therefore, half of the participants answered the first question for the Inconsistent block and the other half answered it for the Consistent block.

Deneyin **birinci** safhasını bitirmiş bulunmaktasınız. Bu safha size göre ne kadar zordu?

Çok zordu	Zordu	Orta	Kolaydı	Çok kolaydı
○	○	○	○	○

Figure 9: The question that was presented to all participants right after they had completed the first block of the experiment.

Deneyin **ikinci** safhasını bitirmiş bulunmaktasınız. Bu safha size göre ne kadar zordu?

Çok zordu	Zordu	Orta	Kolaydı	Çok kolaydı
○	○	○	○	○

Figure 10: The question that was presented to all participants right after they had completed the second block of the experiment.

When the participants answered these questions about the blocks, they were given another questionnaire. This last questionnaire was adopted from a previous study of Usal (2016) on the comparison between individual and joint social conditions in time perception. Some questions in it were modified so that they would comply with the conditions in our study. In this modified questionnaire, first 5 questions were given to all participants (see Figure 11), while questions numbered 6 to 9 (Figure 12) were given to the participants in the Dual Setting conditions only. A 10^{th} question was also given to the participants in Dual Setting conditions, but was different between the cooperative and competitive conditions (Figure 13 and 14).

The first 5 questions (see Figure 11 below), which all the participants answered, consisted of questions that would supply information about the emotional aspect of the task and the participants' self-evaluations. First question was "How do you define your general emotion during the experiment" with choices ranging from "I was very bored" to "I had a lot of fun". Second question was "How excited were you during the experiment?" with choices ranging from "I was not excited at all" to "I was very excited". Third question was "How much under pressure have you felt during the experiment?", and the choices ranged from "I was under no pressure at all" to "I felt under a lot of pressure". Fourth and fifth questions were about the flicker task. Fourth question was "How accurate do you think you were in detecting the Changes and NoChanges in the pictures?" with the options ranging from "I could not make any correct detections at all" to "I always made correct detections". Fifth question was "How fast do you think you detected the Changes and NoChanges in the pictures?" with the options ranging from "Very slow" to "Very fast" (Figure 11).

1. Deney sırasındaki genel duygunuzu nasıl tanımlarsınız?

Çok sıkıldım	Sıkıldım	Orta	Eğlendim	Çok eğlendim
O	O	O	O	O

2. Deney sırasında ne kadar heyecanlandınız?

Hiç heyecanlanmadım	Heyecanlanmadım	Orta	Heyecanlandım	Çok heyecanlandım
O	O	O	O	O

3. Deney sırasında ne kadar baskı altında hissettiniz?

Hiç hissetmedim	Hissetmedim	Orta	Baskı hissettim	Çok baskı hissettim
O	O	O	O	O

4. Resimlerdeki değişiklikleri / değişimsizlikleri ne derece doğru saptadığınızı düşünüyorsunuz?

Hiç saptayamadım	Saptayamadım	Orta	Sıklıkla doğru saptadım	Hep doğru saptadım
O	O	O	O	O

5. Resimlerdeki değişiklikleri / değişimsizlikleri ne kadar hızlı saptadığınızı düşünüyorsunuz?

Çok yavaş saptadım	Yavaş saptadım	Orta	Hızlı saptadım	Çok hızlı saptadım
O	O	O	O	O

Figure 11: Questions which were given to all participants.

The next four questions (see Figure 12 below) were given only to the participants who were in the Dual Setting conditions. The sixth and seventh question were about the comparison of self-performance and peer-performance, while eighth and ninth questions were about social feelings. Sixth question was "If you compare yourself with your partner, which of you do you think were more accurate in detecting the Changes and NoChanges in the pictures?" with choices ranging from "My partner was much more accurate" to "I was much more accurate". Seventh question was "If you compare yourself with your partner, which of you do you think were faster in detecting the Changes and NoChanges in the pictures?" with choices ranging from "My partner was much faster" to "I was much faster". Eighth question was "How do you describe your view of your partner?", and the choices ranged between "Very hostile" and "Very friendly". Ninth question was "How close have you felt to your partner?" with the choices ranging from "Very far" to "Very close" (Figure 12).

6. Kendinizi ortağınızla kıyasladığınızda, hanginizin resimlerdeki değişiklikleri / değişimsizlikleri daha doğru saptadığını düşünüyorsunuz?

Ortağım çok daha doğruydu	Ortağım daha doğruydu	Eşit	Ben daha doğruydum	Ben çok daha doğruydum
○	○	○	○	○

7. Kendinizi ortağınızla kıyasladığınızda, hanginizin resimlerdeki değişiklikleri / değişimsizlikleri daha hızlı saptadığını düşünüyorsunuz?

Ortağım çok daha hızlıydı	Ortağım daha hızlıydı	Eşit	Ben daha hızlıydım	Ben çok daha hızlıydım
○	○	○	○	○

8. Ortağınız hakkındaki görüşünüzü nasıl tanımlarsınız?

Çok düşmanca	Düşmanca	Tarafsız	Dostça	Çok dostça
○	○	○	○	○

9. Ortağınızı kendinize ne kadar yakın hissettiniz?

Çok uzak	Uzak	Orta	Yakın	Çok yakın
○	○	○	○	○

Figure 12: Questions that were common for both Dual Setting conditions.

Participants in the Dual Cooperative condition were given a tenth (and the last) question so as to assess their self-evaluation of the cooperation with their partners. The question was “How well do you think you have worked together with your partner?” with the choices ranging between “Very bad” and “Very good” (see Figure 13 below).

10. Ortağınızla ne kadar iyi uyum gösterdiğinizi düşünüyorsunuz?

Çok kötü	Kötü	Orta	İyi	Çok iyi
○	○	○	○	○

Figure 13: The last question for the Dual-cooperative condition.

Participants in the Dual Competitive condition were given a tenth (and the last) question in order to assess their self-evaluation of the competition with their partners. The question was “How much competition have you felt between you and your partner?” with the choices ranging from “Not at all” to “Very much” (see Figure 14 below).

10. Ortağınızla ne kadar rekabet içinde olduğunuzu düşünüyorsunuz?

Hiç	Az	Orta	Fazla	Çok Fazla
○	○	○	○	○

Figure 14: The last question for the Dual-competitive condition.

4.5. Data Preparation

After the experiments were over, the raw data of all participants were gathered *via* E-Merge 2.0, a data management tool which is a part of the E-Prime 2.0 software package. The practice session, which consisted of 6 trials, was excluded from the analyses for all participants. Only the remaining 120 actual experimental trials were analyzed.

Consistency (i.e., inconsistent, consistent), Change Status (i.e., change, no change), Task Setting (i.e., individual, dual-cooperative, dual-competitive), and Block Order (i.e., inconsistent-first, inconsistent-second) were the independent variables, with the first two as within-subjects variables and the last two as between-subjects variables.

Participants' reaction times (RT) and accuracy levels were the dependent variables.

Accuracy data was registered in this way: When a trial was a Change (or a NoChange) trial and the participant responded to it as such, it was a correct response and was logged into the data file as "1"; on the other hand, when the participant's response did not match the status of a trial (e.g., a NoChange response to a Change trial), that was an incorrect response and was logged as "0".

RT indicates the elapsed time from the onset of the flicker loop to the participant's pressing a response button. In this study, RTs were analyzed only for correct responses.

Note that, in the Dual Setting conditions, pressing a response button once, regardless of which member of the dyad did it, sufficed to terminate a trial; hence, there was a single response registered for every trial. But we can still identify, by looking to the raw data, which member made a response in which trial.

In the Individual Setting condition, the mean RT and mean accuracy values of the trials were calculated for every participant. In the Dual Setting conditions, the same calculations were done for every dyad collectively.

After the mean RT and mean accuracy data were organized under the levels of the independent variables in the form of a factorial table, they were transferred into IBM SPSS Statistics 24.0 for further statistical analyses.

CHAPTER 5

RESULTS

In this chapter, we report the results of the analyses of the participants' flicker task performance, which has two dimensions (Accuracy and Reaction Time). We also present the results of the questionnaires, which assessed the participants' cognitive, emotional, and motivational states during the experiment.

5.1. Accuracy (Success Rate)

Accuracy (Success Rate) is the ratio of correct responses to all responses. Initial analyses showed that Gender and Block Order did not have any significant effects on participants' performance; therefore, we collapsed our data over these two factors. Then, we conducted a 2 (Consistency: Consistent, Inconsistent) x 2 (ChangeCondition: Change, NoChange) x 3 (TaskSetting: Individual, Cooperative, Competitive) Mixed ANOVA in order to see whether semantic consistency and change conditions of the flickering pictures as well as the social setting had any effects on participants' success rates. Please consult Table 1 for the descriptive statistics.

Table 1: Participants' mean accuracy levels for consistency and change conditions across three social settings (SE in parentheses).

	Consistent		**Inconsistent**	
	Change	**NoChange**	**Change**	**NoChange**
Individual	.70 (.03)	.98 (.01)	.88 (.02)	.99 (.01)
Cooperative	.70 (.04)	.98 (.01)	.92 (.03)	.96 (.02)
Competitive	.58 (.04)	.92 (.01)	.76 (.03)	.88 (.02)

The main effect of consistency was statistically significant ($F(1,32)=116.36$, $p<.001$, $\eta_p^2=.78$). Participants' detections were more accurate for the pictures containing a semantically inconsistent object ($M=.90$, $SE=.01$) than for the pictures containing a semantically consistent object ($M=.81$, $SE=.01$). The main effect of change was also significant ($F(1,32)=120.98$, $p<.001$, $\eta_p^2=.79$). Participants were more successful at deciding that there was no change in the pictures ($M=.95$, $SE=.01$) than they were at detecting that there was a change in the pictures ($M=.76$, $SE=.02$) (see Figure 15).

Moreover, consistency and change condition had a significant interaction ($F(1,32)=87.78$, $p<.001$, $\eta_p^2=.73$). Multiple comparisons (with Bonferroni corrections) showed that participants' success rates for the pictures containing a semantically inconsistent object ($M=.94$, $SE=.01$) and the pictures containing a semantically consistent object ($M=.96$, $SE=.01$) were very similar in the NoChange trials ($F(1,32)=2.50$, $p=.12$, $\eta_p^2=.072$), whereas in the Change trials, semantically inconsistent objects were detected substantially more often ($M=.85$, $SE=.02$) than semantically consistent objects ($M=.66$, SE=.02) ($F(1,32)=146.49$, $p<.001$, $\eta_p^2=.82$) (see Figure 15).

Social Setting revealed a significant main effect ($F(2,32)=9.65$, $p=.001$, $\eta_p^2=.38$). Simple contrasts revealed that overall success rate of the Individual setting ($M=.89$, $SE=.014$) was almost identical to that of the Cooperative setting ($M=.89$, $SE=.019$) ($F(1,24)=0.24$, $p=.874$, $\eta_p^2=.001$), but was significantly higher than the overall success rate of the Competitive setting ($M=.79$, $SE=.020$) ($F(1,24)=16.87$, $p<.001$, $\eta_p^2=.413$).

However, social setting did not show any significant interaction either with consistency ($F(2,32)=.77$, $p=.47$, $\eta_p^2=.05$) or with the change condition ($F(2,32)=1.2$, $p=.35$, $\eta_p^2=.06$). The three-way interaction between consistency, change condition, and social setting was also insignificant ($F(2,23)=.72$, $p=.50$, $\eta_p^2=.059$).

Since we formulated our hypotheses for change trials only, we wanted to examine the effects of semantic consistency and social setting on these trials in a separate analysis. For this purpose, we conducted a 2 (ChangeConsistency: ConsistentChange, InconsistentChange) x 3 (TaskSetting: Individual, Cooperative, Competitive) Mixed ANOVA for Accuracy data.

The main effect of change consistency was significant ($F(1,32)=146.40$, $p<.001$, $\eta_p^2=.821$). Participants detected semantically-inconsistent changes more often ($M=.85$, $SE=.02$) than the semantically-consistent changes ($M=.66$, $SE=.02$) (see Figure 15).

The main effect of social setting was also significant ($F(2,32)=4.94$, $p=.013$, $\eta_p^2=.236$). Simple contrasts revealed that success rate of the Individual setting ($M=.79$, $SE=.03$) was similar to that of the Cooperative setting ($M=.81$, $SE=.03$) ($F(1,24)=0.26$, $p=.611$, $\eta_p^2=.011$), but was higher than the Competitive setting ($M=.67$, $SE=.04$) ($F(1,24)=6.86$, $p=.015$, $\eta_p^2=.222$).

However, the interaction between change consistency and social setting was insignificant ($F(2,32)=0.37$, $p=.69$, $\eta_p^2=.023$).

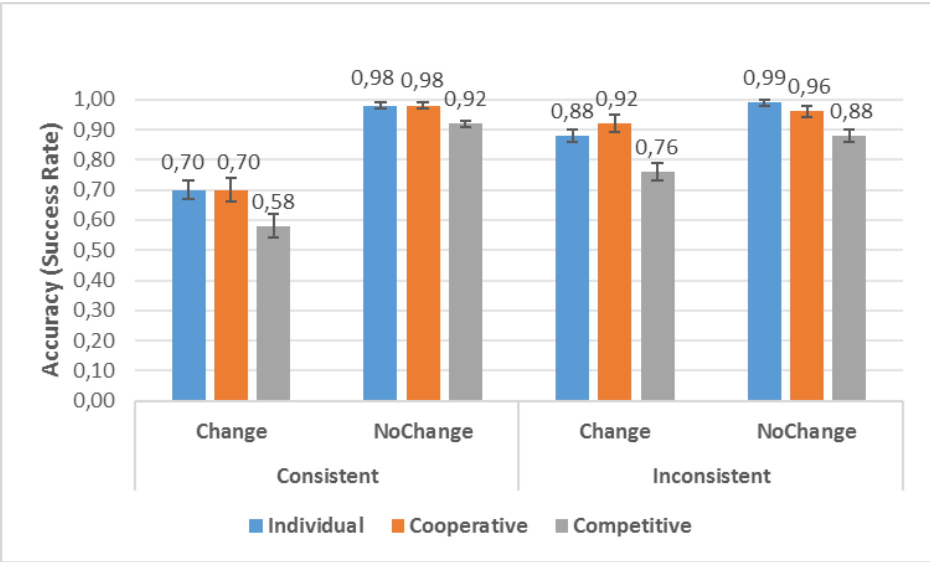

Figure 15: Mean Accuracy values for consistency and change conditions across all social settings. Error bars show SE and the numbers above show the accuracy.

5.2. Reaction Times (RT)

Reaction Time (RT) is the elapsed time from the onset of the flicker to the participant's response. RTs were calculated only for the trials that were given a correct response. Initial analyses revealed no significant effects of Gender and Block Order on participants' performance, so we collapsed our data over these two variables. Then, we ran a 2 (Consistency: Consistent, Inconsistent) x 2 (ChangeCondition: Change, NoChange) x 3 (TaskSetting: Individual, Cooperative, Competitive) Mixed ANOVA in order to see whether semantic consistency and change conditions of the flickering pictures as well as the social setting had any effects on participants' reaction times. Please consult Table 2 below for the descriptive statistics.

Table 2: Reaction Times (RT) in milliseconds (ms) for consistency and change condition across all social settings (SE in parentheses).

	Consistent		**Inconsistent**	
	Change	**NoChange**	**Change**	**NoChange**
Individual	3142 (237)	7791 (714)	2248 (139)	6574 (679)
Cooperative	2510 (326)	5862 (981)	2032 (191)	5650 (933)
Competitive	1519 (326)	3094 (981)	1291 (191)	2977 (933)

The main effect of consistency was statistically significant ($F(1,32)=11.14$, $p=.002$, $\eta_p^2=.26$). Participants detected the change faster when an image contained a semantically inconsistent object ($M=3462$, $SE=285$) than when an image contained a semantically consistent object ($M=3986$, $SE=338$) (see Figure 16).

The main effect of change was also significant ($F(1,32)=67.86$, $p<.001$, $\eta_p^2=.68$). Participants took more time to decide that there was no change in an image ($M=5325$, $SE=493$) than to detect if there was a change in an image ($M=2124$, $SE=127$) (see Figure 16).

However, there was no interaction effect between consistency and change condition ($F(1,32)=.007$, $p=.93$, $\eta_p^2=.0002$).

The main effect of social setting was significant ($F(2,32)=7.41$, $p=.002$, $\eta_p^2=.32$). Simple contrasts were conducted for further analysis. There was no significant difference when the Individual setting was compared to the Cooperative setting ($F(1,24)=1.37$, $p=.25$, $\eta_p^2=.05$). Overall reaction times of the Individual setting ($M=4939$, $SE=465$) and of the Cooperative setting ($M=4014$, $SE=639$) were similar to each other. However, the difference between the Individual setting and the Competitive setting was significant ($F(1,24)=16.9$, $p<.001$, $\eta_p^2=.41$). Overall reaction times were longer in the Individual setting ($M=4939$, $SE=465$) than in the Competitive setting ($M=2220$, $SE=534$), indicating that competing participants gave their decisions more quickly than the single participants (see Figure 16).

The interaction between consistency and social setting was significant ($F(2,32)=3.59$, $p=.039$, $\eta_p^2=.18$). Pairwise comparisons (with Bonferroni corrections) showed that in the individual setting inconsistent images were responded 1055 ms ($SE=216$) earlier than the consistent images ($F(1,32)=23.94$, $p<.001$, $\eta_p^2=.43$), whereas in the cooperative setting they were responded 345 ms ($SE=296$) earlier ($F(1,32)=1.36$, $p=.25$, $\eta_p^2=.04$) and in the competitive setting they were responded 172 ms ($SE=296$) earlier ($F(1,32)=.34$, $p=.57$, $\eta_p^2=.01$). That is, consistency had a clear impact on the individual setting, whereas it did not have a significant effect on the dual settings.

Change trials were responded faster than NoChange trials in all social settings. But the interaction between change condition and social setting was still significant ($F(2,32)=4.97$, $p=.013$, $\eta_p^2=.24$). Pairwise comparisons (with Bonferroni corrections) showed that (1) in the Change trials, RTs were similar in the individual and cooperative settings ($M=2695$, $SE=198$ and $M=2271$, $SE=272$, respectively) ($F(1,24)=1.59$, $p=.219$, $\eta_p^2=.06$), RT in the competitive setting ($M=1405$, $SE=201$) was shorter than in the cooperative setting ($M=2271$, $SE=272$) ($F(1,16)=9.33$, $p=.008$, $\eta_p^2=.37$), and RT in the competitive setting ($M=1405$, $SE=201$) was shorter than in the individual setting ($M=2695$, $SE=198$) ($F(1,24)=20.77$, $p<.001$, $\eta_p^2=.46$); and (2) in the NoChange trials, RTs did not significantly differ between the individual ($M=7183$, $SE=638$) and cooperative settings ($M=5756$, $SE=929$) ($F(1,16)=1.24$, $p=.277$, $\eta_p^2=.05$) but differed between the cooperative ($M=5756$, $SE=929$) and competitive settings ($M=3035$, $SE=877$) ($F(1,16)=5.37$, $p=.034$, $\eta_p^2=.25$), and differed even more between the individual setting ($M=7183$, $SE=638$) and the competitive setting ($M=3035$, $SE=877$) ($F(1,24)=14.62$, $p=.001$, $\eta_p^2=.38$). That is, the individual and cooperative settings were similar to each other in terms of speed, regardless of change condition; but the competitive setting was faster than the cooperative setting and even faster than the individual setting, regardless of change condition.

Furthermore, the three-way interaction between consistency, change condition, and social setting was insignificant ($F(2,32)=.75$, $p=.48$, $\eta_p^2=.045$).

Since our hypotheses were for change trials only, we wanted to examine the effects of semantic consistency and social setting on these trials in a separate analysis. Therefore, we conducted a 2 (ChangeConsistency: ConsistentChange, InconsistentChange) x 3 (TaskSetting: Individual, Cooperative, Competitive) Mixed ANOVA for RT data.

The main effect of change consistency was significant ($F(1,32)=18.47$, $p<.001$, $\eta_p^2=.366$). Participants detected semantically-inconsistent changes faster ($M=1857$, $SE=101$) than the semantically-consistent changes ($M=2390$, $SE=173$) (see Figure 16).

The main effect of social setting was also significant ($F(2,32)=9.48$, $p=.001$, $\eta_p^2=.372$). Simple contrasts revealed that Individual setting ($M=2695$, $SE=198$) was similar to the Cooperative setting ($M=2271$, $SE=271$) ($F(1,24)=1.59$, $p=.219$, $\eta_p^2=.062$) in speed, but was slower as compared to the Competitive setting ($M=1405$, $SE=228$) ($F(1,24)=20.77$, $p<.001$, $\eta_p^2=.464$).

However, the interaction between change consistency and social setting was not significant ($F(2,32)=2.87$, $p=.071$, $\eta_p^2=.152$).

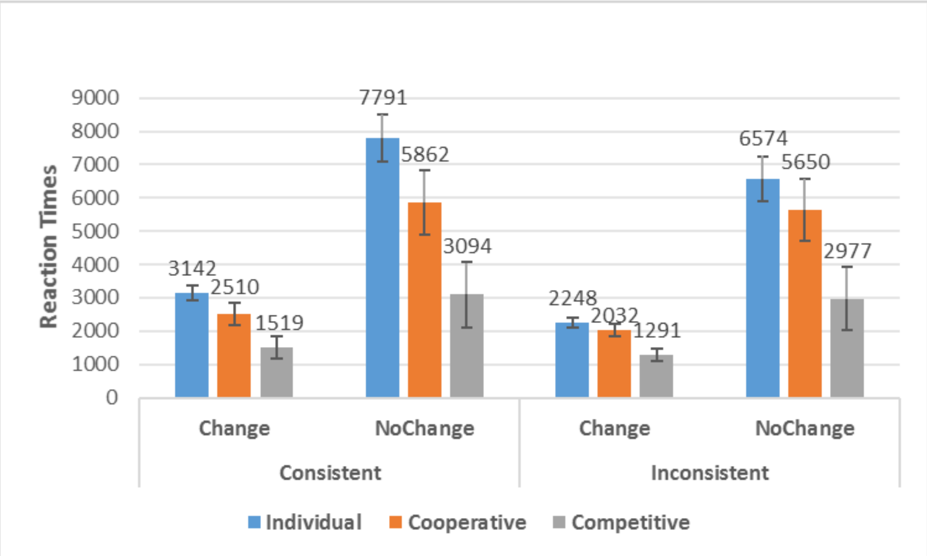

Figure 16: Mean RTs for consistency and change conditions across all social settings. Error bars show SE and the numbers above show RTs.

5.3. Questionnaires

For the sake of the statistical analysis, choices in the questionnaires were given numeric values ranging from 1 to 5, with the most negative choice being 1 and the most positive one being 5.

5.3.1. Block-specific questions

As mentioned before, we hypothesized the inconsistent block to be the simple/easy task block and the consistent block to be the complex/difficult task block. In order to see whether participants would experience the difficulty of the blocks as such, we asked them (right after each block was over) to rate their perceived difficulty of the block they had just completed. Since we counterbalanced the order of these two blocks across the participants, half of them rated first the inconsistent block and the other half rated first the consistent block. Initial analyses showed that Gender and Block Order had no significant effects on participants' ratings, so we collapsed our data over these two factors. A 2 (BlockType: Consistent, Inconsistent) x 3 (Task Setting: Individual, Cooperative, Competitive) Mixed ANOVA was conducted to see whether block type and social setting had any effects on the perceived difficulty of the blocks. Please consult Table 3 for the descriptive statistics.

Table 3: Participants' mean ratings (SE) of the task difficulty for the two block types across all social settings.

	Individual	**Cooperative**	**Competitive**
Consistent Block Ratings	3 (0.2)	2.5 (0.2)	2.56 (0.2)
Inconsistent Block Ratings	3.8 (0.2)	3.3 (0.2)	2.78 (0.2)

There was a significant main effect of consistency ($F(1,50)=21.6$, $p<.001$, $\eta_p^2=.30$), meaning that participants perceived the inconsistent block as easier ($M=3.31$, $SE=0.12$) than the consistent block ($M=2.69$, $SE=0.12$).

There was also a significant main effect of social setting ($F(2,50)=5.16$, $p=.009$, $\eta_p^2=.17$). Simple contrasts revealed that participants in the Individual setting perceived the overall experiment as easier ($M=3.41$, $SE=0.17$) than participants in the Cooperative setting ($M=2.92$, $SE=0.16$) ($F(1,33)=6.29$, $p=.017$, $\eta_p^2=.16$). Likewise, the overall experiment was rated as easier by the Individual setting ($M=3.41$, $SE=0.17$) than by the Competitive setting ($M=2.67$, $SE=0.16$) ($F(1,33)=8.60$, $p=.006$, $\eta_p^2=.21$).

5.3.2. General Questionnaire

Common Questions for all task settings

First the 5 questions which were given to participants in all social settings, were analyzed with a One-way ANOVA on the 3 social settings (Single, Cooperative, Competitive). This analysis was conducted for each question. Please consult Table 4 for the descriptive statistics.

Table 4: Participants' mean answers (SD) for the first 5 questions across each task setting.

	Individual	**Cooperative**	**Competitive**
Q1: Boredom/Fun	3.71 (.85)	3.44 (.98)	3.83 (.79)
Q2: Excitement	2.65 (1.0)	2.89 (1.1)	3.00 (.84)
Q3: Pressure	2.18 (1.1)	1.89 (.96)	2.77 (1.2)
Q4: Flicker Task – Self Accuracy	3.71 (.59)	3.50 (.62)	3.28 (.67)
Q5: Flicker Task – Self Speed	3.35 (.70)	3.00 (.84)	3.06 (.80)

The first question was whether the participant had fun or were bored during the experiment. A One-way ANOVA on the 3 task settings (Individual, Cooperative, Competitive) was conducted. The main effect of task setting was not significant ($F(2,50)=.92$, $p=.4$). Mean values of answers were similar in Individual ($M=3.71$, $SD=.85$), Cooperative ($M=3.44$, $SD=.98$) and Competitive ($M=3.83$, $SD=.79$) task settings.

The second question was how excited the participant was during the experiment. A One-way ANOVA on the 3 task settings (Individual, Cooperative, Competitive) was conducted. The main effect of task setting was insignificant ($F(2,50)=.59$, $p=.6$). Mean values of answers were similar in Individual ($M=2.65$, $SD=1.0$), Cooperative ($M=2.89$, $SD=1.1$) and Competitive ($M=3.00$, $SD=.84$) task settings.

The third question was how much under pressure the participant had felt during the experiment. A One-way ANOVA on the 3 task settings (Individual, Cooperative, Competitive) was conducted. The main effect of task setting was significant ($F(2,50)=3.2$, $p=.048$). Helmert contrasts revealed that there was no difference between the individual setting ($M=2.18$, $SD=1.1$) and both dual settings ($M=2.33$, $SD=1.1$) ($F(1,51)=0.23$, $p=.637$), but there was a significant difference between the cooperative setting ($M=1.89$, $SD=.96$) and the competitive setting ($M=2.77$, $SD=1.2$) ($F(1,34)=6.21$, $p=.02$), indicating that competing participants felt under more pressure during the experiment than the cooperating participants.

The fourth question was how accurate the participant thought s/he had been in detecting the changes and no-changes in the pictures. A One-way ANOVA on the 3 task settings (Individual, Cooperative, Competitive) was conducted. The main effect of task setting was not significant ($F(2,50)=2.04$, $p=.14$). Mean values of the answers were close to each other for Individual ($M=3.71$, $SD=.59$), Cooperative ($M=3.50$, $SD=.62$) and Competitive ($M=3.28$, $SD=.67$) task settings.

The fifth question was how fast the participant thought s/he had detected the changes and no-changes in the pictures. A One-way ANOVA on the 3 task settings (Individual, Cooperative, Competitive) was conducted. The main effect of task setting was insignificant ($F(2,50)=1.01$, $p=.37$). Mean values of the answers were similar to each other in Individual ($M=3.35$, $SD=.70$), Cooperative ($M=3.00$, $SD=.84$) and Competitive ($M=3.06$, $SD=.80$) task settings.

Questions for the Dual settings

Questions 6-10 were given only to the participants in the cooperative and competitive task settings. A One-way ANOVA on the 2 task settings (Cooperative, Competitive) was conducted for each question. Please consult Table 5 for the descriptive statistics.

Table 5: Participants' mean answers (SD) for the 6th-10th questions across both dual task settings.

	Cooperative	**Competitive**
Q6: Flicker Task – Partner/Self Accuracy Comparison	2.61 (.78)	2.83 (.62)
Q7: Flicker Task – Partner/Self Speed Comparison	2.83 (.86)	3.06 (.80)
Q8: Friendliness	4.56 (.62)	4.17 (.86)
Q9: Social Warmth	4.22 (.73)	3.94 (.73)
Q10: Cooperation/Competition Evaluation	4.33 (.69)	2.89 (.76)

The sixth question was how the participant evaluated their partner's accuracy in the flicker task, by comparing it to their self-performance. A One-way ANOVA on the 2 task settings (Cooperative, Competitive) was conducted. The main effect of task setting was insignificant ($F(1,34)=.90$, $p=.35$). Mean values of the answers were similar in Cooperative ($M=2.61$, $SD=.78$) and Competitive ($M=2.83$, $SD=.62$) task settings.

The seventh question was how the participant evaluated their partner's speed in the flicker task, by comparing it to their self-performance. A One-way ANOVA on the 2 task settings (Cooperative, Competitive) was conducted. The main effect of task setting was not significant ($F(1,34)=.65$, $p=.43$). Mean values of the answers were close to each other in Cooperative ($M=2.83$, $SD=.86$) and Competitive ($M=3.06$, $SD=.80$) task settings.

The eight question was how friendly the participant felt towards their partner during the experiment. A One-way ANOVA on the 2 task settings (Cooperative, Competitive) was conducted. The main effect of task setting was not significant ($F(1,34)=2.43$, $p=.13$). Mean values of the answers were similar in Cooperative ($M=4.56$, $SD=.62$) and Competitive ($M=4.17$, $SD=.86$) task settings.

The ninth question was how close the participant felt to their partner during the experiment. A One-way ANOVA on the 2 task settings (Cooperative, Competitive) was conducted. The main effect of task setting was insignificant ($F(1,34)=1.31$, $p=.26$). Mean values of the answers were close to each other in Cooperative ($M=4.22$, $SD=.73$) and Competitive ($M=3.94$, $SD=.73$) task settings.

The tenth (last) question was different between the two task settings. While participants in the cooperative setting were asked how they would evaluate the cooperation between them and their partner during the experiment, participants in the competitive setting were asked how they would evaluate the competition between them and their partner during the experiment. A One-way ANOVA on 2 task settings (Cooperative, Competitive) was conducted. The main effect of task setting was significant ($F(1,34)=36$, $p<.001$). Participants in the cooperative setting rated their cooperation with a higher value ($M=4.33$, $SD=.69$) as compared to participants in the competitive setting who rated their competition ($M=2.89$, $SD=.76$). This shows that cooperative partners reported to feel more as a team, relative to the competitive partners who reported to feel as rivals.

Finally, we also wanted to see if there was a difference between the members in the dyads in terms of the number of responses (key pressings) they gave. An experimental session consisted of 120 trials and we had 9 dyads in each dual setting. That is, there were 1080 trials in total for each dual setting. If the members of the dyads contributed equally to the experiment (50% - 50% distribution), the number of responses members sitting on the right gave would be the same (i.e., 540) as that members sitting on the left gave. Indeed, total response counts in the competitive setting were almost equally distributed between participants sitting on the right (534) and participants sitting on the left (546) (49% - 51% distribution). However, in the cooperative setting, participants sitting on the right gave more responses (685) than the participants sitting on the left (395) (63% - 37% distribution). This unequal distribution of responses made by the members in the cooperative setting indicates that they engaged in some division of labor beyond what was required by the task instruction. Perhaps it occurred to them that an “asymmetric” response strategy would be more efficient as compared to a symmetric response strategy. Why the symmetry was broken in favour of right responses yet awaits a proper answer, in future studies.

CHAPTER 6

DISCUSSION

In this study, our aim was to find out how performance on a change/no-change detection task involving semantically-consistent and semantically-inconsistent objects would be influenced by the social setting of the task – whether the task was done individually or in cooperation or in competition with a partner. In line with our first hypothesis, we have found that changes to semantically-inconsistent objects were detected more often and faster than the changes to semantically-consistent objects, probably because attention was drawn earlier to inconsistent objects relative to the consistent ones, increasing the chance of the inconsistent objects being detected (LaPointe & Milliken, 2016; Hollingworth and Henderson, 2000).

In our second hypothesis, we expected to find a social facilitation effect in our dual settings (cooperative and competitive). More specifically, we had predicted that detecting semantically-inconsistent changes, which we considered a simple/easy task, would be more accurate and faster in the dual settings than in the individual setting (performance improvement), because cognitive overload caused by the presence of a co-actor might restrict the focus of attention, making it be drawn more efficiently to central cues (i.e., inconsistent objects); but, detecting semantically-consistent changes, which we considered a complex/difficult task, would be less accurate and more slowly in the dual settings than in the individual setting (performance impairment), because, when all cues were similarly central (i.e., all were consistent objects), the same cognitive overload and the resulting attentional restriction might cause some of these central cues to be neglected. However, as our results showed, we could not obtain this effect. What we found instead was that there was no difference between individual setting and the cooperative setting in terms of speed and accuracy; both, at similar performance levels, detected the semantically-inconsistent changes more quickly and accurately than the consistent ones. The competitive setting was also better in the inconsistent-change trials than in the consistent ones, but it neither outperformed the individual setting in inconsistent-change accuracy nor it was slower in consistent-change trials.

Nevertheless, we can still interpret our results to figure out why we did not obtain the expected social facilitation effect and also to see what these results tell us regarding the influence of our social settings on participants' cognitive performance. We will discuss the effects of semantic consistency and social condition on performance first in the Change trials, which were our primary interest; then, we will discuss the NoChange trials.

6.1. Evaluation of Change Trials

Our results for the Change trials indicated that the success rate was almost identical in the individual and cooperative settings. In both settings participants detected semantically inconsistent changes at a higher rate than the semantically consistent changes. In the competitive setting participants also detected the inconsistent changes better than the consistent ones but their success rate was lower than in the other two settings.

Reaction times for correct change-detections were also similar in the Individual and Cooperative settings. In both settings, participants detected the semantically inconsistent changes faster than the semantically consistent ones. However, the competing participants' response time for inconsistent changes did not differ significantly from that of consistent changes.

Why was the performance of single participants (both in accuracy and in speed) similar to that of the cooperating participants? Although there is one study in the literature indicating that cooperation improves change detection performance (Tollner-Burngasser, Riley, & Nelson, 2010), it did not do so in our study. However, there were some differences between that study and ours. In Tollner-Burngasser et al.'s study the cooperation setting consisted of three people and the stimuli were different colored squares, whereas in our study the cooperative setting involved only two people and our stimuli were complex scenes. Furthermore, they had manipulated the factor whether groups communicated or not systematically, whereas we did not. These differences might account for the lack of improvement in performance in our cooperative setting. Another possible reason for the similarity between the Individual and Cooperative settings might be a ceiling effect. The task might have been quite easy to be solved by one individual or likewise by two cooperating individuals. In addition, our instruction might have spurred participants to high levels of performance. We told all our participants at the beginning of the experiment to respond to the trials as fast and accurately as possible; with this kind of instruction, performance might already have reached a peak, regardless of whether a single subject or two cooperating subjects engaged in the task.

Besides, the cooperating subjects did not demonstrate the social facilitation effect we had expected (i.e., improvement of inconsistent-change trials and impairment of consistent-change trials compared to the individual setting). We allowed cooperating subjects to communicate with each other during the experiment, and also, as the questionnaires indicated, the cooperating subjects rated their cooperation very highly. Thus, it might be that the high sense of cooperation between the partners as well as the communication between them might have enabled them to develop some strategies to solve the task more efficiently, which in turn might have alleviated the effects of cognitive overload and nullified the social facilitation effect. Besides, social facilitation generally occurs in mere co-action or when a co-actor's success poses a threat to self-evaluation (Muller, Atzeni, & Butera, 2004; Muller & Butera, 2007).

The change-detection performance of the Competitive setting was interesting. Their overall success rate was the worst of all settings and at the same time they were the fastest of all settings. A possible conclusion is that there might be a trade-off between accuracy of responses and the speed of responses, such that competing participants' being very fast caused them to miss many changes. The reason why competing subjects responded to the trials so fast might lie in the fact that which member of the dyad was going to press the response button was of critical importance in this setting. A single response was enough to terminate a trial, and participants were told in advance that their scores would be compared to their partners; so, in order to outnumber their partner's scores, they might simply have needed to press the buttons before their partners could, without sufficiently examining the images. A support for this view comes from the questionnaires we administered to our participants; although competitive participants rated their competition moderately high, at the same time they reported to feel under more pressure during the experiment compared to the cooperative setting. This suggests that the pressure to terminate a trial before the partner made these participants act very fast, which resulted in a lower overall success rate compared to the cooperative setting.

However, the fact that the overall success rate of the competitive setting was lowest of all settings and its overall speed was fastest of all settings cannot be totally explained by the speed-accuracy trade-off caused by the pressure to terminate a trial. When analyzing the accuracy and speed on the basis of the semantic consistency of the changing objects, we see that participants in the competitive setting still detected the semantically-inconsistent changes more successfully than the semantically-consistent ones, even though the speed in the inconsistent-change trials was similar to the speed in the consistent-change trials. This discrepancy suggests that the need to act very fast deteriorated the accuracy performance to some extent but not as much as to disrupt the semantic-consistency effect.

Like in the cooperative setting, in the competitive setting participants did not show a social facilitation effect, either. Some studies showed competitive co-action increased simple-task performance (e.g., Carment, 1970) and others showed it had no effect on simple tasks but impaired performance on complex tasks (e.g., McGlynn, 1981). In our study, however, we found that competition impaired performance on our simple-task (i.e., inconsistent-change detection) as well. The difference between those studies and ours is that the competitive settings of those studies were not joint-action settings. That is, although the competing dyads in those studies were in the same room and dealt with the same task, each member of the dyad performed his task individually, with a separate apparatus given to him or her. In our study, however, the competing dyads sat in front of the same computer, saw the same screen, and also dealt with every trial together. That is, our competitive setting was not an independent co-action setting but a joint one.

Consequently, it may be that in joint action settings, where co-actors interactively engage in a task, social facilitation does not occur (Sebanz, Knoblich & Prinz, 2003). Indeed, the studies in the literature that claimed to have found a social facilitation effect in co-action settings (Hunt & Hillery, 1973; Muller & Butera, 2007; Muller, Atzeni, & Butera, 2004) did employ *independent* co-action settings, where co-actors engaged in the same task separately, without seeing what their partners were doing. That is, the critical difference between independent co-action and joint co-action is that in the former, the co-actors do not mentally share one another's task representations, but in the latter, they do. Thus, there must be something unique to joint action settings that prevents social facilitation.

Furthermore, our study differs from the traditional joint action (e.g., joint Simon task) studies in that in typical joint tasks, which partner will respond to which trial is determined via a go/no-go paradigm, wherein a different stimulus characteristic is given to each partner and he must respond when he sees his stimulus characteristic and refrain from responding when he sees his partner's stimulus characteristic (Sebanz, Knoblich & Prinz, 2003; Böckler, Knoblich, & Sebanz, 2011). However, the change detection task in our study was not of that kind. Instead, our task can be labeled as a go/go task, wherein partners could respond freely to every trial.

An interesting bridge between psychology and artificial intelligence (AI) can be formed regarding the issue of task complexity in our study. In AI, the amount of resources needed to execute algorithms is studied, and time complexity (computation time) is an important measure of problem difficulty. Time complexity is defined as the number of steps it takes to solve a problem (e.g., finding a specific node in a search tree) as a function of input size. The more steps (e.g., the more generated nodes) have to be taken, the more complex the problem is in terms of computation time. In uninformed search strategies, all nodes are expanded in some order or another until the critical goal node is found. In informed search strategies, a heuristic, i.e., additional knowledge beyond the problem definition, is used to help solve the problem more efficiently (Russell & Norvig, 2010). Similarly, in psychology, specifically in our change-detection experiment, when all objects in an image are semantically congruent with the scene context, the attentional system searches the scene, by processing the objects in it in some order or another, until it finds which object is changing. This resembles the uninformed search strategies in AI and also its time complexity is greater than in the following case: When only one object in a scene is semantically incongruent with the scene context, attention is drawn to this object earlier than to the other objects, enabling it to be found earlier. This resembles the informed (heuristic) search strategies in AI, because the mechanism (e.g., non-conscious processing or whatever) that draws the attention to the incongruent object can be deemed as a kind of heuristic, which reduces the time complexity of the task.

6.2. Evaluation of NoChange Trials

NoChange trials were of secondary interest to us, still their results are worth-while evaluating. The results showed, like other studies (e.g., Hollingworth & Henderson, 2000), that participants' success rate was nearly perfect on the NoChange trials, and they were also much slower on these trials than on the Change trials. These results can be explained as follows: To see if a change occurs between the flickering images, participants start to search the image, concentrating each time on some part of it to check if it is changing during the flicker. If there is a change in the image, participants may spot it at some point and then do not need to search the image further. However, if there is no change in the image, participants need to search all parts of the image to decide whether a change occurs or not. That is why the NoChange trials took more time to respond to than the Change trials. On the other hand, since our stimuli are complex scene images, searching all parts of the images requires a lot of time and is exhaustive; therefore, participants might stop searching at some point if they could not notice a change and give a NoChange response. That is, participants might be more biased towards giving a NoChange response than giving a Change response. That might be the reason why success rate was very high in the NoChange trials.

Furthermore, in NoChange trials, while success rates in the Individual and Cooperative settings were very high and almost identical (98%), the success rate in the Competitive setting (90%) was significantly lower in comparison. That is, when there was NoChange, competing participants gave a Change response more often than in the other two settings. A possible explanation is that the false alarm rate of 2% in the individual and cooperative settings could mostly be attributed to pressing mistakenly a wrong response button, whereas the false alarm rate of 10% in the competitive setting might not mostly be attributed to mistaken responses. Because of the nature of the competitive setting, where there was a pressure to respond to a trial before a rival could, it is reasonable to think that the competing participants might sometimes have used a guessing strategy; that is, in order to surpass their rivals, they sometimes might have responded to the trials cursorily, without sufficiently examining the images, which must have sometimes resulted in incorrect responses. After all, this is just a speculation; our design was not sensitive enough to ensure it.

The data of the NoChange trials also showed that semantic consistency had no impact on the success rate; but it had a significant effect on the reaction times of only the Individual setting. Participants were almost equally successful in consistent and inconsistent NoChanges, but only single participants' reaction times showed that they were faster in inconsistent NoChanges than the consistent ones. That is, when an image contained a semantically inconsistent object which did not change, single participants gave the NoChange response more quickly than when an image contained a semantically consistent object which did not change. A possible reason is that single participants might have adopted a strategy, such that when they saw a strange (semantically inconsistent) object in a scene image, they might have reasoned 'if this object was not changing, then the other objects must not be changing, either', and made a no-change response without looking further to the image. However, since the dual settings did not show such a speed difference between the inconsistent and consistent no-changes, it may be that they did not adopt this strategy, at least not as often as participants in the individual setting did.

6.3. The effects of emotions on change-detection performance

So far, change-detection and joint action literatures did not investigate participants' emotional states during their performance. Some social facilitation studies indeed examined participants' mood during their performance (Groff, Baron, & Moore, 1983), but found no difference between individual and social conditions regarding the feelings of anxiety, apprehension, and excitation. Since we investigated change-detection performance in different joint action settings, we wanted to see whether participants' mood during the experiment would change as a function of social condition and whether possible performance differences between the groups could be attributed to participants' feelings.

Our questionnaires did not show any difference between the three settings in terms of boredom and excitement, but showed a significant difference between the cooperative and competitive settings in the amount of pressure they felt. While participants in the cooperative setting reported to feel under very little pressure during the experiment, probably because of the very high sense of cooperation with their partners, participants in the competitive setting reported to feel under more pressure than in the cooperative setting, probably because of the urge to terminate the trials before their partners so as to outperform their scores. This pressure may be the reason why performance in the competitive setting was so counter-productive. The additional questionnaire given to the participants in the dual settings also showed no difference between these settings in terms of friendliness, social warmth, and participants' evaluation of their partner's performance. Therefore, participants' change detection performance across the social settings cannot be attributed to their general mood, except the felt pressure (stress) in the competitive setting.

Furthermore, the last question showed that cooperative dyads rated their cooperation very high whereas competitive dyads rated their competition only moderately high. That is, participants were more inclined to cooperate than to compete. This finding is in line with a study conducted by Iani et al. (2011), which showed that in a joint action task people had a tendency to spontaneously cooperate with their partners even if they were not told to do so.

A last note regarding our dual settings that is worth mentioning is that when we checked the response counts of the dual settings during the experiment, we saw that the total response counts in the competitive setting were almost equally distributed between the participants sitting on the right and the participants sitting on the left (49% - 51%). However, in the cooperative setting, participants sitting on the right gave more responses than the participants sitting on the left (63% - 37%). We think this unequal distribution of responses in the cooperative setting can be explained by a division of labor among (some of) the dyads. Since the cooperative dyads were allowed to talk to each other during the experiment and they also knew their scores would be evaluated as a team, some of them must have realized that it did not matter who in the dyad would press a response button, and accordingly agreed among themselves that one could press the buttons while they were examining the pictures together. This finding as well as the high ratings of cooperation in the questionnaires indicate that cooperative relations are easy to build among people in such experimental settings.

6.4. Limitations and Future Directions

This study has some limitations which will be pointed out in the following. Suggestions how they can be addressed in future studies will be made. One limitation of this study is its small sample size. Considering the statistical assumption that larger sample sizes (at least 30 for a group) are more representative of the population than smaller ones, our sample size (i.e., less than 20 in each setting) might not be large enough. Moreover, since in our social settings we analyzed the performance of every dyad *collectively* (rather than individually for each member in the dyad), the number of cases in these settings were lowered to half (i.e., 9 analyzed cases for a total of 18 subjects in each social setting); this may seem our results appear even more resistant to generalization.

Another limitation is that our Individual setting was not a true-alone one. If we want to explore the influence of the presence of others on cognitive performance, then, in the Individual setting, for the sake of clear comparison with the social settings, no one other than the participant should be present in the laboratory during the experiment, not even the experimenter. Indeed, some social facilitation studies in the literature have been criticized on the ground that the experimenter was present in the alone conditions (Guerin, 1993). Although in these studies the experimenter was not watching them or was partially concealed, the *mere* presence of him/her could still have the potential of arousing the participants, and therefore might contaminate the results somewhat. Likewise, in our study, the presence of the experimenter, although he was not watching the participants, might have somewhat affected their performance in the Individual setting.

In this study, a “simple” and a “complex” task was performed by our participants. However, it is possible that our criterion of complexity/difficulty (i.e., semantic consistency) is not of the kind that could produce social facilitation as we had expected. In order to address this issue, in future studies, we might conduct our change-detection experiment in more traditional social facilitation settings (i.e., audience and independent co-action), rather than the joint action settings as we did in this study. If we find a social facilitation effect in those settings, then we can be more confident in our arguments that our manipulation of task complexity (i.e., semantic consistency) is indeed sensitive to social facilitation and that joint action settings eliminate the social facilitation effects.

Another direction for future studies is to investigate the role of communication in the cooperative setting. In our study, we allowed the cooperating subjects to communicate with each other during the experiment, but we did not record their speech. Thus, we do not know what kinds of strategies they developed to accomplish the change-detection task together and when they did this during the experiment. Thus, in order to see the effects of communication and of the ensuing strategies on dyads’ performance more clearly, it might be a good idea to record and analyze cooperating participants’ speech.

Group eye-tracking might also be suitable to investigate the performance in social settings. Since participants in joint action settings might have shared representations of the task, their allocation of overt attention and image searching strategies during the change-detection task might be different compared to individual participants. Monitoring dyads' eye movements and fixations might reveal interesting differences in the results.

A final possible direction for future research is to employ a go/no-go procedure in our change detection task. Semantically consistent and inconsistent objects can be placed either at the right or at the left side of the images, and each partner can be instructed to respond according to the location or some characteristic of the changing object. This way, we may have a chance to see to what extent co-actors share each other's mental representations while they attend to complex scene images.

6.5. Conclusion

In this study, our first aim was to replicate a well-established finding that semantically-inconsistent changes to images were noticed more often and faster than semantically-consistent changes. The most likely reason is that attention is drawn to the areas where a violation of the scene context occurs earlier (Hollingworth & Henderson, 2000; LaPointe & Milliken, 2016). Our results showed, as we had expected, that participants were faster and more accurate in the semantically-inconsistent change trials than they were in the semantically-consistent change trials.

Our second aim was to study social effects in our dual settings (i.e., cooperative and competitive). We had expected that in the dual settings, inconsistent-change trials, which we considered simple trials, would be performed even more accurately and faster compared to the individual setting, whereas consistent-change trials, which we considered complex trials, would be performed even less accurately and more slowly in the dual settings compared to the individual setting. Our results showed, however, that the dual settings did not produce such a differential consistency effect relative to the individual setting. Instead, the accuracy and speed of participants in the cooperative setting were quite similar to participants in the individual setting – indicating that similar cognitive processes were at work in individuals and in members of dyads. Although participants in the competitive setting were less accurate in the consistent changes compared to participants in the individual setting, which is partially consistent with our prediction, they did not show any improvement in accuracy in the inconsistent-change trials compared to the individual setting, which refutes the other half of our prediction. Moreover, in the inconsistent-change trials, participants in the competitive setting were faster than participants in the individual setting, which supports half of our prediction, but were also faster in the consistent-change trials than their peers in the individual setting, which contradicts the other half of our prediction. To sum up, the expected social facilitation effect could not be obtained in our dual settings.

However, although our hypothesis for the social settings was not supported, our study showed for the first time that the semantic-consistency effect in the change-detection paradigm is robust to social effects: in all settings, participants detected the inconsistent changes more accurately than the consistent ones. Second, competing participants reacted to the trials very fast; this finding may be considered an *overall* social facilitation effect. Third, considering that most of the joint action studies have been conducted by employing the go/no-go paradigm, our study – together with the study by Tollner-Burngasser et al. (2010) – is one of the few studies which employed the go/go paradigm.

To conclude, the contribution of this study to the literature on joint action is beneficial because the joint change-detection task has different characteristics than the traditional joint tasks (e.g. the joint Simon task), and thus adds to our understanding how social settings may affect cognitive performance across different types of joint tasks.

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APPENDICES

APPENDIX A

Voluntary Participation Form

Araştırmaya Gönüllü Katılım Formu

Bu araştırma, Bilişsel Bilimler Bölümü yüksek lisans öğrencisi Mustafa Akkuşçu tarafından yürütülen bir çalışmadır. Çalışma danışmanı, ODTÜ Bilişsel Bilimler Bölümü öğretim görevlilerinden Doç. Dr. Annette Hohenberger'dir. Bu form sizi araştırma koşulları hakkında bilgilendirmek için hazırlanmıştır.

Çalışmanın Amacı Nedir? Araştırmanın amacı, insan görsel algı sistemi ve dikkat süreçleri arasındaki ilişkileri anlamaktır

Bize Nasıl Yardımcı Olmanızı İsteyeceğiz? Araştırmaya katılmayı kabul ederseniz, sizden beklenen, ekranda görünen her bir resim için, o resimde bir değişiklik oluşup oluşmadığını hızlı ve doğru bir şekilde saptamaya çalışmanızdır. Bu saptamayı, size araştırmacı tarafından önceden gösterilen tuşlardan uygun olanına basarak yapmanız gerekmektedir. Resimlerin gösterimi sona erince, sizden kısa bir anketi yanıtlamanız istenecektir. Anketteki sorular deney esnasındaki duygularınız ile ilgilidir. Ankette hiçbir kimlik bilginiz istenmeyecektir. Bu çalışmaya katılım ortalama olarak 30 dakika sürmektedir.

Sizden Topladığımız Bilgileri Nasıl Kullanacağız? Araştırmaya katılımınız tamamen gönüllülük temelinde olmalıdır. Araştırmada, sizden kimlik veya kurum belirleyici hiçbir bilgi istenmemektedir. Cevaplarınız tamamıyla gizli tutulacak, sadece araştırmacılar tarafından değerlendirilecektir. Katılımcılardan elde edilecek bilgiler toplu halde değerlendirilecek ve bilimsel yayımlarda kullanılacaktır. Sağladığınız veriler gönüllü katılım formlarında toplanan kimlik bilgileri ile eşleştirilmeyecektir.

Katılımınızla ilgili bilmeniz gerekenler: Bu araştırma, katılımcıların sağlığı vb. açısından, bilinen herhangi bir risk faktörü içermemektedir. Katılım sırasında size gösterilen resimlerden ya da herhangi başka bir nedenden ötürü kendinizi rahatsız hissederseniz prosedürü yarıda bırakıp çıkmakta serbestsiniz. Böyle bir durumda çalışmayı uygulayan kişiye, çalışmadan çıkmak istediğinizi söylemeniz yeterli olacaktır. Çalışma sonunda, bu araştırmayla ilgili sorularınız cevaplanacaktır.

Araştırmayla ilgili daha fazla bilgi almak isterseniz: Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz. Deney sonunda bu çalışmayla ilgili sorularınız cevaplanacaktır. Çalışma hakkında daha fazla bilgi almak isterseniz, çalışmayı yürüten Mustafa Akkuşçu (e-posta: akkuscu.mustafa@metu.edu.tr) ile iletişim kurabilirsiniz.

Yukarıdaki bilgileri okudum ve bu çalışmaya tamamen gönüllü olarak katılıyorum.

(Formu doldurup imzaladıktan sonra uygulayıcıya geri veriniz).

İsim Soyad　　　　　Tarih　　　　　İmza

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APPENDIX B

Questionnaire Presented to Participants in Individual Setting

KATILIM SONRASI DEĞERLENDİRME ANKETİ

Yaşınız:

Cinsiyetiniz:

Mesleğiniz:

Aşağıdaki sorularda size en uygun gelen seçeneği işaretleyiniz. Sonuçlar sadece bilimsel yayınlarda kullanılacaktır.

1. Deney sırasındaki genel duygunuzu nasıl tanımlarsınız?

Çok sıkıldım	Sıkıldım	Orta	Eğlendim	Çok eğlendim
O	O	O	O	O

2. Deney sırasında ne kadar heyecanlandınız?

Hiç heyecanlanmadım	Heyecanlanmadım	Orta	Heyecanlandım	Çok heyecanlandım
O	O	O	O	O

3. Deney sırasında ne kadar baskı altında hissettiniz?

Hiç hissetmedim	Hissetmedim	Orta	Baskı hissettim	Çok baskı hissettim
O	O	O	O	O

4. Resimlerdeki değişiklikleri / değişimsizlikleri ne derece doğru saptadığınızı düşünüyorsunuz?

Hiç saptayamadım	Saptayamadım	Orta	Sıklıkla doğru saptadım	Hep doğru saptadım
O	O	O	O	O

5. Resimlerdeki değişiklikleri / değişimsizlikleri ne kadar hızlı saptadığınızı düşünüyorsunuz?

Çok yavaş saptadım	Yavaş saptadım	Orta	Hızlı saptadım	Çok hızlı saptadım
O	O	O	O	O

Katılımınız için teşekkür ederiz.

APPENDIX C

Questionnaire Presented to Participants in Cooperative Setting

KATILIM SONRASI DEĞERLENDİRME ANKETİ

Yaşınız:

Cinsiyetiniz:

Mesleğiniz:

Aşağıdaki sorularda size en uygun gelen seçeneği işaretleyiniz. Sonuçlar sadece bilimsel yayınlarda kullanılacaktır.

1. **Deney sırasındaki genel duygunuzu nasıl tanımlarsınız?**

Çok sıkıldım	Sıkıldım	Orta	Eğlendim	Çok eğlendim
O	O	O	O	O

2. **Deney sırasında ne kadar heyecanlandınız?**

Hiç heyecanlanmadım	Heyecanlanmadım	Orta	Heyecanlandım	Çok heyecanlandım
O	O	O	O	O

3. **Deney sırasında ne kadar baskı altında hissettiniz?**

Hiç hissetmedim	Hissetmedim	Orta	Baskı hissettim	Çok baskı hissettim
O	O	O	O	O

4. **Resimlerdeki değişiklikleri / değişimsizlikleri ne derece doğru saptadığınızı düşünüyorsunuz?**

Hiç saptayamadım	Saptayamadım	Orta	Sıklıkla doğru saptadım	Hep doğru saptadım
O	O	O	O	O

5. **Resimlerdeki değişiklikleri / değişimsizlikleri ne kadar hızlı saptadığınızı düşünüyorsunuz?**

Çok yavaş saptadım	Yavaş saptadım	Orta	Hızlı saptadım	Çok hızlı saptadım
O	O	O	O	O

6. **Kendinizi ortağınızla kıyasladığınızda, hanginizin resimlerdeki değişiklikleri / değişimsizlikleri daha doğru saptadığını düşünüyorsunuz?**

Ortağım çok daha doğruydu	Ortağım daha doğruydu	Eşit	Ben daha doğruydum	Ben çok daha doğruydum
O	O	O	O	O

7. **Kendinizi ortağınızla kıyasladığınızda, hanginizin resimlerdeki değişiklikleri / değişimsizlikleri daha hızlı saptadığını düşünüyorsunuz?**

Ortağım çok daha hızlıydı	Ortağım daha hızlıydı	Eşit	Ben daha hızlıydım	Ben çok daha hızlıydım
O	O	O	O	O

8. **Ortağınız hakkındaki görüşünüzü nasıl tanımlarsınız?**

Çok düşmanca	Düşmanca	Tarafsız	Dostça	Çok dostça
O	O	O	O	O

9. **Ortağınızı kendinize ne kadar yakın hissettiniz?**

Çok uzak	Uzak	Orta	Yakın	Çok yakın
O	O	O	O	O

10. **Ortağınızla ne kadar iyi uyum gösterdiğinizi düşünüyorsunuz?**

Çok kötü	Kötü	Orta	İyi	Çok iyi
O	O	O	O	O

Katılımınız için teşekkür ederiz.

APPENDIX D

Questionnaire Presented to Participants in Competitive Setting

KATILIM SONRASI DEĞERLENDİRME ANKETİ

Yaşınız:

Cinsiyetiniz:

Mesleğiniz:

Aşağıdaki sorularda size en uygun gelen seçeneği işaretleyiniz. Sonuçlar sadece bilimsel yayınlarda kullanılacaktır.

1. **Deney sırasındaki genel duygunuzu nasıl tanımlarsınız?**

Çok sıkıldım	Sıkıldım	Orta	Eğlendim	Çok eğlendim
O	O	O	O	O

2. **Deney sırasında ne kadar heyecanlandınız?**

Hiç heyecanlanmadım	Heyecanlanmadım	Orta	Heyecanlandım	Çok heyecanlandım
O	O	O	O	O

3. **Deney sırasında ne kadar baskı altında hissettiniz?**

Hiç hissetmedim	Hissetmedim	Orta	Baskı hissettim	Çok baskı hissettim
O	O	O	O	O

4. **Resimlerdeki değişiklikleri / değişimsizlikleri ne derece doğru saptadığınızı düşünüyorsunuz?**

Hiç saptayamadım	Saptayamadım	Orta	Sıklıkla doğru saptadım	Hep doğru saptadım
O	O	O	O	O

5. **Resimlerdeki değişiklikleri / değişimsizlikleri ne kadar hızlı saptadığınızı düşünüyorsunuz?**

Çok yavaş saptadım	Yavaş saptadım	Orta	Hızlı saptadım	Çok hızlı saptadım
O	O	O	O	O

6. **Kendinizi ortağınızla kıyasladığınızda, hanginizin resimlerdeki değişiklikleri / değişimsizlikleri daha doğru saptadığını düşünüyorsunuz?**

Ortağım çok daha doğruydu	Ortağım daha doğruydu	Eşit	Ben daha doğruydum	Ben çok daha doğruydum
O	O	O	O	O

7. **Kendinizi ortağınızla kıyasladığınızda, hanginizin resimlerdeki değişiklikleri / değişimsizlikleri daha hızlı saptadığını düşünüyorsunuz?**

Ortağım çok daha hızlıydı	Ortağım daha hızlıydı	Eşit	Ben daha hızlıydım	Ben çok daha hızlıydım
O	O	O	O	O

8. **Ortağınız hakkındaki görüşünüzü nasıl tanımlarsınız?**

Çok düşmanca	Düşmanca	Tarafsız	Dostça	Çok dostça
O	O	O	O	O

9. **Ortağınızı kendinize ne kadar yakın hissettiniz?**

Çok uzak	Uzak	Orta	Yakın	Çok yakın
O	O	O	O	O

10. **Ortağınızla ne kadar rekabet içinde olduğunuzu düşünüyorsunuz?**

Hiç	Az	Orta	Fazla	Çok Fazla
O	O	O	O	O

Katılımınız için teşekkür ederiz.

APPENDIX E

Debriefing Given to Participants After Questionnaires

Araştırma Sonrası Bilgilendirme Formu

Öncelikle araştımamıza katıldığınız için teşekkür ederiz.

Bu araştırma, daha önce de belirtildiği gibi, ODTÜ Bilişsel Bilimler Bölümü Yüksek Lisans öğrencisi Mustafa Akkuşçu tarafından Doç. Dr. Annette Hohenberger danışmanlığındaki yüksek lisans tezi kapsamında yürütülmektedir. Bu araştırmanın amacı, görsel algı ve dikkat arasındaki ilişkilerin bireyler ve gruplar bazında nasıl olduğunu incelemektir. Literatüre göre, bir resime yapılan küçük bir değişikliğin farkedilme süresi, o değişikliğin resmin genel bağlamına ne kadar uyduğuna göre değişmektedir. Ayrıca, literatürdeki diğer çalışmalar, algı ve dikkat gibi bilişsel süreçlerin, etkileşimli grup ortamında, bireysel ortamdan daha farklı çalıştığını göstermiştir.

Bu çalışma da bu soruları daha detaylı incelemek amacıyla yapılmaktadır.

Katılımcıların araştırmanın hipotezlerini fark etmesi, verecekleri tepkileri etkileyebileceğinden, araştırmanın amacı çalışmanın başında katılımcılara eksik olarak anlatılmıştır.

Her bir katılımcı, rastgele olarak, "bireysel", "rekabet", veya "işbirliği" koşullarından birine atanmıştır.

Gruplar şu şekildedir:

- Yalnız (Bireysel) Eylem grubu: Katılımcı deneyi tek başına yapmıştır.
- Destekleyici (İşbirliği) Ortak Eylem grubu: İki katılımcı deneyi birlikte (takım olarak) yapmıştır. Puanları birleşik olarak hesaplanıp diğer takımlar ile karşılaştırılacaktır.
- Rekabetçi Ortak Eylem grubu: İki katılımcı deneyi birlikte yapmıştır. Puanları bireysel olarak hesaplanıp birbirleriyle karşılaştırılacaktır.

Siz .... grubunda yer almış bulunuyorsunuz.

Bu çalışmadan alınacak ilk verilerin Mayıs 2016 başında elde edilmesi beklenmektedir. Elde edilen bilgiler sadece bilimsel araştırma ve yazılarda kullanılacaktır. Çalışmanın sağlıklı ilerleyebilmesi ve bulguların güvenilir sonuçlar vermesi için, çalışmaya katılacağını bildiğiniz diğer kişilere çalışmayla ilgili detaylı bilgi paylaşımında bulunmamanızı önemle rica ederiz. Bu araştırmaya katıldığınız için tekrar çok teşekkür ederiz.

Araştırmanın sonuçlarını öğrenmek veya daha fazla bilgi almak için aşağıdaki isimlere başvurabilirsiniz:

Mustafa Akkuşçu (akkuscu.mustafa@metu.edu.tr)

Doç. Dr. Annette Hohenberger (hohenber@metu.edu.tr)

Çalışmaya katkıda bulunan bir gönüllü olarak katılımcı haklarınızla ilgili veya etik ilkelerle ilgili soru veya görüşlerinizi ODTÜ Uygulamalı Etik Araştırma Merkezi'ne iletebilirsiniz.

e-posta: ueam@metu.edu.tr

APPENDIX F

Ethics Committee Approval

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
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Sayı: 28620816 / 200

05 NİSAN 2017

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Annette HOHENBERGER;

Danışmanlığını yaptığınız yüksek lisans öğrencisi Mustafa AKKUŞÇU'nun ***"Değişim Körlüğünün Sosyal İşbirliği Koşullarında İncelenmesi"*** başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülerek gerekli onay **2017-FEN-010** protokol numarası ile **05.04.2017 – 30.06.2017** tarihleri arasında geçerli olmak üzere verilmiştir.

Bilgilerinize saygılarımla sunarım.

Prof. Dr. Ş. Halil TURAN
Başkan V

Prof. Dr. Ayhan SOL
Üye

Prof. Dr. Ayhan Gürbüz DEMİR
Üye

Doç. Dr. Yaşar KONDAKÇI
Üye

Doç. Dr. Zana ÇITAK
Üye

Yrd. Doç. Dr. Pınar KAYGAN
Üye

Yrd. Doç. Dr. Emre SELÇUK
Üye