PROCESSING OF CAUSAL AND CONCESSIVE CONNECTIVES IN CHILDREN

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ABSTRACT

PROCESSING OF CAUSAL AND CONCESSIVE CONNECTIVES IN CHILDREN

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This thesis aims to investigate how children integrate causal and concessive coherence markers. A visual world eye-tracking study was devised to investigate children's looks to pictures of objects in different connective conditions. Interpretation of a concessive connector (ama) and a causal connector (bu yüzden) was tested. Sentences were manipulated by both types of connectors, connector type as a within-subject factor. While seeing two images on the screen, participants listened to spoken utterances made of a context phrase with a critical adjective (e.g., sweet) and a result sentence with a connector (e.g., pepper and chocolate for the adjective sweet). The gaze patterns of the participants after they heard the connector were examined. This was followed by a comprehension question asking the child to choose the correct picture. The proportion of looks indicated that both adults and children looked more at the target image after hearing the connector. However, according to accuracy scores children performed more poorly compared to adults. Moreover, children performed worse in concessive condition compared to causal condition.

The results may propose that children understand the connective meaning incrementally as adults do. However, it may be difficult for them to use this meaning to make inferences online. The reason why children could not use concessive connectors to make reasoning might be related to their developing executive function abilities.

Keywords: Psycholinguistics, Discourse Connectors, Predictive Language Processing, Language Development, Eye Tracking

ÖZ

ÇOCUKLARDA NEDENSEL VE ÖDÜNLEYİCİ BAĞLAÇLARIN İŞLEMLENMESİ

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Bu çalışma temel olarak çocukların nedensel ve ödünleyici bağlaçları nasıl işlemlediklerini araştırmayı hedeflemektedir. Bu hedef doğrultusunda bir göz izleme çalışması dizayn edilmiştir. Bu çalısmada çocuklar, nedensel bağlaç olarak *bu yüzden*, ödünleyici bağlaç olacak *ama* ile bağlanmış kısa cümleleri dinlediler ve bu sırada bilgisayar ekranındaki iki resime baktılar. Cümleler yapılmak, yenilmek, içilmek istenen şeyi niteleyen bir sıfatı içeren birinci cümleden (örn. Ali tatlı bir şey yemek istedi.) ve ardından *ama* ya da *bu yüzden* ile başlayan sonucu beliten ikinci cümleden oluşur (Ama/Bu yüzden şunu yedi). Bu cümleleri dinlerken çocuklar ekranda bir adet sıfat ile uyumlu nesne (örn. tatlı sıfatı için çikolata resmi) ve sıfat ile uyumsuz bir nesne (örn. tatlı sıfatı için bir biber resmi) gördü. Bu iki cümlenin ardından çocuklardan iki resimden birini seçmeleri istendi (örn. Sence Ali hangisini yedi?). Göz izleme çalısmasının sonuçları çocukların yetişkinler gibi sıfatı duyduklarında sıfat ile uyumlu nesneye baktıklarını, *bu yüzden* bağlacını duyduklarında bu nesneye bakmaya devam ettiklerini, *ama* bağlacını duyduklarında ise uyumsuz nesneye daha çok baktıklarını göstermiştir. Buna karşın, çocukların cümle sonundaki soruya verdikleri cevapların analizine göre çocukar iki bağlaç koşulunda da yetişkinlere kıyasla daha zayıf bir performans sergilemiştir. Ayrıca çocukların *ama* bağlacı koşulunda çok daha düşük

skorlar aldığını göstermiştir. Bu sonuç çocukların gelişmekte olan bilişsel fonksiyonları (örn. baskılama yetenekleri, çalışma belleği) ile ilgili olabilir.

Anahtar Kelimeler: Psikodilbilim, Söylem Bağlaçları, Öngörüsel Dil İşlemlenmesi, Dil Gelişimi, Göz İzleme

To my parents

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
GAMM	Generalized Additive Mixed Model
ms	Millisecond

CHAPTER 1

INTRODUCTION

This chapter initially introduces the background of the research questions. Following that, structure under investigation is presented with the research questions guiding the present study.

1.1.Introduction

Natural speech, and also the input through which children acquire language, does not consist of random sentences, instead, it is made up of interconnected utterances that form a coherent whole. The utterances that are related by causality, contrast, or temporal sequence create a discourse. The unity of the entities in discourse is sustained by conjunctions, reference, substitution, lexical cohesion, and ellipsis (Halliday & Hasan, 1976). Discourse connectors or conjunctions such as *therefore, however, and* are considered as processing directives signaling how to integrate two or more sentences (Sanders & Spooren, 2010). Connectors tailor the relationship between the discourse entities, and by doing so, they also enhance meaningful comprehension of the message in the utterance or the text (Millis & Just 1994). Connectives may indicate a contrast (e.g., *nevertheless*), sequence of events (e.g., *after that*), or a cause and reason relationship (e.g., *because*). They constrain processing by indicating how to bring two different discourse items together considering the relationship between them (Halliday & Hasan, 1976). For instance, sentence (1) requires an explicit connective to decode the coherence links between the two events introduced in the main phrase and the embedded clause. Whether this connective is *because* or *however* makes a critical contribution to the meaning construction. When connected with *because* the latter event is taken as the cause or prerequisite of the former event. On the other hand, when the connector is *however* the latter event is considered to as an obstacle to the former event.

(1) I will book a flight *however/because* I need to apply for a visa.

The meaning that connectors entail in discourse and how they affect language processing have been discussed and examined widely in both written (Sanders & Noordman, 2000) and spoken (Köhne-Fuetterer et al., 2021) language processing in adults. For example, Traxler et al. (1997) provided evidence for incremental integration of connectors. In their eye-tracking experiment, participants read sentences connected with *because* and their reading times indicated an effect of condition (i.e., diagnostic or causal) before the end of the sentence.

This incremental integration of connectives can also facilitate discourse-level prediction during language processing. Integration of linguistic inputs like morphemes or semantic features incrementally leads the human parser to estimate the next content. (Altmann & Kamide, 1999; Kamide, Altmann, et al., 2003; Kamide, Scheepers, et al., 2003). The parser uses all available information to construct a representation before the end of the utterance. Since connectors also convey information about the relationship between sentences or clauses, they can trigger anticipations regarding the upcoming discourse (Köhne-Fuetterer et al., 2021). In other words, the connector enables the listener to reason about the meaning that arises throughout the discourse. For example, Köhne-Fuetterer et al. (2021) when participants hear sentence (2a) they expect to hear a noun that is congruent with the *sweet* category in the following sentence. Since the connector, *therefore,* facilitates this assumption. Nevertheless, when participants hear sentence (2) b. they shift their persisting assumptions about the sweet category and consider alternative options because connector *however* indicates that upcoming content is contrasting with default causal assumptions.

(2) a. Alice wanted to drink something sweet. *Therefore* …
b. Alice wanted to drink something sweet. *However,* …

As for the acquisition of connectives, the literature show that children are sensitive to the existence of coherence markers as early as the ages of 3 and 4 (Bernard et al., 2012). Furthermore, preschoolers are also able to use discourse relationships indicated by connectors to acquire new words. In Sullivan et al. (2019), children starting from age 2 interpreted the meaning of unfamiliar words based on the discourse relationship indicated by the connectors such as *because*.

Yet, we do not have much information about how children process connectives online. Previous studies showed that children use structural markers incrementally to predict the upcoming syntactic and semantic structure (Mani & Huettig, 2012; Özge et al., 2019) but no studies to date to my knowledge have investigated whether children used connectors to generate predictions regarding the upcoming content as soon as they hear them. The present study aims to fill this gap and investigate whether children integrate connectives incrementally during the course of real-time processing and also reason about the content of the upcoming discourse as adults do.

If children and adults have similar predictive processing mechanisms, one would expect this to be reflected at the discourse level as well. However, studies on the development of connectives indicate a production and comprehension asymmetry (Bernard et al., 2012). That is, production studies indicate that children start to use both causal and contrastive connectives properly around age 3 (Bloom et al., 1980); however, comprehension studies indicate that children disregard contrastive markers at ages 5 and 6. Therefore, there are reasons to believe that connective processing may differ between children and adults. First, discourse processing is highly dependent on keeping multiple pieces of the utterances that comprise the discourse in working memory, which is still maturing in children (Davidson et al., 2006). Second, it is based on reasoning about the relationships between these utterances. Therefore, the child must understand the concepts marked by the connective, such as temporality, causality, result, or contrast relations. The foundations of these concepts may be in place from a young age onward, but it may take much longer to use them effectively in the context of online communication. Third, as for the integration of concessive

connectives such as *however* one needs to discard their expectations about the causal continuity of the following discourse and consider opposite alternatives.
This requires fully developed executive function abilities, which continue to develop until adolescence (Davidson et al., 2006). Therefore, examining the underpinnings of processing discourse-level utterances in children is crucial as it would shed light on these multiple aspects of development.

1.2. Structure Under Investigation

In this study, we examine how causal and concessive connectors are integrated during the course of language processing. Causal connectives accept the truth value of the previous sentence and signal the causal continuance of preceding assumptions, as in (3a). Nevertheless, concessive connectors both concede the truth value of previous content and signal upcoming denial of expectations, as in (3b) (Bell, 2010). That is to say, to negate the existing predictions one needs to consider those predictions first. Upon encountering the cancellative signal (e.g., a concessive discourse marker) one needs to shift their existing predictions. Bell (2010) indicates that concessive discourse markers interfere in the reasoning process by shaping possible meanings through cancellation. Regarding these procedural implicatures of connectives, it could be said that causal connectives function as constraints that facilitate previous assumptions regarding causality. On the other hand, concessive connectives function as constraints that deny the expectations and signal that the upcoming content entails a contradiction. In this study, I use the connector *bu yüzden* (therefore) as causal and *ama (but)* as the concessive connector.

In this thesis, an experiment using the visual-world eye-tracking paradigm was designed. The aim was to test the processing of connectors during the course of spoken language interpretation. In the visual-world paradigm, participants listen to spoken utterances while looking at a visual scene. The gaze patterns of the participants are tracked so that which referent in the scene is looked at during which moment in the utterance can be examined. This allows us to understand whether a linguistic item under investigation is actually parsed into the interpretation incrementally (i.e., as soon

as they are heard) and whether it leads to a particular prediction about the upcoming linguistic structure (i.e., looks towards the target object before it is mentioned).

As mentioned above, the structure under investigation in this thesis is the causal (*bu yüzden/therefore*) and concessive (*ama/but*) connectors in Turkish. We aim to understand whether children (i) incrementally integrate causal and concessive connectives and generate expectations about the upcoming discourse, and (ii) they can use connective meaning to reason about the discourse relations. To do this, we used three-sentence discourses, where the first sentence introduced the character and his/her desire/intention, as in (3a). The second sentence presented the critical utterance with the connector that either complies with the desire of the character (i.e., *bu yüzden/therefore*) or contradicts with it (i.e., *ama/however*), as in (3b), and the third sentence presented a question asking the participants to detect what actually happened in the end, as in (3c)

(3) a. Ali AOI1[tatli] bir şey yemek istedi.
(Ali AOI1[sweet] something eat wanted.)
(Ali wanted to eat something sweet)
b. [Bu yüzden/Ama] şunu yedi.
([Therefore/However] (he) this ate.)
(Therefore/However he ate this.)
c. Sence Ali hangisini yedi?
(Which one do you think Ali ate?)

Each utterance was accompanied by a visual scene with two pictures that either complies with the desire of the participant (i.e., with the adjective introduced in the first utterance) (e.g., something sweet; chocolate) or contradicts with it (e.g., something not sweet; pepper). Participants were asked to carefully listen to the utterance while looking at the pictures and answer the comprehension question at the end. The gaze patterns of participants were tracked during the course of the utterance to check whether they show a sign of incremental and predictive processing. If they do so, they are expected to look at the picture that is in line with the desire of the character when they hear the causal/resultative connector (*bu yüzden/therefore*). On

the other hand, when participants hear the concessive connector (*ama/but*), they are expected to look more at the picture that is contradicting the desire of the character. In the subsequent chapter, the background of the research objectives presented in this chapter is discussed.

CHAPTER 2

THEORETICAL BACKGROUND

To discuss the changes in language processing mechanisms over the course of language development, this section initially presents language processing mechanisms in adults and children. In the first subsection, the studies that account for how a developed parser behaves (i.e., adult language processing studies) were presented. Following that the studies on child language processing are introduced. In the second subsection, the background for the definition of discourse, discourse connectives, causal and concessive connectives, and how they are processed and acquired is presented.

2.1. Human Language Processing

Language processing entails the integration of various linguistic and nonlinguistic cues in a rapid fashion. Linguistic cues are segmented in a hierarchy starting from the smallest information-bearing structures such as phonological and morphological items (bottom-up) up to relatively broader information sources such as pragmatic information or discourse structure (top-down). How and in which order the human parser integrates all this information is widely discussed. Experimental studies provided evidence for incremental integration of linguistic items (Altmann & Kamide, 1999; Van Gompel, 2013). For example, Altmann and Steedman (1988) proposed the immediate effects of context on parsing decisions. According to them, the parser generates the parallel (e.g., considering cues from all segments as phonologic cues and pragmatic inferences simultaneously) and continuously updated representations with regard to the discourse-based referential context. This incremental, and parallel processing also triggers expectations about the upcoming content (Altmann & Mirkovic, 2009).

In this thesis we will investigate the predictions triggered by the connectives, therefore, the following subsection introduces what is meant by prediction in human language processing and how it has been studied.

2.1.1. Prediction in Language Processing

Brain is exposed to countless stimuli from the environment. How people perceive the world is often explained that brain makes the best possible assumptions relying on the input and recognize the patterns to make better assumptions. Hohwy (2013) indicated that prediction can be regarded as an explanation of how humans perceive the world. Stawarczyk et al., (2019) stated that brain experiences the real world through senses, and besides this process, it builds event models to conceptualize the surrounding events. They explained event models as constructed representations of the surrounding events which include multimodal data regarding people, objects, event sequence, and consequences in a spatio-temporal structure (Stawarczyk et al., 2019). They also stated that regarding the limits of attention, this process is necessary to tackle complex tasks. It was also indicated that these constructed event models could enhance perception, processing, and learning predictively (Stawarczyk et al., 2019). In the same vein, in the course of language processing, brain tackles a series of tasks that demand analyzing various kinds of inputs such as morphologic, contextual, and pragmatic, in milliseconds.

Incremental integration of language proposes that in the course of language processing, people do not wait to gather all the information until the end of the utterance to build a linguistic representation. Instead, all the relevant information is built up as soon as each piece of information becomes available over the course of comprehension (Altmann & Mirkovic, 2009). That is to say, the human parser generates parallel and continuously updated representations based on the referential context, linguistic and para-linguistic information. As mentioned above this continuously updated representation constrains what may come next and alter the assumptions accordingly. Levy (2013) indicates that anticipation about the upcoming structures manipulates the parsing decisions.

The possible intended meaning and probable structures could be used by the parser before the input is available (Kutas, DeLong & Smith, 2011). Moreover, higher-level representations (e.g., pragmatic cues) can pre-activate lower-level representations (e.g., phonology) and vice versa (Kuperberg & Jaeger, 2016).

In order to understand how this process takes place in the course processing, online methods are employed such as ERP (Event Related Potential) and eye tracking. Studies using online methods tested the immediate effect (i.e., pre-activation of upcoming content). These studies have investigated the integration of various levels of information during comprehension, and the interaction of this information, for example, whether they constrain or facilitate each other.

To begin with, an eye-tracking experiment by Altmann and Kamide (1999) indicate that verb subcategories constrain the anticipations regarding the thematic roles in the context. In their study participants listened to sentences as in (4) while looking at a picture that has a boy, a toy, a cake, and a distractor (Altmann & Kamide, 1999).

(4) The boy *takes/eats* the …

The results indicated that participants' looks towards the objects changed in accordance with the verbs. When participants heard the verb *eat* they looked at the only edible object *cake* more than the other objects in the scene. On the other hand, when the participants heard the verb *take* there was no such difference because all the verb take does not convey such selectional information.

Syntactic and semantic constraints along with the surrounding visual or situational context interact flexibly during the course of sentence comprehension (Spivey & Huette, 2016). Three eye tracking studies (two in English, one in Japanese) observed that individuals considered the verb subcategorizations and also assigned the thematic roles regarding the objects and people in the scene as the sentence unfolded (Kamide et al., 2003).

(5) a. [The man] [will taste] [the beer]
b. [The girl] [will taste] [the sweets]

Participants listened to sentences as (5a) and (5b) as they saw a scene that has a girl, a man, beer, sweets, and distractors. Although *the beer* and *sweets* are both plausible themes for the verb *taste*, participants' looks to these objects changed regarding the agent. When participants heard *the girl* they looked at *the sweets* more than *the* beer.

Furthermore, the experiment in Japanese indicated that in head-final constructions, participants relied on semantic and morphosyntactic cues (e.g., they used accusative and dative cases to assign thematic roles) to generate expectations before they heard the verb (Kamide, Altmann, & Haywood., 2003). The results from online studies showed that human parser builds a representation of the stream of utterances by using each and every relevant information immediately to generate anticipations about the rest of the sentence or discourse.

To summarize, as experimental studies provided evidence, incremental integration of linguistic elements triggers anticipations regarding the upcoming content. Furthermore, prediction of the upcoming content is suggested to facilitate processing. It is indicated that anticipation is an element of natural speech perception and the parser is affected by its absence, in unpredictability or entropy (Hale, 2006). Kutas et al. (2011) further indicated that if the utterance is extremely unpredictable, it would be incomprehensible. Predictive language processing accounts can also explain how brain is able to integrate various inputs in the course of language processing (Bar, 2011; Richmond & Zacks, 2017).

2.2. Child Language Processing

Investigating how a developing parser processes language could help us to understand the underpinnings of human language mechanisms. Studies examining online language processing indicate that children integrate language incrementally as adults. Snedeker and Huang (2015) indicate that incremental integration of language is a basic

property of processing, so it is not a strategy attained with language competence. In this subsection, studies that investigate the looking patterns of children while they listen to sentences as a method to understand processing strategies are presented. Preferential looking and looking while listening methodologies are also used with younger children and infants. The underlying assumption in these methodologies is similar, that is, participants' gaze move towards what they are attending to at that time. These online methodologies investigated children's immediate reaction to the manipulated linguistic items such as phonological cues, morphosyntactic information, gender, case, and prosody (Özge et al., 2019; Snedeker & Trueswell, 2004; Snedeker & Yuan, 2008)

To begin with, in a preferential-looking task 2-year-olds were able to incrementally activate word form by relying on phonological cues. In Swingley et al. (1999) children looked at pictures as they listened to sentences. 2-year-olds were shown pictures of things whose names either overlapped (like "doggie" and "doll") or didn't overlap (like "doggie" and "tree"). On each trial, one picture was named in a sentence like (6)

(6) Look at the doggie!

Children looked at the target image when they heard the word "doggie" earlier when they saw a picture of a dog and a tree than when they saw a picture of a dog and a doll (Swingley et al., 1999) and this pattern was similar to that of adults.

In addition to phonological cues, children can also integrate verb information incrementally. In a looking while listening experiment, Fernald et al. (2008) tested whether 26-month-old children were sensitive to verbs' selectional information and generated anticipations about the referent object in the scene considering the verb as in Altmann and Kamide (1999) with sentences as in (7).

(7) drink/take the juice.

Results indicated that 26-month-olds used the verb information to generate expectations as they process language. When they heard the verb *drink* they started to look at the juice immediately after hearing the verb, however, for the verb *take* there was no such effect.
This showed evidence for children's ability to understand the verb subcategorizations and use them incrementally to construct a representation during the course of comprehension as adults do.

As well as the semantic meaning of verbs or nouns, children can also integrate morphosyntactic cues to understand the thematic roles. Özge et al. (2019) investigated whether Turkish children use case markers to anticipate the thematic roles. In two eye-tracking experiments with 4-year-olds in Turkish, they tested the eye gaze of children as they listened to sentences as in (8).

(8) a. Minik tavşan-ı birazdan yiy-ecek şurada-ki tilki-Ø.
little rabbit-ACC soon eat-Fut there-Rel fox-Nom
(The fox over there will soon eat the little rabbit.)
b. Minik tavşan-ı birazdan şurada-ki tilki-Ø yiy-ecek.
little rabbit-ACC soon there-Rel fox-Nom eat-Fut
(The fox over there will soon eat the little rabbit)

The eye-gaze of children indicated that in both verb-medial (8a) and verb-final conditions (8b) children integrated the case markers to generate anticipations about the patient and the agent of the event before they heard them, and even before hearing the verb in the verb-final condition (Özge et al., 2019).

Overall, studies investigating online processing above have shown evidence for incremental language processing in children starting from an early age. On the other hand, children also show different patterns of integration in the course of language development. For example, when they process sentences that need a revision of existing assumptions.

To begin with, the first eye-tracking study conducted with children conducted by Trueswell et al. (1999) examined whether children could also integrate linguistic cues and reassess their assumptions "on the fly" as adults do (Altmann & Kamide, 1999). Studies with adults showed that the parser makes flexible commitments to the representations being built and when something contradicts this representation, the parser reassesses the assumptions. That is, garden-path sentences that may lead to temporary ambiguity cause temporary ambiguity that leads the parser to reconsider the estimations. Lexical biases, word frequency, or the surrounding context may aid the parser in constraining the possible inferences and the parser infers the intended meaning directly (Trueswell et al., 1999). To test whether children can also recover from their initial interpretation they used an eye-tracking experiment with temporarily ambiguous sentences as in (9)

(9) Put the frog on the napkin in the box.

While listening to the sentence (9), participants saw a scene where there is a box, a frog, a napkin, and a frog on a napkin. In sentence (9), on the napkin is temporarily ambiguous. That is when the participants heard the frog on the napkin initial interpretation could be that they were asked to put the frog on the napkin in the scene. As the sentence unfolded, participants heard *in the box* as the destination, and *on the napkin* turned out to be the modifier for the frog. Referring to the fog on the napkin in the scene. The eye data indicated that children considered on the napkin as the destination early in processing indicating an incremental integration. However, they kept looking at *the napkin* and considered *the napkin* as the destination by incorrectly (in 60 % of the ambiguous trials) putting the frog on the napkin even though they heard the disambiguating *in the box* by the end of the sentence. Trueswell et al. (1999) stated that this may indicate that children at age 5 incrementally integrate language; however, they have difficulty in recovering from initial assumptions that have been falsified by the rest of the sentence. A more recent study investigated whether children could reconsider their assumptions in a head-final language. Choi and Trueswell tested 4 and 5-year-olds' (Mean age: 4:9) interpretations in temporarily ambiguous (i.e., garden-path) sentences in an eye-tracking experiment in Korean.

(10) naypkhin-**ey** kaykwuli-lul cipu-sey-yo (PP as a noun modifier)
napkin-on frog pick up
‘‘Pick up the frog on the napkin.”

(11) naypkhin-**ey** kaykwuli-lul nohu-sey-yo (PP as a verb argument)
napkin-on frog put
‘‘Put the frog on the napkin.”

The suffix *-ey* can be both a locative and genitive marker depending on the verb. The verb put needs a locative so, in (11) -er should be interpreted as a locative marker when the verb is heard (Choi & Trueswell, 2010). Considering the previous studies this interpretation, location is the default. On the other hand, the verb put needs an object to be picked up, so in (10) *-er* should be considered as a genitive marker (Choi & Trueswell, 2010). Since the verb is located at the end of the sentence, disambiguation is expected to take place by the end of the sentence. The results indicated that, unlike adults, children could not use the verb knowledge to disambiguate and override their initial interpretation. Choi and Trueswell (2010) indicate that previous research in English presented evidence for children’s reliance on verb information. In these studies, children built a representation relying on the verb and could not override it with upcoming disambiguating linguistic cues (Fernald et al., 2008). Regarding this it is indicated that children’s failure to use verb information is not specific to verbs, rather it is related to their developing cognitive control abilities (Choi & Trueswell, 2010).

In a similar vein, children also have difficulty recovering from their predictions triggered by phonetic cues. As the word is activated semantic representations of it are activated simultaneously. To shed light on whether children, age 5, cope with this informational cascade as adults do or if there is a developmental pattern Huang and Snedeker examined children’s looks in a word recognition task where the words are primed (Huang & Snedeker, 2011).

(12) Pick up the *logs*

For sentence (12) the target in the scene was *logs* and competitor was *key* and the phonological cohort was a *lock*. Results indicated that although children incrementally activated semantic information, they could not revise their first assumption, kept looking at the competitor image, and chose the incorrect option (Huang & Snedeker, 2011). This result is in line with previous studies indicating children have difficulty in ruling out the information that is proved to be irrelevant by the unfolding language (Choi & Trueswell, 2010; Trueswell et al., 1999).

To sum up, online experiments have shown that children, as adults, incrementally integrate relevant information to derive an interpretation. Nevertheless, they also show a developmental pattern. That is their looks to the target and accuracy scores increase with age. The tasks that children mostly perform poorly on are the tasks or sentences requiring revision on the fly. Regarding this, noticing the conflict between the existing interpretation and the conflicting input may be cognitively demanding for children. Possible reasons why there is such a developmental pattern in these kinds of tasks are discussed in the following section.

2.2.1. Children's Cognitive Development and Language Processing

In this subsection, cognitive control mechanisms that are most cited in language processing research are introduced. There are numerous types of them and other functions for different kinds of cognitive processes. However, for this thesis, this section only mentions the ones that might be related to connective processing. In this study, the concept of "domain-general abilities" is used interchangeably with executive functions and cognitive control abilities to refer to the processes such as working memory, inhibition, and task switching. These cognitive processes are defined as top-down control mechanisms. They are used when the automatic or default response is not desired, incongruent, or inappropriate (Diamond, 2013).

Working memory refers to the phenomenon that one keeps the information in mind and uses that information to build a representation, associate it with other concepts or use that information to solve the problems (Diamond, 2013). Inhibition is defined as overriding external distractors or predispositions to control the self to successfully manage a task (Diamond, 2013).

It is indicated that domain-general abilities have an effect on language acquisition and development (D'Souza et al., 2017). D'Souza et al. (2017) indicate that in the past when children cannot do something language-related, it used to be associated merely with children's language processing system. However, a recent approach, the neuroconstructivist perspective, suggests that language development is interwoven with context-dependent and progressive processes that are also related to non-linguistic learning (D'Souza et al., 2017). Accordingly, it is indicated that children who have problems with linguistic development are likely to have problems in domain-general abilities (e.g., learning disabilities in atypical populations).

In typically developing populations, the development of executive functions continues till adolescence. Davidson et al. (2006) indicated that children starting from this study could hold information and inhibit dominant response and could associate the information with others as long as the rules of the task did not change. However, when cognitive flexibility was tested with task switching or the rules were changed children could not perform very well and indeed, children at age 13 could not perform as young adults did in many executive function tasks (e.g., Simon Task, inhibitory control tasks). They further indicate that task switching is also considered a demanding task. Switching, in this context, means a person's ability to change the current mindset. It is deemed difficult because it requires both working memory to work on the existing mindset and inhibition to suppress it in order to consider the new mindset (Davidson et al., 2006).

Similarly, Novic et al. (2005) indicated that children's inability to reanalyze their initial assumptions could be related to their aforementioned developing executive function skills. Cognitive control mechanisms are associated with the prefrontal cortex (i.e., the left inferior frontal gyrus). Its development with age may lead to better

cognitive control and flexibility to handle more complex linguistic tasks that demand a wider working memory span or switching tasks. Snedeker and Huang (2015) provide additional evidence that conflict monitoring and cognitive control continue to develop in childhood. Bearing this in mind, children's developing language competence is not only aided by linguistic input (e.g., developing literacy). Moreover, developing domain-general skills improve the capacity of children to effectively comprehend and modify linguistic input.

2.2.2. The importance of prediction for language learning

Examining child language processing could shed light on understanding language acquisition because the input needed is provided in the representations generated during language processing (Snedeker & Huang, 2015). Children acquire language quickly and accurately mostly based on non-instructive input and without negative feedback. Rabagliati, Gambli, and Pickering (2015) indicated that as well as aiding fast comprehension, prediction could also be part of this rapid language learning. In other words, it is possible for children to predict the likely linguistic elements or behaviors of the speakers, and they are able to maintain or modify their predictions based on the feedback they get.

As also mentioned in previous sections prediction is considered a unifying factor of language processing and learning (Chang, Kidd, & Rowland, 2013; Dell & Chang, 2014). According to the predictive learning account, learning is an active process that takes place during processing in addition to offline learning (Zettersten, 2019). That is to say, language processing and learning along with external factors such as input quantity and quality, children also make use of internal strategies to learn languages (Gambi, Jindal, Sharpe, Pickering & Rabagliati, 2020).

Moreover, it is indicated that language processing is also an indicator of a child's current and future language skills (Gambi et.al., 2020; Fernald &Marchman, 2012). The way a child processes a language in the course of the interaction could affect the quality and the quantity of the information that the child learns from that input (Gambi

et.al., 2020; McCauly & Crhristiansen, 2019). As stated in the Child Language Processing section, during language processing children make estimations regarding the upcoming input. Based on this, Gambi et.al. (2020) indicate that prediction during processing, as an internal factor, may enhance language learning.

How may prediction affect language processing in order to facilitate the acquisition of new linguistic elements? Learners process language more effectively when their predictions are accurate. Activating future representations can merge the linguistic input into bigger representational units in the course of language processing (Reuter, 2020). This process may lower cognitive demands and enhance the speed and accuracy of understanding. Over the course of language development, accurate predictions allow children to integrate familiar words more quickly and effectively, freeing up working memory and attention resources for learning new words as they are encountered (Reuter, 2020).

Reuter (2020) further reported that both accurate and erroneous predictions can contribute to development's advancement. Similarly, the error-driven learning account also proposes that learning the meaning of words or grammatical functions takes place as a result of a child's constant prediction of the upcoming input (Fazekas et al., 2020). Children learn from their fulfilled or rejected predictions, namely, regarding the input followed by their predictions, in the course of language processing, children keep their predictions that are supported by the input, and revise their falsified predictions (Gambi et.al., 2020; Ramscar, Dye, & McCaurley, 2013; Chang, Dell, & Bock, 2006). Fazekas et al. (2020) tested the proposition of error-based theories of language acquisition that indicate higher surprisal in processing leads to better retention. By surprisal, it is indicated that encountering an unexpected linguistic structure during processing (Hale, 2001). It was stated that children remember, or better representation of syntactic input is observed in a less predictable context when compared with a predictable one (Fazekas et al., 2020). In summary, it could be indicated that regardless of the accuracy of the prediction, it appears that prediction during language processing can assist language acquisition.

2.3. Discourse Connectives

This subsection begins by defining discourse, connectors, and their respective functions. Following this, we discuss how adults process discourse connectives. The remainder of this section discusses the acquisition of connectives and discourse bootstrapping in language learning.

2.3.1. Discourse

There are various approaches to discourse. Some identify it as the language beyond sentence level (Stubbs 1983) or the real use of language (Fasold 1990). The context of where, to whom, and why something is said all contribute to the construction of its meaning in discourse. As natural human interaction also takes place within a context and comprises a unit of interrelated sentences, Sanders and Spooren (2007) indicate that understanding how discourse works is crucial for understanding human communication. In a similar vein, Greasser, Millis, and Zwaan (1997) state that discourse makes it possible for humans to convey feelings and ideas as they intend. They also indicate that discourse is more than a sequence of sentences and it constrains the interpretation process by providing a context that has been built upon the sentences uttered. Regarding this, it could be indicated that through discourse, people are able to build a common representation, and thanks to this representation, interaction becomes possible.

In the same vein, Halliday and Hasan (1976) indicate that a text, or discourse, whether written or spoken, is a semantic unit. That is, a text is not structurally integrated instead, it is realized as a meaning unit, unlike a sentence. The meaningful unity of a text is sustained by cohesion. Halliday and Hasan (1976) define cohesion as the meaning relationship between items of a text. It is also stated that the interpretation of one item is dependent on the other ones. Cohesion in a text can be grammatical (e.g., reference) or lexical (e.g., using the same words). It is indicated that conjunctions are somewhere in between: they are grammatical coherence markers but they also have lexical elements. They allow the reader to infer the meanings of other textual components based on their indirect connections to preceding or subsequent phrases. (Halliday & Hasan, 1976).

Discourse connectors are also used to sustain coherence as their conventionalized meanings function as indicators of certain relationships between sentences (Mauri & van der Auwera, 2012). There are different views on the definition and the name of connectives.

In this study, relying on previous studies, discourse marker, coherence marker, discourse connective, conjunction, and connective are used interchangeably to refer to the connectors such as *but, although, nevertheless, on the other hand,* and *therefore.*

Sanders and Spooren (2007) address the interconnection of discourse as a mental phenomenon consisting of mental representations and explicit signals in a text that influence the comprehender's mental representations. Considering coherence to be a mental phenomenon implies that constructing a coherent representation requires not only cues in conversation, but also the human information processing system. Sanders and Spooren (2007) present referential coherence, which is maintained by the signals that refer to the same entities throughout the discourse (e.g., lexical cues or pronouns), and relational coherence, which involves the way that causal or contrastive relationships are marked between entities. They highlight that relational coherence is concerned with the meaning connections between utterances as cause and effect, and they are not necessarily stated explicitly with a connective as in (13a) and (13b).

(13) a. I ate the whole cake. (because/since) I was so sad.

b. This article is very engaging and relevant. (as a result/therefore) We have added it to the reading list.

2.3.2. Meaning and Function of Discourse Connectives

Early studies describing discourse markers focused on their function in discourse. To illustrate Schiffrin (1987) states that coherence in discourse is built by the relatedness between sentences and discourse markers facilitate coherence by indexing previous or following utterances. Farser (1999) states that discourse markers impose a relationship between two different discourse segments.

Similarly, Sanders et al. (1992) consider connectors as linguistic markers that state the underlying cognitive representation of the discourse constructed.

Segment 1 ./, Discourse Marker + Segment 2

As for the meaning of the connectors, Redeker (1991) add that the core meaning of the connectors signals the semantic relationship between two sentences. Regarding these, the meaning of a connector is assigned by the relationship it encodes for utterances, that is by its procedural function of it in the discourse. Similarly, it is indicated that connectives have a core meaning that is procedural, rather than conceptual (Fraser, 1990; Urgelles-Col, 2010; Blakemore 2005). For example, discourse connectors such as *but* do not encode a concept as the word *smart*. That is to say, the intended message to be conveyed is not the meaning of the connector *but*. On the contrary, the message is the outcome of the inference governed and constrained by the connective (Urgelles-Col, 2010). On the other hand, the word *smart* encodes semantic properties that are intended to be conveyed as a message itself.

Discourse connectives vary regarding the semantic meaning they encode. Some connectives encode concepts whereas others signal procedural meaning (Urgelles-Col, 2010, Blakemore 2005). Blakemore (1992) states that this procedural meaning of connectives is related to the relationship it proposes for the sentences.
Moreover, Blakemore (1992) classifies connectives as conventional implicatures. Implicature is conveying meaning by uttering something else (Grice, 1975). How this implied meaning can be understood by discussing the two kinds of implicatures: conversational and conventional. According to Grice (1975) decoding what conversational implicatures mean depends on the conversation or the context. To illustrate:

(14) What are you doing tonight?

What sentence (14) could mean depends on the context. That is to say, the speaker may say sentence (14) out of curiosity, suggest something to do, to ask for a favor. On

the other hand, conventional implicatures such as *but*, *know*, and *regret* have a core meaning that leads the inferences to a certain way regardless of the context.

(15) He is a journalist but he lies.

In sentence (15) the connector *but* conveys a contrast, that is, it triggers the implicature that being a journalist and lying contrast each other.
The listener or reader may infer that normally journalists are not expected to lie. To linguistically analyze the meanings of connectives, Blakemore (1992) proposes four ways that connectives constrain the interpretation or lead to conventional implicatures:

1. They may lead to implication derivation (e.g., so, therefore).
2. They may signal that upcoming sentences will provide further evidence for existing supposition (e.g., moreover)
3. They may signal that the following content will contradict existing assumptions (e.g., however, but)
4. They may indicate the role of that specific sentence in the discourse (e.g., finally)

2.3.3. Causal and Concessive Connectors

Understanding the causal relationships in everyday life is crucial to making sense of the workings of the world and making predictions and decisions. Starting from a young age children get acquainted with volitional causation where an animate object intentionally causes something to happen in addition to inanimate object causation as heat and ice cream melt (Boyer, 1996). In daily life how do people decide that two or more events that occur together are causally related or they just have a temporal order? According to Hume (1739), Mackie (1974) indicates that there are three factors to lead us to consider a sequence of events as causally related.

1. The events should happen in succession.
2. They should have contiguity
3. There should be a connection

Causal and concessive connectors mark the causal relationship between utterances explicitly. Presence of a causal connector signals that adjacent sentences are causally related. Such as the connective *because* indicates that the following sentence is the reason (16), or *therefore* indicates that the following entity is the result of the previous utterance (17). Connectives indicating the result are also named "resultative"; however, as previous research on discourse processing (e.g., Köhne-Fuetterer et al. 2021) refer to connectors such as *because*, *as, therefore,* and *so* as causal connectors, we also refer to them as causal in this thesis.

(16) [Mark was so tired] *because* [he played tennis for 5 hours.] reason
(17) [Mark was so tired] *so,* [he took a nap] result

Concessive connectors are also known as negative causals, which means that the internal negation of a causal connector is equivalent to its exterior negation (König & Siemund, 2000). Janssens and Shaeken (2013) present how concessives function in discourse. They state that in a *p* but *q* condition, *p* is acknowledged, whereas, the presence of *but* (as a concessive connector) cancels the inference that normally follows *p*. Cancelling or denying in this context should not be interpreted as deleting all the previous assumptions. Instead, it should be viewed as offering a new interpretation that could only be reached by taking into account the earlier ones as well (Hall, 2007). Considering this, it could be said that *p* triggers a causal interpretation, which is *r*. That is, the "*p* so *q"* statement signals the presence of the estimated causal conclusion, *r*. For example, when a person is sleepy, *p*, a default expectation will be about this person going to sleep or taking a nap, *r*. However, in "*p* but *q*" statements, *r* is canceled. There are two ways that explain how this cancellation occurs. First, there exists a contradiction between *p* and *q* (direct concession). To illustrate:

p(p(p -> r), but q(q = not-r) (so not-r))
I am hungry (-> I will eat) but I won't eat.

Second, when comparing *p* and *q*, *q* proposes a stronger claim so *p* is eliminated (i.e., indirect concession). For example;

p(p(p -> r), but q(q -> not-r) (so not-r))
I am hungry (-> I will eat) but the food is spoiled.
(Janssens \& Shaeken, 2013; Van Belle, 2003)

In this thesis, the focus is on the former where the two arguments, *p* and *q* are contradicting. Considering what causal and concessive connector signal in discourse, their presence triggers presuppositions (Lagerwerf, 1998). It is indicated that this presupposition may lead to assumptions regarding the upcoming entities. To illustrate, upon seeing sentence (18) one might have the assumption that when Ali is bored, he tends to watch movies. Considering this presupposition, the parser could generate expectations about watching a film as a consequence of getting bored.

(18) Ali is bored and he wants to see a movie.

(19) Ali is bored and he wants to see a movie. *However,* he decides to

Seeing the concessive connector *however* in (19), which indicates a future discontinuity in the discourse, the parser needs to reconsider the prediction and generate contrasting predictions accordingly. Thus, predictions about movies should be discarded. On the other hand, seeing *therefore*, which indicates continuity, in the sentence (20) below enhances the predictions regarding seeing a movie.

(20) Ali is bored and he wants to see a movie. Therefore, he decides to …

The connector *therefore* indicates that upcoming content will be in line with the initial predictions and the expected result will be encountered. This is referred to as enhancing the semantic expectations. Nevertheless, seeing *however*, signaling a future discontinuity, is called reversing semantic expectations (Xiang & Kuperberg, 2014). Both connectors indicate that the subsequent content will present the consequence of

the preceding phrase. The functional distinction between them is that causal connective strengthens expectations while concessive connective denies them. In later parts, we will discuss how these meanings of causal and concessive connectors manifest themselves in processing.

2.3.4 *bu yüzden* and *ama* Connectors in Turkish

Connector *bu yüzden* is the translation of *therefore* or *so* in English. It signals the causal relationship between sentences. Kurtul (2012) discusses *bu yüzden* as a connector that signal the causal relationship between discourse entities. The connector *bu yüzden* introduces the result of the reason in the preceding utterances as in (21) similar to *so, therefore,* and *thus* in English. Kurtul (2012) further indicates that the reason clause conveys a statement and the result clause conveys the fulfillment of the statement.

[REASON] bu yüzden + [RESULT]

(21) Tatil için sakin yerleri seviyorum bu yüzden yazın Selimiye'ye gideceğiz.
[Tatil için sakin yerleri seviyorum]REASON + bu yüzden + [yazın Selimiye'ye gideceğiz]RESULT
[I like quiet places for holiday]REASON + bu yüzden + [we will go to Selimiye this summer]RESULT

Moreover, the result happens after the reason (Kurtul, 2012). It could be indicated that two sentences connected with *bu yüzden* have an inherent temporal order. Sentences connected with temporal connectors as *then, after that, as the result* initially present the first event then the second event follows. This is also true for causals and concessives.

Connector *ama* is the translation of *however, but, nevertheless* in English. It is borrowed from Arabic and is mostly used to convey the meaning discrepancy between phrases, clauses, or sentences in Turkish (Doğan, 1994; Özbek, 1998). *Ama* is used as a coordinating conjunction, merging two or more same-category syntactic items (e.g.,

ucuz *ama* kalitesiz), and as a connective, stating the relationship between sentences in discourse (Zeyrek & Web, 2008). Doğan (1994) discusses pragmatic meanings of *ama* similar to the distinction drawn by Zeyrek and Webber (2008). Initially, the denial of expectation function is introduced.

Connectors that signal a denial of expectations are identified as concessive connectors (Robaldo et al., 2010). In this function, *ama* is used as a linguistic cue that triggers a change in the assumptions as in (18).

(22) a. Seni seviyorum.
(I love you.)
b. Beni seviyorsa benimle evlenmek isteyecektir.
(If she loves me, she wants to marry me.)
c. Benimle evlenmek istiyor.
(She wants to marry me.)

Sentence (22a) triggers expectations in (22b) and (22c). However, in (23) causal expectations b and c are negated by a contrasting sentence (seninle evlenemem (I can't marry you)) and this contrasting sentence is signaled by the connector *ama*.

(23) A: Benimle evlenir misin?
(Will you marry me?)
B: Seni seviyorum *ama* seninle evlenemem.
(I love you *but* I can't marry you.)

Regarding this function, Doğan (1994) indicates that denial of the expectation may lead to assumptions regarding the previous sentence. In (24) although the listener does not know about the habits of singers, they may assume that being active in social media is a common thing for a singer because this assumption is negated with *ama*.

(24) Başarılı bir şarkıcı *ama* sosyal medyada pek aktif değil.
(She is a very successful singer *but* she is not so active on social media.)

Doğan (1994) continues with the contrast function of *ama*. Similar to the connector *but* mentioned in previous sections, *ama* is also used to contrast two phrases or words. In (25), two contrasting personality types are connected with *ama*.

(25) Erkek kardeşim çok çalışkandır ama kuzenim çok tembel.
(My brother is very hardworking but my cousin is very lazy.)

Doğan (1994) formulates this relation as being hardworking is *X*:

[(my brother)] *X* AMA (BUT) [(my cousin) *X* NOT]

As for the denial meaning of *ama,* Ercan (2019) discusses *it* as a disclaimer in everyday language. Speakers use disclaimers to convey the information that the following utterances will not be in line with the expectations of the listener (26) (Ercan, 2019). They can be used to save face, convey tentativeness or prevent misunderstanding and used to smoothly convey opposition rather than directly opposing. It is also indicated this meaning of *ama* is also in line with its counter-expectation use of it. That is, with the presence of *ama* the expectations generated regarding the sentence before *ama* are declined.

(26) Çok yorucu bir iş ama yeterince vakit ayrılırsa kolaylıkla yapılabilir.
(It is a very tiring thing to do but if enough time is allocated it can easily be done.)

This thesis analyzes the processing of *bu yüzden* as a causal link signaling the outcome of the preceding sentence. As for the concessive connector that negates the default causal consequence *ama* is analyzed. We will aim to test whether children and adults can interpret these coherence markers as soon as they hear them in the utterance and create anticipations about the rest of the discourse.

2.4. Discourse Level Language Processing

During discourse processing, it is indicated that people build mental models of the events mentioned. These models are also updated, and estimations are generated about what might come next. (Grüter, Takeda, Rohde, & Schafer, 2018; Johnson-Laird, 1983; Van Dijk & Kintsch, 1983). Kaiser (2016) suggests that discourse parsing is not a compartmentalized or secondary processing that follows the integration of smaller linguistics units initially. Rather, discourse-level parsing comprises the processing of both higher and lower-level units incrementally and synchronously. The effects of immediate integration of all relevant cues in discourse processing were studied vastly. People simultaneously consider the relevant context and the linguistic cues immediately to build the best possible representation of the discourse during processing.

People use various levels of cues to understand the discourse. For example, Van Berkum et al. (2005) state that humans can exploit discourse cues (i.e., gender-marked adjectives) to generate expectations about upcoming words in the course of sentence processing. In their study when participants heard a word that was inconsistent with the predicted gender marking of the preceding adjective, a differential ERP effect was observed. This effect disappeared in the absence of discourse control (Van Berkum et al., 2005).

Apart from these, for a coherent representation of the discourse parser needs to know when and how to integrate new information. To do that, the parser must understand the connections among the sentences; whether they encode cause and effect, contradiction, or a temporal sequence (Kaiser, 2016). Since discourse connectives convey information about the relationships between sentences, people may use this information to build a coherent representation during processing. The following subsections will present the research on how connectives are integrated and acquired, and also their role in building a discourse representation in language learning.

2.4.1. Connective Processing in Adults

As mentioned in earlier sections, people process language incrementally. Furthermore, as a byproduct of incremental integration the parser generates expectations about what will follow (Altmann & Mirkovic, 2009). This strategy is also evident in beyond sentence level (Rohde & Horton, 2014). This section presents the experimental studies that investigate how connectives are integrated during processing.

To begin with, Townsend (1983) proposes that connective meaning interferes in the integration process. Experimental studies suggest that the presence of connectors facilitates processing and comprehension. One of the earliest studies reported that readers spent less time when the second sentence started with a connective than when the same sentence did not (Haberlandt,1982). Another reading study also provided experimental evidence for the presence of a connective leading the parser to make inferences relying on the semantic meaning of the connector (Millis et al., 1995). That is to say, the causal connective *because* is not simply integrated as a connective that proposes a sequence of events as *and* and *after*. These results are in line with a paradox of causal complexity (Sanders, 2005). That is irrespective of the complexity of causal relationships, they are processed faster than structures that are not causally connected. The complexity in this context refers to the complexity of constructed relationships, for example, addition is less complex than causality.

To account for when connectives are integrated during processing Reactivation Hypothesis was proposed (Millis & Just, 1994). According to this account, connectors such as *because*, stimulate the activation of the previously parsed sentence. The Reactivation Hypothesis predicts better comprehension and longer wrap-up times at the end of the sentence for conditions with connective (Millis & Just, 1994). In a study, reading times were measured and participants were tested for their recall of a word they saw in sentence sets with and without a connective Millis and Just, 1994). The results were compatible with the Reactivation Hypothesis and earlier studies that indicated evidence for the comprehension facilitation effect of connectives (i.e., causal connectives) (Haberlandt, 1982). These results provided evidence for Connective Integration Model (Millis &Just, 1994). According to this model, the parser needs to

integrate the two clauses and come up with a common representation when the sentences are connected with a marker. Otherwise, the parser may or may not create a meaningful representation of these sentences. A discourse connector's function is to trigger the reactivation of a previously parsed sentence in order to integrate it with the one that is being parsed.

This model indicates that how the parser combines and creates a common representation for two sentences combined by a connective is summarized by Millis and Just (1994) considering *p* and *q* as separate sentences:

p + connector + q

The reader initially processes *p* and the connector. As the processing of the second sentence starts, the parser reactivates *p*. Regarding the semantic meaning of the connector, *p* and *q* clauses are integrated and a common representation of both clauses is structured. In other words, integration of the two clauses occurs during or immediately after the processing of *q*. The reason why Millis and Just (1994) indicated the integration does not occur immediately after the connective is that they observed an increase in the sentence wrap-up times in the presence of a connective not when the word after the connective is parsed. Nevertheless, they reported that there was not such a wrap-up time increase when the sentences were not connected with a connector. On the other hand, in the discussion part, they stated that this increase in wrap-up times could be due to different sentence lengths. They also tested the connective *although* to examine whether the negative meaning bearing connective is also reactivated as a positive one (i.e., *because*). The reason why is that MacDonald and Just (1989) stated that negative constructions lead to a decrease in the activation, which is the opposite of what a connective does: reactivate. Thus, Millis and Just (1994) examined whether the negative effect of negation would influence the facilitation caused by the existence of a connective. However, they observed the facilitation effect in connective conditions and they presented evidence for the facilitative effect of connectives irrespective of their polarity. For the memory task, they reported evidence for the facilitative effect of connectives in the construction of the discourse representation.

However, considering the incremental and predictive nature of language processing reactivation hypothesis should be examined carefully. Setting a currently processed sentence aside and reactivating it later contradicts this account. Another study tested the reading of sentences connected with *because* in an eye-tracking experiment (Cozijn, 2000).

Similar to the results of Millis and Just (1994), the reading times were shorter and comprehension scores were better in sentences with connective but also a slow-down by the end of the sentence was observed (Cozijn, 2000). Millis and Just (1994) explained this as an integration cost, however, Cozijn (2000) stated that this might be the cost of causal reasoning explicitly instructed by the connector.

On the other hand, there is also evidence for incremental integration of connectors. In this perspective, there is no need to reactivate previous entities. In an eye tracking study participants' eyes were recorded in a reading task (Traxler, Bybee, and Pickering, 1997). They tested diagnostic (27b) and causal (27a) sentences connected with *because*. In causal sentences the second clause presents the cause for the event stated in the former clause; however, in diagnostic clauses, the second clause presents evidence for the statement in the first clause (Traxler et al., 1997). Diagnostic sentences are reportedly more difficult to process than causal ones.

(27) a. [Sam developed strong leg muscles] **clause1** *because* [he rode his bike to work every day.]**clause 2**

b. [Sam didn't have a car] **clause 1** *because* [he rode his bike to work every day.] **clause 2**

The results indicated that participants experienced a disruption (i.e., an increase in the reading times) by the middle of the second clause in diagnostic sentences. This result presents evidence for the combined semantic representations of causally related two sentences are incrementally constructed and not delayed (Traxler et al., 1997). Furthermore, as people integrate connectives incrementally, they also use surrounding lexical cues as well. Schwab and Liu (2020) examined discourse level prediction in terms of the interaction of lexical and contextual cues accompanied by concessive

discourse markers. They tested German *zwar…aben* and English *true/sure…but* as in (28). They used a self-paced reading experiment whereby after participants read the statements with (28) or without (29) a lexical cue, then they rated the naturalness of the sentence sets. In (28) lexical cue is *outdoor*.

This cue contradicts running on a treadmill. In this context both semantic contrast and *true* connective signals an upcoming concessive marker, i.e., *but*. It is indicated that participants could use both types of cues together and when concessive meaning is enhanced with lexical cues, it can facilitate comprehension (Schwab & Liu, 2020)

(28) James likes to run **outdoors**. *True,* he has a treadmill in the living room, *but* he often jogs in parks.

(29) James likes to run. *True*, he has a treadmill in the living room, *but* he often jogs in the park.'

Immediate integration account garnered further evidential support with a more precise examination of parsing strategies by visual world paradigm and brain imaging studies. To begin with, Mak et al. (2013) reported evidence for how the procedural meaning intervenes in the connective integration. An eye-tracking experiment was conducted to understand whether the connectors are used to make decisions during discourse level processing, Mak et al. (2013) analyzed whether the semantic meaning of the connectors triggers expectations regarding discourse references. The participants' eyes were recorded as they read Russian and Dutch counterparts of connectives *and* and *but*. Dutch connectives *maar* and *en* are relatively flexible in terms of the following referent choices. That is, in the second sentence there could be a maintenance or shift of reference. On the contrary, Russian counterparts *i* and *a* are more constraining about the upcoming referent item. *i* calls for a continuation but *a* signals a shift of references. They found out that people incrementally employed the semantic meaning of the connectors as processing guides and generated estimations in accordance with connectors. In the relatively more constraining condition, in Russian, they observed a difference between the connector's integration. However, in Dutch, due to the semantic flexibility, there was no difference between connectors.

In the same vein, further evidence supports many other connectives trigger discourse level anticipations. Scholman, Rohde, and Demberg (2017) investigated the effect of the connective *on the one hand*.

Presence of this connective triggers the assumption that the following discourse will present a contrasting entity and expect the connective "on the other hand". In the same way, the connector *even so* denies existing predictions and signals that the upcoming discourse will entail something contrasting with the previous discourse. Xiang and Kuperberg (2014) state that connectives as *therefore* enhance the expectations, however, *even so*, denies the expectations. In their study participants read sentences connected with (30) or without (31) *even so*. The sentences without *even so* would lead to a semantic anomaly because they present two clauses contrasting each other and there is no connective to signal that.

On the other hand, in the other sentences, since the upcoming denial is signaled by *even so*, participants would not experience any processing difficulty. The results were in line with the predictions and participants used the meaning of *even so* to reverse their expectations.

(30) Alice had a paper due the next morning. She decided to go to the party.

(31) Alice had a paper due the next morning. *Even so*, she decided to go to the party.

The aforementioned studies indicated that adults integrate both causal and concessive connectors incrementally. Nevertheless, the previous sections presented the functional difference between causal and concessive connectors. They both explicitly mark the causal relationship between two entities. Causal connectives signal causal continuity, whereas, concessives signal denial of expectations. Does this difference manifest itself during online processing? In the remainder of this subsection, we present the visual world eye-tracking study that this thesis is mostly based on. This study is in a recent paper by Köhne- Fuetterer et al. (2021) (the same eye tracking studies in Köhne & Demberg, 2013) present three online experiments (two eye tracking, one EEG) to investigate the processing of causal and concessive connectives in German and Dutch. Regarding the approach that indicates the concessives are negative causals, they might be integrated with a delay and may incur processing difficulties compared to their

causal counterparts. In a visual world experiment, they examined causal and concessive discourse connectors with a scene and objects belonging to different categories. In the scene, there were five objects: one distractor, two different categories (e.g., sweet, salty), and two different pre-target gender markers for the categorical objects. The first two sentences (32) present the context and present the category to which two of the objects in the scene belong (e.g., category [sweet], objects in the scene [ice-cream], [chocolate], other objects belong to the other category [salty], objects in the scene [cheese], [burger]). The final sentence (33) begins with a causal or a concessive connector that is followed by the gender-marked pre-target word and the target word that is always congruent with the scene presented.

(32) Marc fancies a [snack. He feels like having something] topic [sweet]category.

(33) [Therefore / Nevertheless, he gets] connector [from the kitchen] extended [the[fem]/[masc]delicious[fem]/[masc]] pretarget [waffle / cake / pretzel / cheese] target.

(Köhne- Fuetterer et al.,2021; Köhne & Demberg, 2013., p.2761)

It is predicted that the category would direct the attention to the two items in the scene (e.g., the adjective *sweet* would indicate that ice-cream or chocolate could be mentioned in the following utterances because they are semantically associated with the adjective *sweet* rather than cheese or burger that are contrasting with it). When the discourse connective is being processed, the participants are expected to keep looking at the two objects that belong to the category that has been mentioned, however, for concessives, it is predicted that participants would shift their looks to the objects that belong to the other category.

The results also supported the predictions. Both connective types were integrated immediately during online parsing. Furthermore, for causal connectors processing was smoothly increased and the discourse marker is effectively used to predict the target word. In concessive conditions, participants looked at the target before it was heard but with a delay. This delay is reportedly related to the recovery process. That is

because they heard the adjective the participants were looking at the competitors and they had to shift their assumptions after hearing the connector. That was not the case for the causal connector conditions as participants were already looking at the targets. Nevertheless, comprehension results indicate lower scores for concessive cases compared to causal ones. In causal cases, the results may also be attributable to the already focused attention on the target words. During an online reading experiment, participants' eyes were recorded to determine whether the results could be replicated. Overall, results indicate that even though the accuracy scores were lower in the concessive condition, in both causal and concessive conditions, participants were able to integrate connectives incrementally and make predictions.

In this thesis, we aim to examine whether children can process both connectives incrementally. The following subsections introduce how and when these connectives are acquired and how children use (or fail to use) their assumptions based on connectives to understand discourse relations.

2.4.2. Acquisition and Processing of Connectives

Children are exposed to extended discourse and engage in dialogues in early childhood (Herould & Akhtar, 2008). Reaching adult-like competence calls for the ability to understand the pragmatic rules indicating how information is encoded between sentences to build a coherent representation of the discourse (Hickmann et al., 1995). Understanding the connectives is important for children to make sense of the discourse-level relationships.

As for the acquisition of connectives, studies investigating children's language production indicate that children merge simple sentences in order to build complex sentences around the ages of 2 to 3 (Bloom et al., 1980; Lieven, 2009). These complex sentences comprise syntactic structures and connectives, content (semantic relations among discourse items), and use (cohesion) (Bloom et al., 1980). In that, comprehending or uttering a complex sentence would call for the awareness of the semantic relations between different parts of the discourse and how to combine them

coherently by using syntactic markers. The child speech data proposed a sequence of acquisition where negative meaning-bearing connectives (e.g., adversatives) are acquired the latest (34) (and (35) for the detailed version). It is argued that cumulative complexity explains this developmental sequence regarding the differences between semantic complexities of the connectives. That is, temporal and causal connectives also entail addition as they combine two events or states and there is a temporal sequence in both of them.

The complexity order can be indicated from the most complex to the least complex as:

(34) additive < temporal < causal < adversative

(35) negative causal [+ negative, + causal] > positive causal [α negative, + causal] = negative additive [+ negative, α causal] > positive additive [α negative, α causal] (Evers-Vermeul & Sanders, 2011)

Regarding the difference between causal and adversative connectives Bloom et al. (1980) stated that causal sentences were both additive and temporal; however, some adversative ones are additive, and temporal and quasi-causal. From the cumulative complexity perspective, discourse connectors' complexity increases as they have more relations to encode (e.g., some adversative connectors both have additive and temporal relations therefore, they are more complex than additive connectors). Children reportedly acquire these connectives in line with this cumulative complexity order. That is to say, children initially learn a given connection (e.g., addition) later begin to produce coherence relations that can be described in terms of that relation plus something else (e.g., additive + temporal = causal). That complexity order is also in line with the conceptual development of children, in that children acquire the meaning of a collection of things and then learn the temporal sequence or the causal relationship of these collected things (Bloom et al., 1980).

A more recent study examined whether this order in (34) or (35) is followed cross-linguistically in a strict order. They investigated the acquisition of connectives in children ages between 1 and 5 in Dutch and English (Evers-Vermeul & Sanders, 2009).

They examined the corpus and considered the following criteria to mark the emergence of a connective:

1- Correct use of the connective
2- It combined two clauses
3- It was used in a productive way

The results indicated that children varied in the route, however, overall order followed the route proposed by cumulative complexity. Simply put, comparatively more complicated connectives appeared after less complex ones in child speech (Evers-Vermeul & Sanders, 2009).

As for the comprehension and processing of the connectives, experimental studies have yielded results compatible with the cumulative complexity account. For example, due to their more complex nature compared to causal connectives, concessives are acquired in later stages when compared to causals. For example, in Dragon et al. (2015), 2nd and 3rd graders decided whether sentences connected with concessive and causal connectors made sense. The experiment was in German. Experimenters manipulated the coherence as well. The conditions were: causal coherent, causal incoherent, concessive coherent, and concessive incoherent. Children accepted incoherent concessives as true but rejected coherent concessives. It is hypothesized that primary school students disregarded the concessive connector. On the other hand, authors also reported that children may have overlooked both types of connectors and considered the semantic consistency between the sentences. Similarly, Knoepke et al. (2017) examined causal and concessive connector processing in primary school children from 1st to 4th graders in German. They used visual and auditory semantic verification tasks. In these tasks, a situation was presented then a picture appeared accompanying the verification question. The question was about whether the picture depicted the situation or not. In the first task, participants read and in the second task, they listened to the sentences. Similar to Dragon et al. (2015) there were causal coherent, causal incoherent (36a), concessive coherent (36b), and concessive incoherent conditions.

(36) a. Ronald overslept. Therefore, he arrived on time.

b. Sandra was not tired. Nevertheless, she went to bed.

The results indicated that children performed worse in concessive conditions when compared with causal conditions. The authors stated that children's comprehension of concessives continues to develop during primary school.

Similarly, Spenader (2018) tested children from ages 7 to 10 with a pronoun identification task. The sentences were connected with *want* (because) (37a) and maar (but) (37b) in Dutch.

(37) a. Ernie asked Big Bird for money *because he* had enough money. (he=Big Bird)

b. Ernie asked Big Bird for money *but he* had enough money. (he=Ernie)

In both *because* and *but* conditions the correct answers were above chance level. It was at chance level in *but* condition only in the youngest age group, age 7. As for the difference between positive and negative connectors, similar to previous studies, children scored better in *because* condition. The accuracy scores increased with age. Nevertheless, even the oldest child group, age 10, could not perform in an adult-like manner. This is in line with the late development of connectives, even continuing after age 10.

Contrary to these results, in Turkish Oğuz and Özge (2020) provided evidence for a better performance in negative connectors. 3rd and 5th graders chose the appropriate connective in a written task. Both groups performed better in contrastive (contrastive use of *ama* (but) in Turkish) connectors than temporal and causal. The authors indicated that this might be due to the high-constraining nature of this connective type as Murray (1994) indicated. The difference can also stem from methodological issues, that is multiple-choice test used in this study might have triggered a comparative type of reasoning.

In summary, the cumulative complexity account proposes that connectives have an inherent complexity. This complexity accounts for the order of acquisition and development of connectives. Considering the cumulative complexity hypothesis, concessive connectives should be more complex than causal connectives because the former entails both a causal relationship and negation. Most of the aforementioned experimental studies presented evidence for the late acquisition of concessive connectives. Cumulative complexity account is also in line with connective processing where adults perform worse in concessive conditions even though they integrate these connectives incrementally as they integrate causal ones. This subsection indicated that children starting from age 2 are sensitive to the meaning of connectives and this development continues in primary school (Cain & Nash, 2011). The following subsection presents how the discourse information and connectives are used by children in language acquisition.

2.4.2.1. Discourse Bootstrapping

Bohn et al (2021) indicate that between the ages 2 to 5 there is a substantial development in children's common ground conception via which they can infer ambiguous pronouns relying on discourse comprehension. Children's reliance on this mutually held representation of conversation could shed light on how children infer implied referents in the discourse over the course of their language development (Bohn et al., 2021). Bohn et al. (2021) present evidence for children's development of knowledge of common ground in discourse-level language. In this subsection, we introduce the Discourse Bootstrapping account that proposes that children can use discourse constraints to infer the meaning of unknown words.

Children learn words during interaction by relying on linguistic (e.g., syntactic cues) and paralinguistic cues (e.g., gestures). However, in some cases, the possible meaning of the novel word is not constrained by the surrounding syntax or gestures. In these cases, it is possible to deduce the meaning of an unfamiliar word relying on the discourse relationships. Evidence suggests that children, as young as 2 years of age, make use of the discourse relations to learn new words, which is also referred to as discourse bootstrapping (Sullivan & Barner, 2015; Sullivan, Boucher, Kiefer,

Williams, and Barner, 2019). Sullivan and Barner (2015) examined whether children, 2 to 4-year-olds, can use discourse cues to infer an ambiguous referent to a novel word.

The experimental task required the children to infer the meaning of the novel word by considering the relationship between the sentences, in other words, the probable meaning for the novel word is constrained by the discourse relations as in (38) and (39).

(38) a. I am thirsty! Look, there is a *blick* on the table.
b. Can you show me the *blick*?
(39) Okay, we know what a *blick* is. But can you point to the *drong*?

When children heard the sentences (38a) and (38b) they saw a scene that has 3 items. In sentence (38) the scene had a banana, a can of a beverage, and a dog. Therefore, children were expected to choose the beverage in (38b) since they hear *thirsty* in (38a). However, the scene changed when they heard (39). This time participants saw two pictures: only the beverage and banana. Considering they had assigned the work *blick* to the beverage, they were expected to choose banana when *drong* was asked. In other words, children were supposed to use mutual exclusivity relying on the previous discourse to infer the meaning in (39). In the second experiment, they modified the experimental sentences by including a connector as a constraint as in (40b).

(40) a. I am very hungry, *but* cold things hurt my teeth.
b. Look what I want! There is a *gazz* on the table.

The results indicated that children as young as 2 could constrain their assumptions considering the discourse information when they infer unknown meaning. Supporting that, Sullivan et al. (2019) presented further evidence for discourse bootstrapping. They tested 2 to 6-year-old children with a similar task as in (41). In *and* condition children were expected to infer a result of the action, whereas, in *because* condition, the explanation is provided for the first action.

(41) One animal gave the book to the other animal *and/because* the Bambo finished reading the book.

Learning new words based on the discourse elements shows a developmental pattern that is explained by the authors as developing world knowledge of the children. The results of the two experiments indicate that children starting from age 4 capitalize on surrounding linguistic discourse items to learn new words.

Similarly, Rabagliati et al. (2018) tested whether children can learn novel words by relying on the connector as in (42). Children were asked to choose between two pictures that represent contrasting choices.

(42) a. Katy was cold, *so* she wore a *dax.*

b. Katy was cold, *but* she wore a *dax.*

For the sentences in (42) children saw two pictures of an animal. In one of them, it was wearing thick clothes, whereas, in the other, it was wearing a swimsuit. Therefore, when participants heard (43a) they were expected to choose thick clothes as the *dax*. However, when they heard (42b) were to choose swimsuit as the *dax* relying on the meaning of *but*. They observed a U–shaped developmental pattern in concessive condition (but) which indicates a decline in the accuracy scores at ages 4 and 5 and an increase at age 7. They become adult-like at age 8. There was not such a pattern in the causal connective (so) condition. Rabagliati et al. (2018) state that this could be regarded as a disadvantage of prediction in world learning because when the parser sticks to their initial prediction, the following discrepancy that demands a prediction shift could be cognitively costly due to children's limited executive function abilities. This result contradicts Sullivan and Barner (2015). However, it is compatible with comprehension tasks that indicate a worse performance in negative connective conditions. To investigate whether children were unable to understand the meaning of *but*, Rabagliati et al. (2018) conducted a follow-up task. In this task, there was not an unknown word. Children were asked to complete the sentences as in (43). The results

indicated that children performed well and there was not a significant difference between *and also* and *but* conditions.

(43) a. Mae is wearing a jumper *and* Freddie is *also* wearing a …..
b. Mae is wearing a jumper *but* Freddie is wearing a …..

To conclude, considering the research discussed so far, connectives constrain the probabilities regarding the rest of the sentence thereby, they could facilitate learning new words. However, negative meaning-bearing connectives may not always facilitate discourse bootstrapping. The reason for this could be related to their complexity.
This complexity may demand too much mental resource to complete the tasks in these studies as explicitly reasoning about the meaning of an unknown word.

The studies on how children acquire and process connectives have shown that children starting from age 2 are sensitive to the procedural meaning of connectives and can use them actively in language learning. However, it is also reported development of connectives still continue during primary school. Moreover, there is also a difference in the acquisition route of different connectives. Studies so far stated that children have difficulty comprehending the sentences connected with negative meaning bearing connectives such as *but*. However, no study so far has observed the online processing mechanisms of connectives in children. Regarding this, we do not know whether children integrate the meaning of concessive connectors while listening or they only have difficulty in comprehension tasks. This study aims to understand whether children can integrate the connectives incrementally as adults do while they process the sentences by eliminating extra processes that other tasks may incur.

CHAPTER 3

EXPERIMENT

In this chapter, aims, methodology, and predictions regarding the results of the experiments carried out are presented.

3.1. Aim

As mentioned in the previous chapters, adults can interpret discourse connectives incrementally and generate expectations regarding the upcoming language. However, research exploring children's acquisition of connectives reveals that children cannot perform adult-like in contrastive conditions. To date, there has been no study examining online interpretation of connectors and the existing studies have relied on offline end-of-task performances that could be confounded by other factors such as memory, executive functions, or task switching. That is, behavioral tasks such as answering questions or sentence-picture matching require further processing demands beyond language comprehension (Reuter et al., 2018). On the other hand, language processing is automatic and time-sensitive. Bearing this in mind, to observe the moment-to-moment behaviors of children as they listen to the spoken sentences, an eye-tracking experiment using the visual-world eye-tracking paradigm was designed. In this paradigm, the participants hear spoken utterances while they are viewing a visual scene and their gaze patterns on this scene are tracked through the course of utterances they hear. Trueswell (2008) state that there are at least three assumptions of this paradigm:

1. Position of the eye is directed by attentional state.
2. This attentional state can give information about the referential decisions during the course of processing.
3. These referential decisions can provide information about the parsing strategies.

Considering these assumptions, this method aims to observe which of the objects in the scene is being attended to during each part of the utterance. (Altmann & Kamide, 1999). This allows us to examine the immediate effect of critical linguistic items, in our case, causal and concessive connectors, as soon as they are heard. In order to check the overall comprehension, a comprehension question after each sentence was asked. This would allow me to test the predictions of the Discourse Bootstrapping Account. As presented in Chapter 2, this account predicts that children can make reasoning about the unknown object by relying on the constraints posed by the surrounding discourse. I supplemented this experiment with a short-term and working memory tests, as well as an inhibition task to assess our participants' executive function abilities. As discussed in Chapter 2, domain-general abilities affect language development and they continue to mature even after adolescence. Previous studies with children suggested that the reason why children cannot perform adult-like in concessive or contrastive conditions may be related to the inherent complexity of such structures. Negative meaning-bearing connectives are reportedly more complicated than additive or causal ones, thus they are acquired later in development (Evers-Vermeul & Sanders, 2009). Considering this, because concessive connectives lead to a shift in the assumptions, processing them may also rely on heavy use of executive abilities. To be more specific, our research questions were as follows.

1. Can children integrate causal and concessive connectives incrementally and generate expectations relying on them as adults do?
2. Can children understand an ambiguous pronoun by relying on constraints posed by the connectives?

3.2. Method

3.2.1. Participants

29 Turkish native children (age range: 4:1- 5:4, mean age: 4:5, 14 Females, 15 Males) and 16 (age range: 18-35, mean age: 26, 12 Females, 3 Males) adults were tested at METU Language and Cognitive Development Laboratory and a kindergarten. Data from six children and an adult were eliminated. Two children did not want to continue the task and four children and the adult could not finish the task due to the issues in

calibration. Consequently, I analyzed data from 23 children and 15 adults. Since the materials were designed for children, I explained to adult participants that they were the control group for an experiment intended for children. Participants reported no issues with hearing or vision. Adults signed a consent form, while parents signed an informed parental consent form for their child. Children received a small treat, while adults received a gift card for books.

3.2.2. Materials and Design

Participants were instructed to look at a visual scene on the computer and listen to some stories. Their gaze patterns on the scene were tracked as they listened to the sentences. They were instructed to listen to brief stories and answer the comprehension question following each story. The stories were pre-recorded by a female Turkish native speaker. 3.0.0 of Audacity(R) recording and editing software was used to standardize the beginnings and endings and critical times of each recording. Each trial was accompanied by two images on the computer screen. The images were obtained from a website containing free clip art images that have no copyrights. The images complemented or contrasted the adjective in the statement. The details about the images and sentences are provided below.

3.2.2.1. Materials

22 items, 18 experimental, 9 *ama* (but) condition and 9 *bu yüzden* (so) condition in 2 counterbalanced lists, and 4 filler sentences with temporal and additive connectives (i.e., *ve* (and), *sonra* (then) were constructed. Each participant was tested on one of the two counterbalanced sentence lists. Each list had 9 bu yüzden and 9 ama sentences. Thus, participants saw both conditions but in different sentences as in the example. In other words, we manipulated the type of the connector used in our critical items between a causal (*bu yüzden/therefore*) and a concessive (*ama/ however).* This was a within-subject variable so each participant saw both types of connectives in a random order within one list.

For this experiment, I adopted the sentences in (Köhne-Fuetterer et al., 2021) and Rabagliati et al. (2018). In these experiments, the critical sentences had two main parts. The first part introduced the context and a character who wishes to eat, buy or drink a particular thing. In this experiment I used a similar structure. The context sentence aimed to lead the participants to generate estimations about the objects in the scene, as in (44a). This context sentence always included an adjective that was congruent with one of the objects in the scene. Following that, the consequent sentence began with a connector encoding a causal continuity or a contrast and then revealed what happened as a consequence, as in (44b).

(44) a. [Ali]subject [tatli]adjective [bir şey yemek istedi]intended action.
(Ali tatlı bir şey yemek istedi. Bu yüzden/Ama şunu yedi)
[Ali]subject [sweet]adjective [wanted to eat]intended action.
(Ali wanted to eat something sweet)

b. [Ama/Bu yüzden] connector [şunu yedi]consequence
(Bu yüzden/Ama şunu yedi)
[Therefore/However]connector [he ate this] consequence
(Therefore/However, he ate this)

These spoken utterances were accompanied by a two-referent visual scenes on the computer screen as shown in Figure 1. One of the referents was compatible with the adjective used in the first part of the utterances (e.g., chocolate that is in line with the adjective *sweet*) and the other was contrasting with this adjective (e.g., pepper).

Figure 1. Experimental scene

Ali tatlı bir şey yemek istedi. Ama/Bu yüzden şunu yedi.
(Ali wanted to eat something sweet. However/Therefore he ate this.)

Unlike the Dutch (Köhne-Fuetterer et al., 2021) and English (Rabagliati et al., 2018), the test items in our experiment followed S(ubject) O(bject) V(erb) order, the canonical word order for Turkish. When the experimental sentences in these studies were translated into Turkish, the target object would appear immediately after the connective, as in (45), in a manner not allowing sufficient time to observe any predictive effects.

(45) … ama elmayı yedi.
… but apple-Acc ate
… but he ate the apple

We used a deictic expression *şunu* (this) instead of overtly naming the object, as in (46).

(46) … ama şunu yedi
…. but this ate
… but he ate this

The advantages of using a deictic pronoun were twofold. First, we could use the canonical word order in Turkish. Studies examining the predictive effects in Turkish-speaking children yielded contradictory results. Özge et.al. (2019) state that children can make use of case markers to make predictions in both SVO and SOV word orders in Turkish. On the other hand, Brouwer et al. (2019) observed no prediction effect for Turkish children at a verb-based prediction in SVO sentences. This could be attributed to different word ordering and linguistic cues in these studies A relatively less familiar word order in Brouwer et al. (2019) may have inhibited prediction in children. This is why we decided to use a more familiar and canonical word order.

The second benefit of using the deictic pronoun is that it requires participants to reason about the identity of the object that was picked by the story character. This allowed us to create a similar context to the one used in Rabagliati et al. (2018) which used a nonce-word to test whether children could reason using connectives to deduce the meaning of this nonce-word (e.g. … *but/so* he wore a *dax*). Instead of the nonce-word, we used the deixis to create a very similar context of reasoning via connectors to decide about the identity of the deictic pronoun *şunu* (this). This, we believe, is a more natural way to draw attention to the object in a natural way. Encountering nonce-words may confuse children or may create an extra processing cost due to lexical processing. Deictic expressions, on the other hand, are one of the most commonly used words in early childhood, and it is a way to establish joint attention between the interlocutors (Clark & Sengul 1978; Diessel, 2006; Diessel et al., 2021; Stevens & Zhang, 2013), and hence they could arguably facilitate predictive processing.

The filler items were similar to the critical items in that they had a context sentence and a consequence sentence with a connector. But different from the critical items, they had temporal connectives. One sample item is given in (47).

(47) Ayşe temiz bir şey almak istedi. *Ve/Sonra* şunu aldı.
(Ayşe wanted to buy something clean. *And/Then* she bought this.)

The order of items was randomized so that an utterance with the same connectors did not appear back-to-back. The pictures were also randomized so that the target object appeared an equal amount of the time on the right or the left of the screen. The vocabulary items for the adjectives and the critical objects were picked among the frequent words and the materials targeted kindergarten children (e.g., colors, toys, food, clothes). We tested the plausibility of the objects and the adjectives with an offline task prior to the visual-world task. The following subsection introduces this norming task.

3.2.2.2. Norming Task

To ensure that the images are consistent with the adjectives and that the connectors drive people to reason based on the connectors, we prepared a forced-choice task version of the visual world experiment before collecting eye-tracking data. Children and adults participated via their phones or personal computers. The experimenter followed the process on a video call platform. Moreover, with child participants, the experimenter interfered the process and asked explicitly "Which one is sweet" or "Which one is cold" "But it says *ama*". Adults chose the correct options in both causal and concessive trials. Children's performance can be seen in Figure 2. Because there were only 10 child participants, we did not make a statistical analysis for the results. Modifications in the pictures and adjectives were made according to the feedback of adult Turkish native speakers and children's responses.

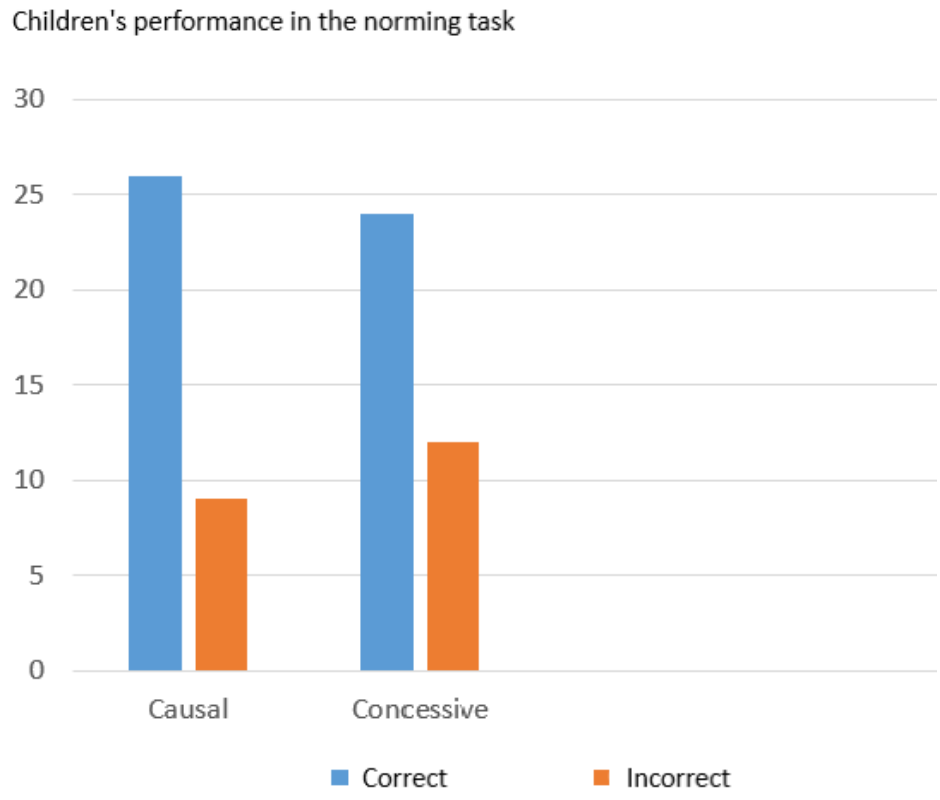

Figure 2. Scores of the Norming Task

3.2.3 Procedure

Child participants were asked to play a computer game that required them to listen to stories and respond to subsequent questions. Adults were told that they were participating in an experiment designed for children as the control group. Following each story, to answer the questions they were instructed to point to one of the pictures on the screen. The participant and the experimenter sat at a table. The experimenter operated the computer that is connected to the eye tracker, instructed the participants, and coded in the comprehension responses of the child participants by pressing the correct button. The reason why the researcher coded in the children's responses is to prevent children from being distracted by the button pressing and to ensure that they look at the screen all the time. Adult participants coded in their responses on their own.

Participants did not see the screen of the computer operated by the researcher. They only looked at the second computer where they completed the experiment. SR Research Eyelink Portable Duo head-free eye-tracking system was used to collect data at 1000 Hz. Both eyes were tracked and data from the left eye was analyzed.

At the beginning of the task, 5 point calibration was completed and repeated, when necessary, throughout the experiment. To verify calibration in between the trials, participants saw a fixation point after each trial. After the calibration was done, instructions were repeated by using pre-recorded sentences and a cartoon character. A female adult native Turkish speaker recorded the experimental items and the instructions. The instruction stated, "Now I will tell you some stories and you will answer my questions. Please listen to me carefully. If you are ready, let's start!". There were four practice sentences before the experiment started. Following each sentence participants received positive comments, but no feedback on the accuracy of their answers.

3.3. Executive Function Tasks

Previous studies that examined end-of-task performances of children in connective comprehension experiments revealed that children could not perform in an adult-like manner in both types of connectives and they performed far worse in concessive

condition. They suggested that concessive meaning could be more difficult to interpret due to its complexity. This may also be related to children's executive function abilities yet to mature. Executive functions enable children to keep multiple alternatives in mind, flexibly shift between alternatives, inhibit and eliminate irrelevant information and focus on the relevant information (Davidson et al., 2006).

Limited executive functions may be leading the children to generate only a default coherence structure (e.g., causal relation) regardless of the connective they hear and they may be having difficulty revising their initial default interpretation. Alternatively, they may be correctly processing the coherence marker right after hearing it but they may be quickly shifting to a more default expectation (i.e., causal relation) and having difficulty inhibiting that expectation. In light of this, we also tested our participants' executive function abilities. These tasks were conducted before or after the eye-tracking experiment.

To test the short-term memory abilities, we used the digit span task (Woods et al., 2010). Participants were required to repeat the numbers in the presented order after the experimenter read them. Beginning with a length of three digits, digit sequences were presented with two trials. After every two trials, the list length increased. The task ended when the participants failed to accurately recall either trial at one sequence length or when the maximum list length is reached. We used the score taken from this for the short-term memory score. To measure working memory, we used the Digit Span Backwards task (Hilbert et al., 2015). The participants were asked to recite the numbers in the reverse order after the experimenter read them. The task began with a length of two digits, the sequences were presented with two trials. Similar to the short-term memory task, after accurately completing at least one of the two trials list length increased. When participants failed to recall both trials or when the maximum list length was met, the task finished.

Moreover, the happy-sad task was used to evaluate inhibitory skills (Lagattuta et al., 2010). Participants looked at the computer screen and saw a happy or sad face in each trial. The experiment was composed of two parts and 4 practice items and 18 trials. In

the first part, participants were asked to identify the emotional state of the individual on the screen as happy or sad. The experimenter pressed the button for both child and adult participants. In the second part, participants were told to say the exact opposite of what they see. They were to say "sad" when they saw a joyful face and "happy" when they saw a sad face.

3.4. Predictions

Recorded eye movements are expected to reveal how the participants integrated causal and concessive connectors in the course of language comprehension. The pronoun identification questions aimed to test whether children are able to deduce the referred ambiguous pronoun by relying on the relationship implied by the connector.

For the first research question, an eye tracking study was designed to observe the immediate effect on connectors in the course of integration. In this study, participants were required to listen to sentences connected with causal and concessive connectors and look at the accompanying scene. Based on previous research, we anticipate observing an immediate effect of the connector (Köhne-Fuetterer et al., 2021). That is, we expect to observe a looking pattern considering the meaning of the connector immediately after hearing it. When participants hear the adjective in 500ms they are expected to look at the object that is compatible with the adjective. However, when they hear the concessive connector *ama*, they are expected to look more at the object that is incompatible with the adjective. In the causal connective condition, however, we expect participants to continue looking at the object they started looking at initially. By doing this, we aim to observe the prediction effect triggered by the adjective and how children use connective information to reassess their predictions.

Figure 3. Experimental scene

Nil küçük bir şey almak istedi. *Ama/Bu yüzden* şunu aldı.
(Nil wanted to buy something small. *However/Therefore,* she bought this)

To illustrate, in the trial above, Figure 3, when participants hear the adjective "small" they are expected to look at the adjective compatible object as in Altmann and Kamide (1999) which is the ball on the right for this trial. After hearing causal connective, *bu yüzden* they are to look more at the small ball since causal connective is expected to facilitate the previous expectations. On the other hand, after they hear concessive connector *ama* they are expected to reverse their expectations (Xiang & Kuperberg, 2015). That is, they are to look at the big ball on the left more than the small one after hearing *ama*. We expect to observe this shift and an increase in the looks to the target immediately after the connective, before the end of the sentence, as in Köhne-Fuetterer et al. (2021).

As for children's performance, in the previous eye-tracking studies children's gaze patterns indicated incremental integration of linguistic cues as adults did (Özge et al., 2019). Considering the early acquisition of connectives (Bloom et al., 1980), we predict that children can integrate connective information to weigh their assumptions. On the other hand, in the eye tracking studies where they needed to reanalyze their predictions, their looking pattern and the behavioral task indicated that they have difficulty in revision. Rather, even though they heard the informative cue, they stuck with their initial assumptions (Choi & Trueswell, 2010). In this study, in concessive

conditions children are supposed to revise their predictions and consider the alternative representation. Regarding this, in concessive connective condition, children might follow a different pattern than they do in causal connective. That is to say, they may have difficulty in revising and we may observe a later or no switch of looks to the target in concessive connector condition. Moreover, previous offline studies indicated that children may not even consider the concessive connectors (Dragon et al., 2015; Evers-Vermeul & Sanders, 2009). If this is the case, children may keep looking at the adjective-compatible object in both causal and concessive conditions. However, we suspect that this might not be the case because it is unlikely that children would totally disregard a known meaning. Since studies rely on offline measures of connective comprehension and we do not know how children react when they hear a concessive connector. Furthermore, Rabagliati et al. (2018) reported that in their study children understood the meaning of the connector and they only failed in the reasoning task, discussed in Chapter 2. As language interpretation is an automatic process, if children understand the functional meaning of the connector, they will immediately use it to constrain their interpretation.

As for the comprehension questions, accuracy scores of the questions asked following each trial will be evaluated. Due to the method's similarity to offline studies, similar outcomes may be observed. In these studies, children performed worse on concessive connectors due to the additional processing cost that these types of tasks may have incurred (Evers-Vermeul & Sanders, 2009). It is indicated that due to the nature of end-task comprehension or reasoning questions that explicitly demand a binary decision-making process, children may perform poorly on end-sentence comprehension tasks (T. Reuter et al., 2018). Similar accuracy scores were also observed in adults as well. Even though participants integrated both connectives incrementally, the accuracy scores indicated that they performed worse in concessive condition (Köhne-Fuetterer et al., 2021). Taking these studies into account, we may observe a poorer performance in *ama* condition when compared with *bu yüzden* condition.

CHAPTER 4

RESULTS AND DISCUSSION

4.1. Eye Tracking

This subsection presents recorded eye gaze patterns of the participants' while they were listening to the sentences.

4.1.1. Data Processing

Visual World Paradigm premises that listeners subconsciously switch their gaze towards the related objects in the scene as the language unfolds (Huettig et al., 2011). To examine the data consisting of eye movements, one needs to determine the onset and offset of critical linguistic items in the stream of utterance and specify the interest areas (e.g., target and competitor) in the scene. The analysis will provide an overview of the proportion of looks to the interest areas over the course of a sentence. We used the VWPre package to preprocess our eye data. We collected data SR Eylink system and used the R program (R Core Team, 2022) for analysis. We changed the names of the columns to be compatible with the VWPre format (Barlaz, n.d.). To obtain proportional data, we binned the data in 100ms bins. In doing so, binned chunks of time provided us how many samples of looks to the interest areas per chunk, and proportions were calculated. For the following analyses, we used data from the left eye.

4.1.2. Raw Plot of Proportion of Looks

To understand the effect of the connectives on the course of processing we analyzed participants' looking patterns on the scene as the sentences unfold. We used the R

package VWPre (Version 1.2.4; Porretta et al., 2016) for preprocessing and plots. Each scene had two interest areas: target picture and competitor picture. We used R (R Core Team, 2022) to map the recorded eye movements to the two interest areas. Other looks were marked as "outside" and were not included in the analysis. The data was binned into 100ms bins. We marked the adjective onset 500ms to observe the effect of the adjective used and connector onset to investigate the effect of the connector on processing. The plot, Figure 4, indicates the proportion of looks towards the competitor and target image framed by the connector (i.e., causal and concessive) and age (i.e., adults and children). Average adjective onset (500ms) and connector onset (2800ms) is marked with the two vertical lines. The figure shows that both adults' and children's looks to the target increased after they heard the adjective and they kept looking at the target image more than the competitor after they heard the causal connective. This pattern was in line with our predictions that the causal connective facilitated the assumptions regarding the object in the scene that is compatible with the adjective. As for the concessive connector, the plot indicated that both adults and children initially looked at the competitor image after hearing the adjective and when they heard the concessive connector, they shifted their gaze to the target image. This means that children canceled out their initial assumptions by relying on the concessive connector as adults did. Nevertheless, plow shows that while adults kept their eyes on the target image till the end of the sentence, by the end of the sentence (sentence ended 4300ms in average) children shifted their gaze back to the competitor image, in other words, the picture that is compatible with their initial assumption. To analyze this non-linear pattern of looks statistically, we fitted Generalized Additive Mixed Models (GAMM). The possible explanations for the looking patterns are discussed in the discussion chapter.

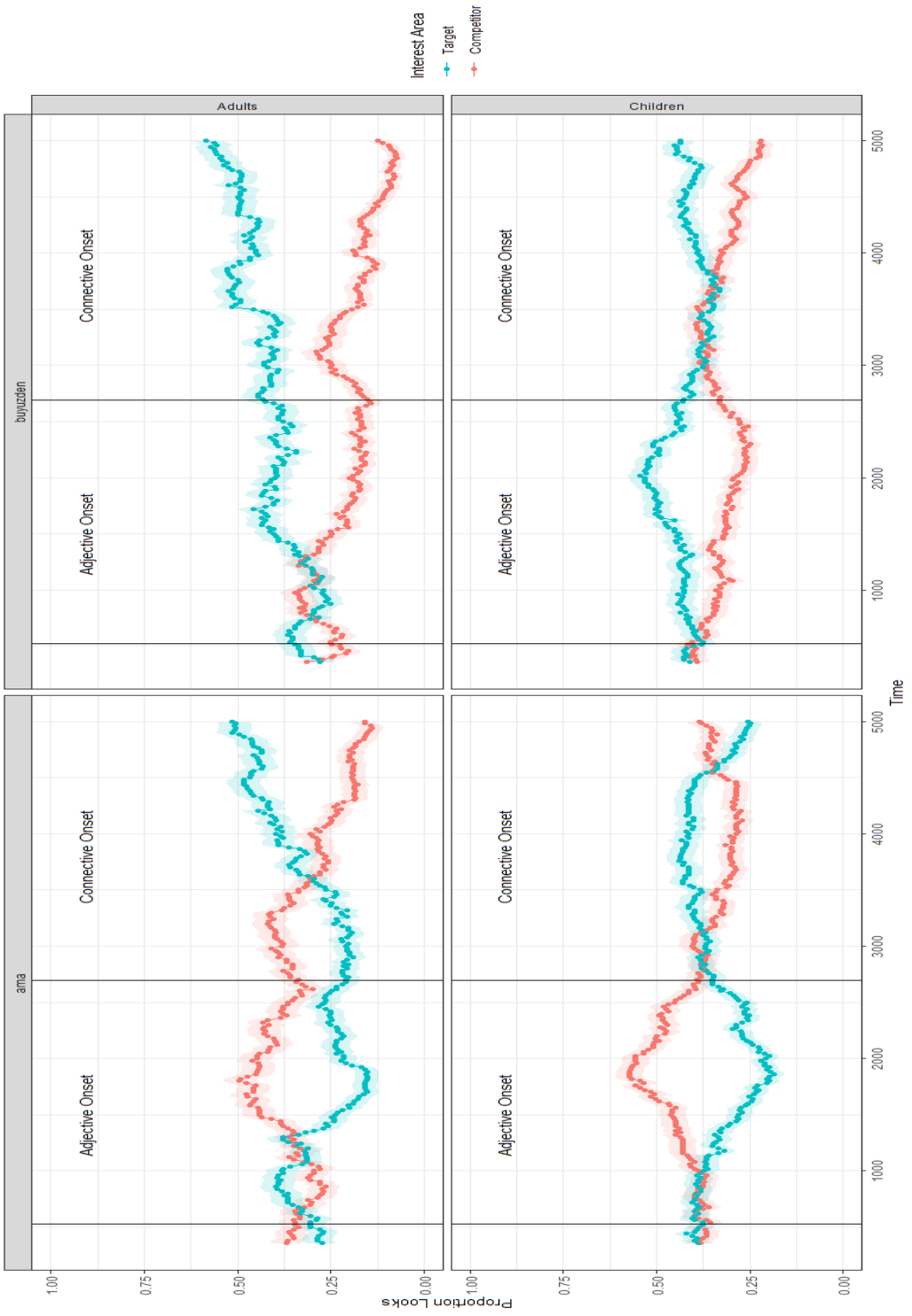

Figure 4. Proportion of Looks

4.1.3. Generalized Additive Mixed Model Analysis

The raw plots describing the proportion of looks indicated a non-linear pattern of looks as the sentences unfolded. In causal condition looks to the target increased incrementally. In concessive condition, we observed a shift in the looks to the target as an effect of the concessive connector. To statistically investigate this pattern, we fitted a GAMM (Generalized Additive Mixed Model). This section explains the reason behind our choice and the outputs of the best fitted model.

As the changes in the comprehension of spoken language with different linguistic cues in time, in this study time is regarded as a continuous variable. The dependent variable is the area where the gaze is directed, so it is a categorical variable (i.e., in this study they are target and competitor). Eye-tracking experiments analyze the changes in the categorical variables (e.g., area of interest) as the time proceeds (i.e., as the sentence unfolds). However, the tests such as ANOVA and t-test examine how categorical variables (e.g., design) affect continuous variables (e.g., accuracy scores) (Barr, 2008). To fit the time variable in these models, it is transformed into a categorical variable by predefining certain time windows for analysis, and for categorical looking area variable is turned into a continuous variable by aggregation (Barr, 2008). This may lead us to miss all the possible patterns in data (Wieling, 2018). Recent articles propose that Generalized Additive Models (GAM) could be a good fit to analyze non-linear changes over time by avoiding simplifying the data and autocorrelation (Wieling, 2018; Porretta et al., 2017; Winter & Wieling, 2016; Brouwer et al., 2018).

Growth curve analysis is also used to analyze non-linear data, however, researcher must predetermine the specifics of the pattern before analysis. This is indicated to lead problem of the researcher's degree of freedom (Wieling, 2018). GAM is a nonlinear regression method and it does not need pre-selection of time windows or aggregation of data points making it possible to examine all data variations that might be overlooked when aggregated (Wieling, 2018). The non-linear relationship between

predictors and the dependent variable is measured automatically by the algorithm of GAMs (Wieling, 2018). For all these reasons, we used GAM to model the dynamically varying eye-gaze of participants following a non-linear pattern over the course of processing.

Our model aimed to show the effect of age and connector type. In our study, the looks to the target image is the dependent variable. age, connector type, and time are the predictors of looks to the target image as the sentence unfolds, they were introduced as smooth terms. The interactions between the connector type (causal, concessive) and age group (children, adult) were combined in one predictor and the interaction of these contrast with Time was tested. The aim was to understand whether the differences, if there were any, between the connector type and age change as time proceeds, in other words as the sentence unfolds (van Rij et al., 2016). Furthermore, subject and item were also included in the analysis as random effects over Time (van Rij et al., 2016). We fitted the model to analyze the changes starting from the connector and ending before the question sentence begins. We then ran a simpler model to see the changes in children in both connector types separately. For the analysis, we used the mgcv package (Wood, 2017), and the istadug package (van Rij et al., 2022) for the smooth graphs.

Table 1 shows the analysis for the time period starting from the onset of the connector till the beginning of the question. We do this analysis in order to focus on the effect of the connector. Parametric coefficients in Table 1 indicate that there is no difference in the overall looks to the target after the connective. The deviance explained by the model is 29.3 %. Smooth terms indicated no effect for age or connector that can be interpreted as after hearing the connective both age groups showed a similar pattern. Smooth plots also indicate that children showed adult-like pattern.

Parametric coefficients				
	Estimate	Std. Error	T value	Significance
(Intercept)	0.1147	0.4934	0.232	0.816
conjunctionbuyuzden	0.7680	0.7392	1.039	0.299
groupChildren	-0.9134	0.5891	-1.551	0.121
conjunctionbuyuzden:groupChildren	-0.7977	0.8717	-0.915	0.360
Smooth terms				
	edf	Ref.df	F	p-value
s(Time):conjunctionama	0.685	0.7596	0.308	0.629
s(Time):conjunctionbuyuzden	1.000	1.0003	1.665	0.197
s(Time):groupAdults	1.000	1.0005	0.586	0.444
s(Time):groupChildren	2.384	2.5394	2.013	0.139
s(Time, Subject):conjunctionama	134.618	187.000	12.124	p < 001
s(Time, Subject):conjunctionbuyuzden	135.894	187.000	11.723	p < 001
s(Time, Item):conjunctionama	92.822	134.000	6.515	p < 001
s(Time, Item):conjunctionbuyuzden	81.570	134.000	8.056	p < 001

Table 1. Summary of Generalized Additive Mixed model

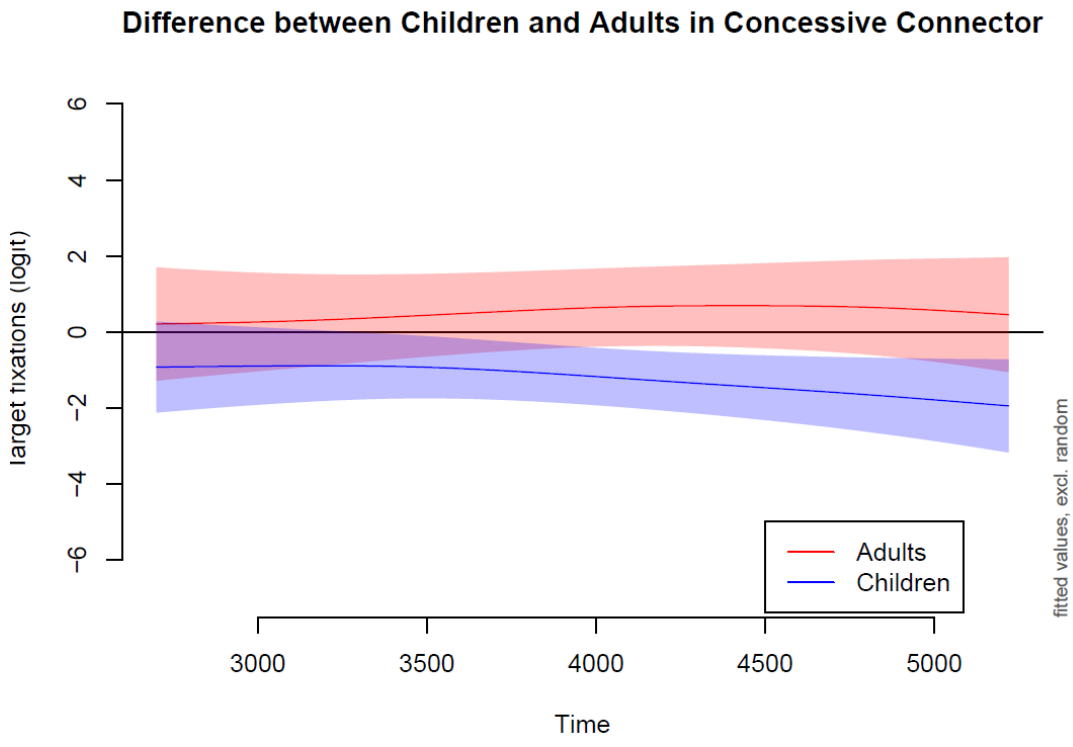

Figure 5. Smooth Plot for the Difference between Adults and Children in the Concessive Connector *ama*.

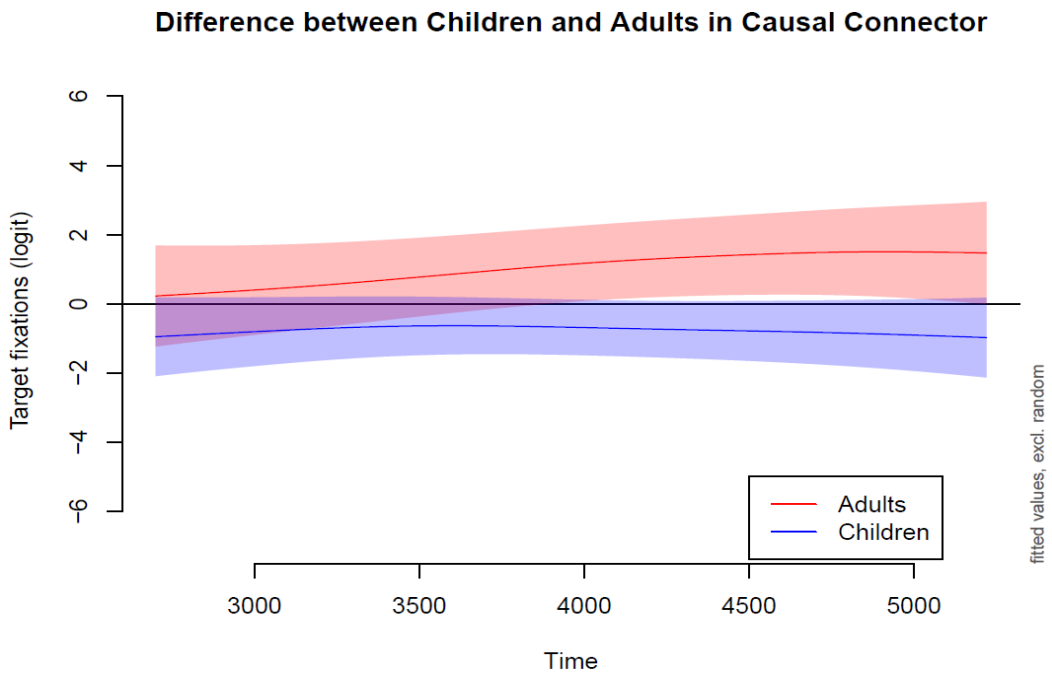

Figure 6. Smooth Plot for the Difference between Adults and Children in the Causal Connector *bu yüzden*.

We also fitted the same model for children comparing causal and concessive connector. The results in Table 2 indicates no difference in the processing these two connectors for children.

Parametric coefficients				
	Estimate	Std. Error	T value	Significance
(Intercept)	-0.6561	0.3563	-1.841	0.656
conjunctionbuyuzden	0.4826	0.5198	0.928	0.3532
Smooth terms				
	edf	Ref.df	F	p-value
s(Time):conjunctionama	1.844	1.935	0.455	0.575
s(Time):conjunctionbuyuzden	1.482	1.536	0.652	0.625
s(Time, Subject):conjunctionama	157.158	188.000	23.710	p < 001
s(Time, Subject):conjunctionbuyuzden	154.076	188.000	21.830	p < 001
s(Time, Item):conjunctionama	110.697	134.000	11.041	p < 001
s(Time, Item):conjunctionbuyuzden	101.753	134.000	11.793	p < 001

Table 2. Summary of Generalized Additive Mixed Model for Children

4.2. Offline Comprehension of Connectives

To compare the performances of children and adults in the pronoun identification task we ran a t-test analysis. Both in causal (t(22.349) = -2.7229, p<0,02) and concessive (t(22.64) = -12.459, p<0,001) children showed a poorer performance than adults (Figure 7).

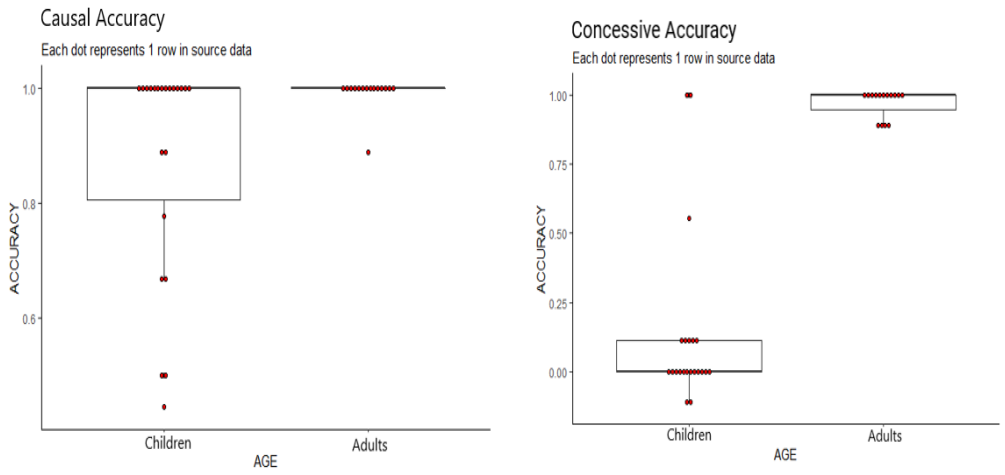

Figure 7. Boxplots for the Difference between Accuracy Scores of Children and Adults

We also ran two separate t-tests to see whether the difference between the scores in the two conditions differ. Adults performed similarly in concessive and causal conditions (t(22.09) = -1.4739, p > 1). Furthermore, all adults performed above chance level in both conditions (scores were over 0.92, as in Figure 8). Adults used both connectives to correctly reason about the consequence.

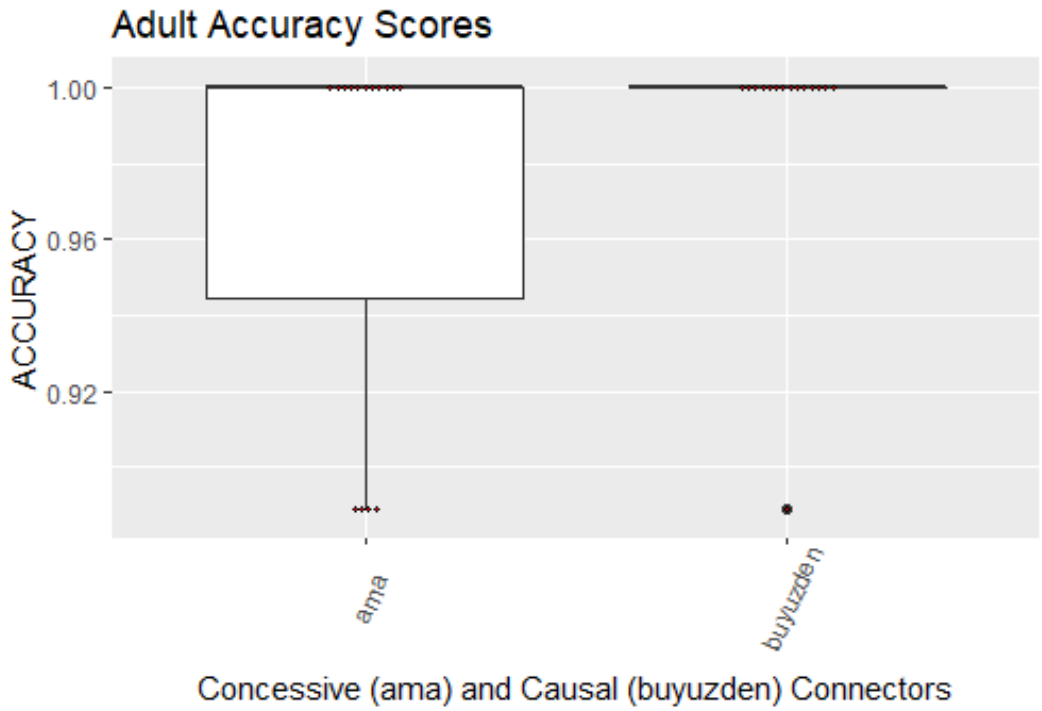

Figure 8. Boxplots for the Difference between Accuracy Scores of Adults

Nevertheless, there exists a difference in the children's scores in both conditions (t(35.159) = -9.6059, p<0,001). As Figure 9 also indicates children performed significantly poorer in the concessive condition in the pronoun identification questions. This result is in line with previous studies that present evidence for children's failure in reasoning by concessive or contrastive connectors in offline tasks (Rabagliati et al., 2018; (Evers-Vermeul & Sanders, 2009).

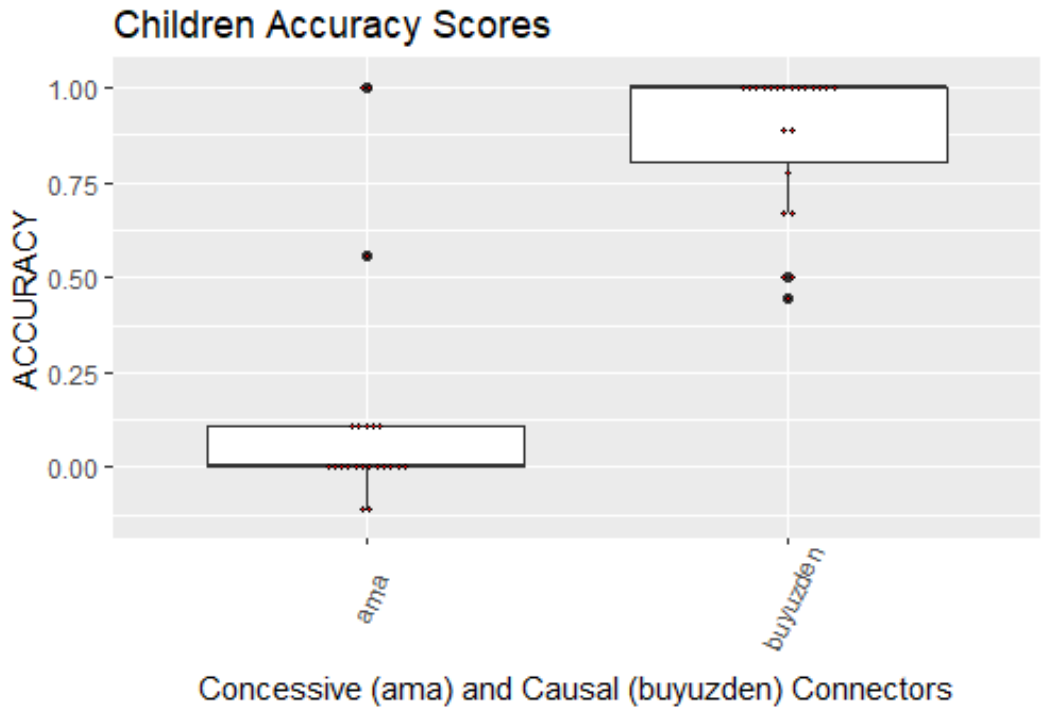

Figure 9. Boxplots for the Difference between Accuracy Scores of Children

4.3. Inhibition and Memory Task Scores

In all tasks children performed worse than adults (Working memory task ($t(19.068) = -3.7267$, $p<0,01$), Short Term Memory Task ($t(22.838) = -4.0882$, $p < 0,001$), Inhibition Task($t(61.978) = -2.6904$, $p < 0,01$)). As discussed in Chapter 2, considering the developing executive function skills of children at ages 4 and 5, these results were in line with our predictions. These results may also explain why children performed worse than adults in both condition types, especially in the concessive condition. Detailed explanation and probable reasons are discussed in General Discussion Chapter.

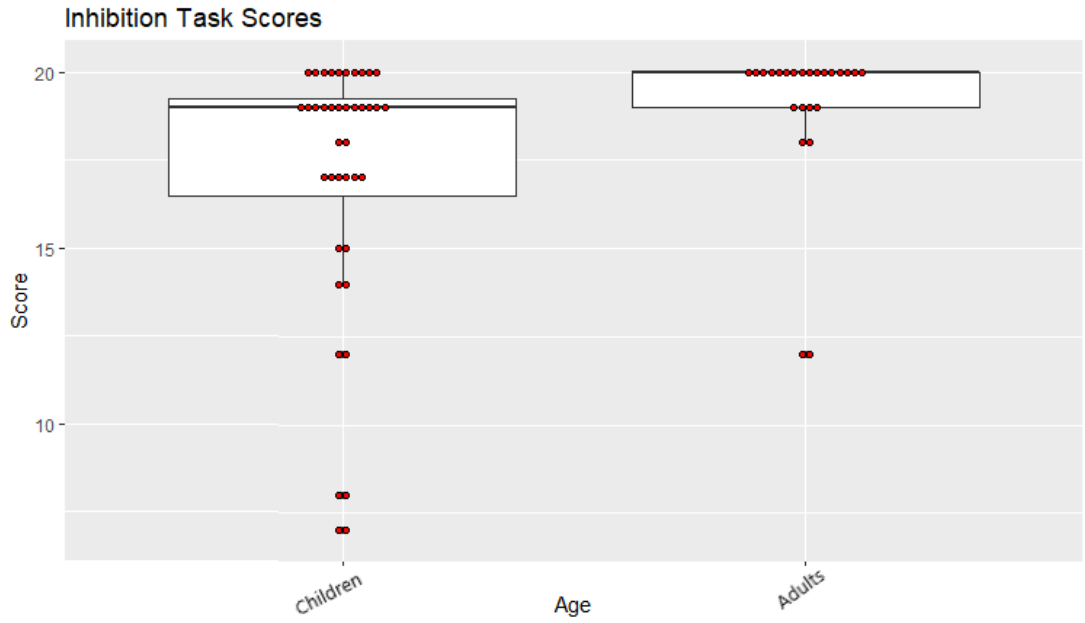

Figure 10. Boxplots for the Difference between the Scores in the Inhibition Task

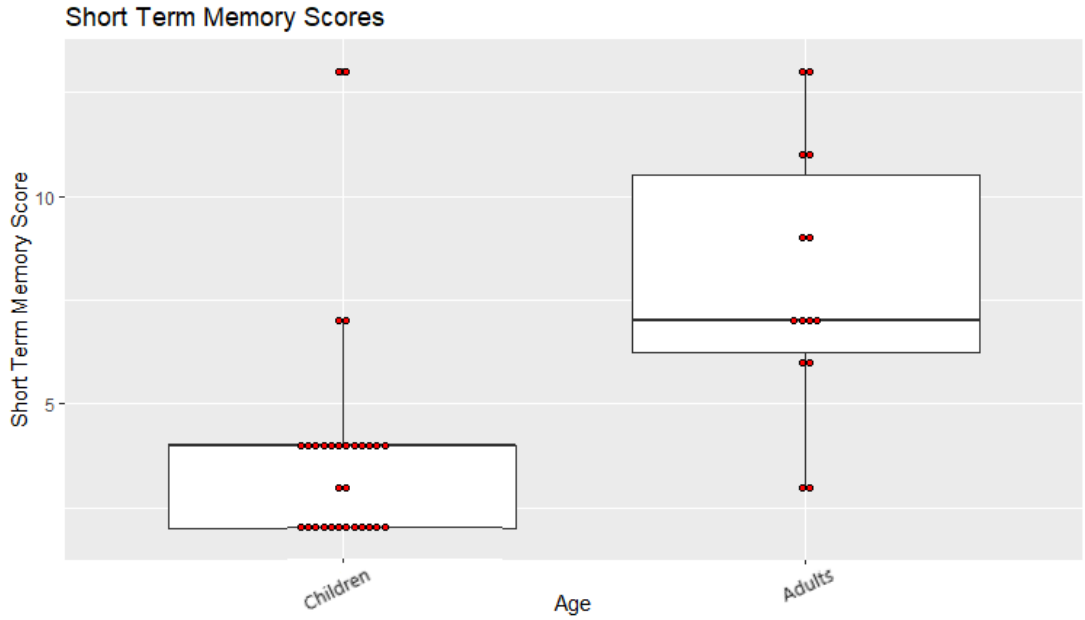

Figure 11. Boxplots for the Difference between the Scores in the Short-term Memory Task

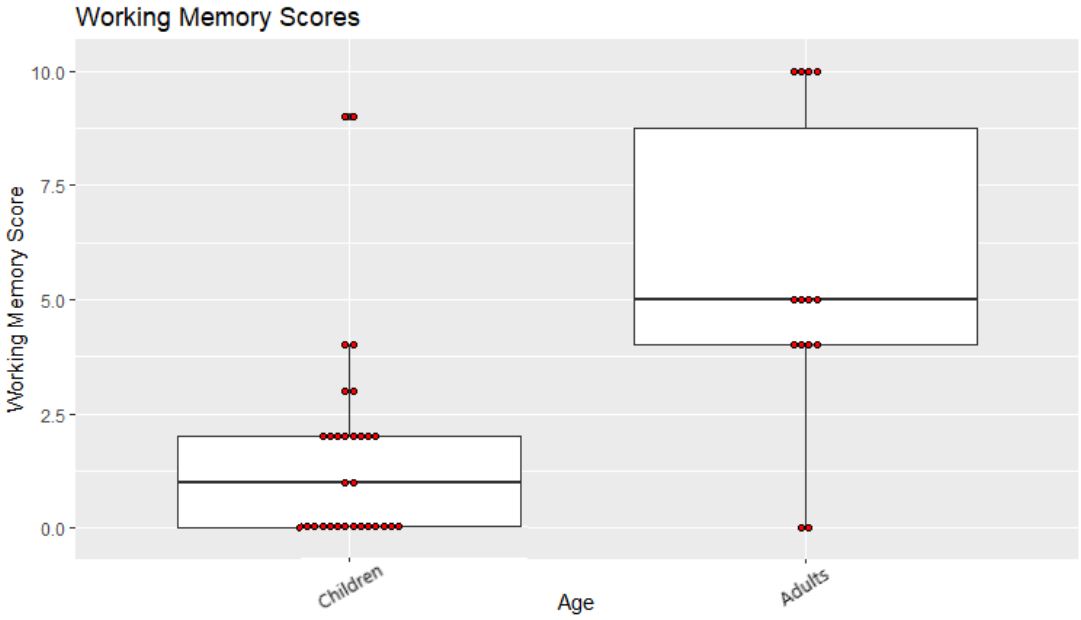

Figure 12. Boxplots for the Difference between the Scores in the Working Memory task

CHAPTER 5

GENERAL DISCUSSION

5.1. Incremental Integration of Connectives

To my knowledge, this is the first study that examined how children integrate discourse connectors in the course of processing. Previous research on children's use and comprehension of discourse connectives yielded conflicted results. To begin with, there is a discrepancy between production and comprehension studies. It is indicated that the meaning and the complexity of the connective affect the acquisition route. When connectives are categorized regarding cumulative complexity, the more meaning a connector entails the more complex it is. For example, additive connectives are the least complex connectives and causal connectives are more complex than additive connectives because causality entails both addition and temporal order. Bloom et al. (1980) indicated that children can use connectors starting from age 2 and 3 in accordance with the complexity order (i.e., additive < temporal < causal < adversative). However, comprehension studies indicate that children still cannot show adult-like performance at age 10 in comprehension tasks, especially in negative connectives (i.e., adversative, contrastive, concessive) (Spenader, 2017; Knoepke et al., 2017). Despite this ongoing development, preschoolers can use both causal and negative connectors to infer an unknown meaning or understand a pronoun (Sullivan et al., 2019; Sullivan & Barner, 2016) in some studies and are unable to do so in some studies (Rabagliati et al., 2018). All these studies rely on the end-of-task performance of children and present contradicting results. It seems implausible to disregard what is interpreted during interpretation because the language processing system is a highly incremental and automatic process.

I suspect that during these offline or end-of-performance tasks, other factors such as working memory or test type (e.g., multiple choice, sentence completion) may have confounded the results. Thus, these studies may not indicate the exact processing patterns.

Moreover, connective processing studies in adults indicated that participants incrementally integrated causal and concessive connectives. Brain imagining studies indicated that when there was a semantic anomaly in the sentence, it disappeared with the presence of a concessive connector (*even so*). Eye tracking data also demonstrated that when they heard a concessive connector, participants switched their looks to the target image before they heard the target word. This indicates that participants revised their previous assumptions and inferred that the upcoming structure entailed an opposite meaning (Köhne-Fuetterer et al., 2021). On the other hand, although they incrementally integrated the concessive meaning, in the comprehension task, participants performed poorer in the concessive condition compared to causal one (Köhne-Fuetterer et al., 2021). Considering the more complex structure of concessives from the perspective of the cumulative complexity account (Bloom et al., 1980), an additional behavioral task (e.g., comprehension question explicitly asking what happened) might have led to an extra processing cost. By processing cost, I mean that integrating complex structures may need more working memory and inhibition capacity. I suspect that this can account for the poor performance of children as well. Bearing this in mind, we aimed to investigate the processing of connectives by children. Considering the time-sensitive nature of language comprehension, methods examining moment-to-moment behaviors are expected to provide insight into the strategies used in the course of processing. Therefore, to examine the immediate reaction to the connectives in the course of processing, we conducted an eye-tracking experiment.

In this study, I tested children (mean age= 4;5) and adults. A scene comprising two objects was presented as participants listen to the sentences connected with concessive *ama* (however) and causal *bu yüzden* (therefore). Participants were asked to listen to

the sentences and answer a subsequent comprehension question. The first sentence presented the context, for example, wanting to eat something cold, or buying something tall. While listening to the first sentence, participants were expected to look at the object that is compatible with the adjective. For example, they were to look at the red sweater more than the blue one when they heard *red*. When they heard the causal connector, they were expected to keep their looks at the red sweater, whereas, when they heard the concessive connector, they were to switch their gaze and look more at the blue one as in Köhne-Fuetterer et al. (2021).

The raw plots showed that both children and adults started to look at the object that is compatible with the adjective. After hearing causal connector *bu yüzden* they continued looking at the target object and by the end of the sentence, they were still looking at it. In line with our expectations, when participants heard concessive connective *ama*, both adults and children switched their anticipations and looked more at the target object. Adults kept their eyes on the target object till the end of the sentence. However, by the end of the sentence, children's looks to the target image decreased and they looked back at the competitor. The reason why children switched back to their initial assumptions may be related to their poor inhibitory skills. This switching back to the initial assumptions pattern may also explain why children performed poorly in the aforementioned behavioral tasks even though children do know the meaning of concessive connectors.

Moreover, I fitted a GAM analysis to statistically investigate this non-linear pattern of eye movements. I examined the time window starting from the connector onset to the question onset to better examine the effect of the connector. Overall results indicated that after the connective onset, children showed an adult-like processing pattern in both connector types. That is to say, they looked more at the object that is compatible with the connective. Regarding these results, it could be indicated that children incrementally integrated connective devices as cues to generate anticipations about the discourse structure when they encounter the connector.

To sum up, the gaze data revealed that children can incrementally integrate both concessive and causal connectives and generate expectations during the course of processing. This result contradicts previous offline studies that indicated that children do not consider the concessive connector and rely on causal reasoning (Knoepke et al., 2017). While listening, children may have considered the negative connector's meaning, but because of their limited executive abilities such as working memory, they showed a poor performance. The switch back to the competitor image at the end of the sentence in the eye data may also be evidence for that. I also examined the comprehension of participants. Following each trial, a question was asked about which object did the person choose. To answer these questions, participants needed to rely on the meaning of the connective. The following subsection presents the results of this task and discusses executive function tasks I conducted to explain the possible reasons behind children's poor performance.

5.2. Offline Comprehension of Connectives

Discourse bootstrapping hypothesis proposes that children can use the cues constrained by the discourse, to reason about the meaning of an unknown word starting from ages 2 (Sullivan & Barner, 2016) and 4 (Sullivan et al., 2019). The second aim of this study was to test whether children could rely on the connector information to understand which object *şunu* (this) referred to. We examined the performance in the question asked after each trial. Accuracy results indicated that there was no significant difference between adults' performance in the causal and concessive conditions. On the other hand, children performed significantly worse in the concessive condition than the causal condition. When adults and children are compared, in both causal and concessive conditions children showed a worse performance. These results are in line with previous studies presenting evidence for the poor performance of children compared to adults. Moreover, this performance also accounts for children's switching their eyes back to the competitor image at the end of the sentence. This indicated that even though children considered the alternative possibility triggered by the concessive connective, they could not discard their initial assumptions.

Children's inability to recover from their initial estimations was also reported by previous research. Choi & Trueswell (2010) stated that while processing garden path sentences, children stuck to their initial assumptions and they did not consider the following disambiguating linguistic cue. For example, in sentence "put the frog on the napkin in the box" children initially interpreted that "on the napkin" is the destination. Even though they later heard "in the box" they did not change their assumption and put the frog on the napkin (Trueswell et al., 1999). Similarly, in this study, the presence of a concessive marker indicates denial of the existing predictions and participants were to discard the initial representation and consider the alternative. In this study children also failed to revise their estimations even after considering the alternative option for a while during comprehension. Considering that executive function abilities of children continue even after age 13 (Bernard et al., 2012), we conjecture this particular pattern is also related to their limited ability to revise initial choices.

In this study, the short-term and working memory as well as inhibition abilities of the participants were also tested. I ran a t-test for each task to compare adults and children. For the short-term and working memory, we used a digit span task where participants were instructed to repeat the numbers in the asked order after the experimenter. The results indicated that adults got higher scores. As for the inhibition abilities, I used the happy-sad task. In the first part of the task, participants were asked to state the emotional state of the face on the screen (e.g., When they saw a happy face, they were to say 'happy'). Whereas, in the second part, participants were instructed to state the opposite of what they see on the screen (e.g., When they saw a happy face, they were supposed to say 'sad'. Results of these task indicated that children had limited short term and working memory span and limited inhibitory capacity when compared with adults. Regarding these results, it can be indicated that children's poorer working memory and inhibition skills may be the reason why they could not disregard their existing assumptions and construct an alternative representation. Furthermore, the low short-term memory score may explain why children could not retain their assumptions till the end of the sentence.

Moreover, the pronoun identification question demanded an inferencing about the identity of the referent on the basis of the information in the sentence. There were two sources of information to rely on: the adjective (e.g., hot, cold) and the connective (e.g., *ama*). The semantic activation of the adjective may have incurred a stronger and more reliable representation for children to reason when compared with the connector. During the course of language acquisition, the meanings of the connectives are inferred from the discourse and they are acquired through lots of input. Their development continues over primary school (Cain et al, 2005; Cain & Nash, 2011) as children have better executive function skills and they learn reading. Regarding the results of the current study, it could be said that children at ages 4 and 5 did understand the meaning of the concessive connector *ama* and integrated this meaning to consider the opposite alternative. Nevertheless, during the comprehension questions, they may have forgotten this shift due to their poorer executive skills or they relied on the adjective that may have led to stronger semantic activation than the connective. Considering their limited executive function skills, inhibiting a stronger semantic activation can be difficult. Furthermore, poor executive function abilities may also account for the difficulty of integrating a discontinuity triggered by the concessive connector. Discarding the initial causal representation to build the alternative one and reason about it may have incurred processing cost in terms of working memory for children. Therefore, they may have relied on the good-enough representation which entails causal continuity.

The previously indicated disparity between studies of children's output and understanding may be attributable to methodological factors. In comprehension studies, children are expected to alter their estimations in milliseconds. In production studies, however, children do not need to reevaluate their interpretation. While they are uttering a sentence, they have already had conflicting representation in their minds.

5.3. Conclusion

The current study found that children, like adults, incrementally interpret the meaning of the connective to make predictions about following discourse relations. This

representation, however, quickly decays over the course of the utterance, and children are unable to maintain this interpretation in their focus until the end of the utterance, causing them to make a greater number of errors in their end-sentence comprehension questions in the concessive condition. In this regard, this study was able to record a highly fragile pattern of incremental and predictive processing in children, highlighting an important distinction between adult and child processing. This distinction can be attribute to the developing executive function abilities of children. This also may explain why children performed worse in concessive connectives in prior offline experiments. Adults, unlike children, could keep a more correct understanding of the concessive connectives until the end of the sentence. This study also pointed an asymmetry between the causal and concessive connectives in children, which is a well-documented trend in the literature (Spenader, 2017; Knoepke et al., 2017). These findings indicate that connectives begin to affect the immediate interpretation and prediction of discourse as early as 4:05 years of age. This is a new result that indicates a comparable online processing mechanism in children and adults when evaluating discourse connectives. The results of this study may be informative for the relationship between developing executive functions of children and their linguistic abilities. Considering cognitive development as an integral part of language competence, teaching programs may focus on facilitation of these executive function abilities as to enhance language learning. Furthermore, as this study also discusses the complexity of connectors and connector processing of language learners, the results can be discussed regarding second language learners. The complexity order of the connectives may be informative in terms of teaching programs. On the other hand, their incremental and predictive processing may be capitalized on word learning as children do (i.e., Discourse Bootstrapping).

5.4. Limitations and Future Directions

Data for this experiment were collected during the COVID-19 pandemic. As a result, participant recruitment was the greatest difficulty for this study. The biggest limitation of our study is the number of participants. Therefore, reaching a larger population is necessary for findings that are statistically more powerful.

To shed insight on the developmental pattern of the usage of connectives in processing, the age range can also be expanded. Moreover, even though the results indicated that there was no difference between the overall processing patterns of children and adults in both connective types, the subject and item random effect was significant. That is participants' performances varied. This indicates that there was an individual variation among participants. Considering this further study may examine individual differences focusing on the differences in executive function and other probable reasons such as language competence, vocabulary abilities, and other cognitive performances. In addition, because we could only test two connectives, future research might examine other concessive and causal connectives to better understand how children process connectives.

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APPENDICES

A. APPROVAL OF THE METU HUMAN SUBJECTS ETHICS COMMITTEE

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

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21 ARALIK 2020

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Dr.Öğretim Üyesi Duygu ÖZGE

Danışmanlığını yaptığınız Özge GÜNAY'ın ***"Ana Dili Türkçe Olan Çocukların Nedensel ve Ödünleyici Bağlaçların Tahminsel İşlemlemesi-."*** başlıklı araştırmanız İnsan Araştırmaları Etik Kurulu tarafından uygun görülmüş ve **375-ODTU-2020** protokol numarası ile onaylanmıştır.

Saygılarımızla bilgilerinize sunarız.

Prof.Dr. Mine MISIRLISOY
İAEK Başkanı

B. EXPERIMENTAL PICTURES AND SENTENCES

a. Practice Items

1. Ali karlı bir yere gitmek istedi. Ama şuraya gitti. Sence Ece hangisinie gitti?

2. Eda yeni bir şey almak istedi ve şunu aldı. Sence Eda hangisini aldı?

3. Ada tüylü bir şey sevmek istedi ama şunu sevdi. Sence Ada hangisni sevdi?

4. Nil güneşli bir yere gitmek istedi ve şuraya gitti. Sence Nil hangisine gitti?

b. Filler Items

1. Ali dolu bir şey almak istedi sonra şunu aldı. Sence Ali hangisini aldı?

2. Ada beyaz bir şey almakistedi ve şunu aldı. Sence Ada hangisini aldı?

3. Eda lezzetli bir şey yemek istedi ve şunu yedi. Sence Eda hangisin yedi?

4. Nil renkli bir şey almak istedi sonra şunu aldıç Sence Nil hangisini aldı?

c. **Experimental Items**

1. Ali tatlı bir şey yemek istedi. Bu yüzden/ama şunu yedi. Sence Ali hangisini yedi?

2. Ayşe ekşi bir şey yemek istedi. Bu yüzden/ama şunu yedi. Sence Ayşe hangisini yedi?

3. Oya tuzlu bir şey yemek istedi. Bu yüzden/ama şunu yedi. Sence Oya hangisini yedi?

4. Ahmet acı bir şey yemek istedi. Bu yüzden/ama şunu yedi. Sence Ahmet hangisini yedi?

5. Ali soğuk bir şey yemek istedi. Bu yüzden/ama şunu yedi. Sence Ali hangisini yedi?

6. Oya sıcak bir şey yemek istedi. Bu yüzden/ama şunu yedi. Sence Oya hangisini yedi?

7. Oya sert bir şey almak istedi. Bu yüzden/ama şunu aldı. Sence Oya hangisini aldı?

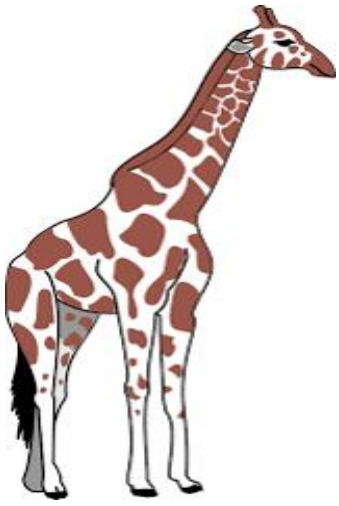
8. Ali yumuşak bir şeyle oynamak istedi. Bu yüzden/ama şununla oynadı. Sence Ali hangisiyle oynadı?

9. Nil küçük bir şey almak istedi. Ama/Bu yüzden şunu aldı. Sence Nil hangisini aldı?

10. Ali küçük bir şey almak istedi. Bu yüzden/ama şunu aldı. Sence Ali hangisini aldı?

11. Eda uzun bir şey almak istedi. Bu yüzden/ama şunu aldı. Sence Eda hangisini aldı?

12. Ada kısa bir şey almak istedi. Bu yüzden/ama şunu aldı. Sence Ada hangisini aldı?



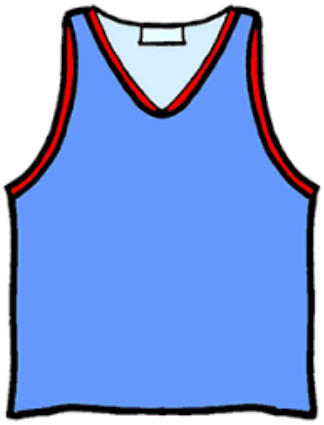
13. Oya yeşil bir şey giymek istedi. Bu yüzden/ama şunu giydi. Sence Oya hangisini giydi?

14. Eda mavi bir şey giymek istedi. Bu yüzden/ama şunu giydi. Eda hangisini giydi?

15. Ali kırmızı bir şey giymek istedi. Bu yüzden/ama şunu giydi. Sence Ali hangisini giydi?

16. Ada kalın bir şey giymek istedi. Bu yüzden/ama şunu giydi. Sence Ada hangisini giydi?

17. Nil ince bir şey giymek istedi. Bu yüzden/ama şunu giydi. Sence Nil hangisini giydi?



18. Ada sarı bir şey giymek istedi. Bu yüzden/ama şunu giydi. Sence Ada hangisini giydi?

C. GAM FITTED MODELS

1. Adults and children

```
Formula:
IA_Target_P ~ conjunction * group + s(Time, by = conjunction,
    k = 8) + s(Time, by = group, k = 8) + s(Time, Subject, by = conjunction,
    bs = "fs", m = 1) + s(Time, Item, by = conjunction,
    bs = "fs", m = 1)

Parametric coefficients:
                             Estimate Std. Error t value Pr(>|t|)
(Intercept)                    0.1147     0.4934   0.232    0.816
conjunctionbuyuzden            0.7680     0.7392   1.039    0.299
groupChildren                 -0.9134     0.5891  -1.551    0.121
conjunctionbuyuzden:groupChildren  -0.7977     0.8717  -0.915    0.360

Approximate significance of smooth terms:
                                    edf   Ref.df      F p-value
s(Time):conjunctionama            0.685   0.7596  0.308   0.629
s(Time):conjunctionbuyuzden       1.000   1.0003  1.665   0.197
s(Time):groupAdults               1.000   1.0005  0.586   0.444
s(Time):groupChildren             2.384   2.5394  2.013   0.139
s(Time,Subject):conjunctionama      134.618 187.0000 12.124  <2e-16 ***
s(Time,Subject):conjunctionbuyuzden 135.894 187.0000 11.723  <2e-16 ***
s(Time,Item):conjunctionama          92.822 134.0000  6.515  <2e-16 ***
s(Time,Item):conjunctionbuyuzden     81.570 134.0000  8.056  <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Rank: 787/788
R-sq.(adj) =  0.315   Deviance explained = 27.4%
fREML =  40951  Scale est. = 0.94308   n = 29029
>
```

2. Children

```
Family: quasibinomial
Link function: logit

Formula:
IA_Target_P ~ conjunction + s(Time, by = conjunction, k = 8) +
    s(Time, Subject, by = conjunction, bs = "fs", m = 1) +
    s(Time, Item, by = conjunction, bs = "fs", m = 1)

Parametric coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)         -0.6561     0.3563  -1.841   0.0656 .
conjunctionbuyuzden   0.4826     0.5198   0.928   0.3532
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
                                   edf  Ref.df      F p-value
s(Time):conjunctionama               1.844   1.935  0.455   0.575
s(Time):conjunctionbuyuzden          1.482   1.536  0.652   0.625
s(Time,Subject):conjunctionama      157.158 188.000 23.710  <2e-16 ***
s(Time,Subject):conjunctionbuyuzden 154.076 188.000 21.830  <2e-16 ***
s(Time,Item):conjunctionama         110.697 134.000 11.041  <2e-16 ***
s(Time,Item):conjunctionbuyuzden    101.753 134.000 11.793  <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.338   Deviance explained = 29.3%
fREML =  66816  Scale est. = 0.9537    n = 47288
>
```

D. TURKISH SUMMARY / TÜRKÇE ÖZET

ÇOCUKLARDA NEDENSEL VE ÖDÜNLEYİCİ BAĞLAÇLARIN İŞLEMLENMESİ

Giriş

Günlük konuşma dili birbirinden bağımsız, rasgele cümlelerden ziyade, anlam ilişkisi taşıyan cümlelerin bir bütün oluşturmasından meydana gelir. Bu bütünlük *söylem* olarak da ifade edilir. Çocuklar dil edinimini bu anlanmlı bütünlük içersinde gerçekleştirirler. Bütünü oluşturan cümleler birbiri ile zamansal, nedensel ya da zıtlık ilişkisi içerisinde olabilir. Söylem bağlaçları bu ilişkilerin okuyucu ya da dinleyici için daha açık olmasını sağlar (Halliday ve Hasan, 1976). *Ama, fakat, bu yüzden* gibi bağlaçlar dinleyici ya da okuyucu için söylem içerisindeki cümlelerin ilişkileri hakkında bilgi verip onların nasıl bağlanması gerektiğini işaret eden yöndergeler olarak da düşünülebilir (Sanders ve Spooren, 2010). Örneğin cümle (1)'in anlamı kullanılan bağlaca göre değişiklik gösterir. Bu cümlecikler *ama* bağlacı ile bağlanırsa sonrasında gelen durum rezerve etme durumuna bir engelmiş gibi anlaşılabilir. Aksine, *çünkü* bağlacı kullanılırsa, reserve etme işinin sebebi sonrsında gelen durum olacaktır. Bağlaçlar olayları ve nedenleri ilişkilerinin nasıl olduğunu belirterek söylemi anlamlandırmada bir araç işlevini görür.

(1) Uçak bileti rezerve edeceğim *ama/çünkü* vize başvurusunda bulunmam gerek.

Bu çalışma temel olarak çocukların bağlaçları nasıl işlemlediklerini araştırmayı hedeflemektedir. Yazılı (Sanders & Noordman, 2000) ve sözlü (Köhne-Fuetterer vd., 2021) olarak bağlaçarın yetişkinler tarafından nasıl işlemlendiklerine dair birçok çalışma mevcut. Örneğin bir kendi hızında okuma çalışması katılımcıların göz hareketlerini incelemiştir. Bu çalışma bağlaçların okunduğu anda entegre edildiği ve çümlenin geri kalanının işlemlenmesinde bu hızlı entegrasyonun etkisinin olduğuna

dair bulgular sunmuştur (Traxler vd.,1997). Dil işlemlenirken çözümleyicinin (ing., parser) mevcut bütün ipuçlarını parallel bir şekilde kullanarak gelecek olan cümleler veya kelimeler ile ilgili öngörüde bulunduğu bilinmektedir (Altmann ve Kamide, 1999; Kamide, Altmann vd., 2003; Kamide, Scheepers vd., 2003). Bağlaçların da duyulduğu ya da okunduğu anda işlemlendiği, bu bağlacın belirttiği anlama göre gelecek olan söylem hakkında öngörülere yol açtığı belirtilmiştir (Köhne-Fuetterer vd., 2021). Örneğin parser cümle (2a)'da *bu yüzden* bağlacı ile karşılaştığında gelecek olan cümlede Ali'nin tatlı bir şey yediğini öngörecektir. Buna karşın (2b) de *ama* bağlacını duyduğunda tatlı ile ilgili olan öngörülerininin tam tersi bir şey yiyeceğini anlar ve diğer seçenekler ile ilgili yeni öngörüler edinir.

(2) a. Ali'nin canı tatlı bir şeyler yemek istiyordu *bu yüzden* …
b. Ali'nin canı tatlı bir şeyler yemek istiyordu *ama*…

Yetişkinler ile yapılan birçok çalışmanın aksine çocukların bağlacı duydukları anda nasıl davrandıklarını inceleyen bir çalışma henüz yürütülmemiştir. Çocukların gerçek zamanlı dil işlemlemesini inceleyen çalışmalar yetişkinlerde olduğu gibi öngörüsel bir işlemleme gözlemlemişlerdir. Örneğin çocuklar "tilki yiyecek" ve "tilkiyi yiyecek" arasındaki farkı duydukları anda anlayıp cümle sonu gelmeden tilkinin yiyebileceği ve tilkiyi yiyebilecek şeyler hakkında öngörüde bulunabilirler (Özge, v.d., 2019). Bğlaçlar için, çocuklarla yapılan çallışmalar genelde bağlaçların hangi yaşta edinildiğine ve çocukların bağlaçları kullanarak cümleler hakkında nasıl çıkarımlar yaptıklarına odaklanmıştır. Bağlaç edinimi çalışmalarına göre çocuklar 2 yaşından itibaren bağlaçları doğru bir şekide kullanabilmektedir (Bloom vd., 1980). Ayrıca 3 ve 4 yaşlarında bağlaçlı olan ve olmayan cümlerere verdikleri tepki değişmektedir (Bernard vd., 2012). Bu da çocukların erken yaşlardan itibaren bağlaçların anlamlarına karşı duyarlı olduklarına işaret ediyor olabilir. Buna ek olarak, çocuklar 2 ve 4 yaşlarında bağlaçların işaret ettiği söylem ilişkilerine dayanarak bilmedikleri kelimelerin anlamı ile ilgili çıkarımda yapabilmektedir (Sullivan et al., 2019). Bu çalışmalarda cümledeki bilinmeyen kelimelerin deneydeki hangi nesneye işaret ettiği bağlacın anlamına göre değişmektedir.

Çocuklar bağlaçların anlamlarını bir işlemleme yönergesi olarak anlayıp buna göre söylem ilişkilerini anlamlandırıp bilmedikleri kelimeler hakkında çıkarım yapabilmektedirler. Bunların aksine, 5 ve 6 yaşındaki çocukların bağlaçarı dikkate alarak yapmaları gereken çalışmalarda özellikle negatif anlam taşıyan bağlaçlarda daha başarısız olduğukları gözlemlenmiştir. Bunun sebebinin olumsuz anlam içeren ifadelerin daha zor işlemlenmesi olarak belirtilmiştir. Bağlaçların anlamsal karmaşıklıkları arasındaki farklılıklara ilişkin bu gelişimsel sırayı kümülatif karmaşıklığın (ing. Cumulative Complexity) açıkladığı ileri sürülmektedir (Bloom vd., 1980). Karmaşıklık sırası, en karmaşıktan en az karmaşıka doğru şu şekilde gösterilebilir:

zamansal < nedensel < olumsuz

Nedensel ve olumsuz bağlaçlar arasındaki farkla ilgili olarak Bloom ve ark. (1980), nedensel cümlelerin aynı zamanda zamansal olduğunu; ancak, olumsuz olanların zamansal, nedensel ve negatif anlam taşıdığını ifade eder. Kümülatif karmaşıklık perspektifinden bakıldığında, söylem bağlayıcılarının karmaşıklığı, taşıdığı anlam sayısı iye doğru orantılıdır. Çocukların bağlaçları bu kümülatif karmaşıklık sırasına göre edindiği bildiriliyor. Başka bir deyişle, çocuklar başlangıçta belirli bir bağlantıyı (örneğin, toplama) öğrenirler, daha sonra nedensel bağlantıyı öğrenirler (örneğin, toplam + zamansal = nedensel). Bu karmaşıklık düzeni aynı zamanda çocukların kavramsal gelişimiyle de uyumludur, çünkü çocuklar öncelikle bir şeyleri bir araya getirmeyi öğrenirler ve daha sonra bu şeylerin zamansal sırasını veya nedensel ilişkisini öğrenirler (Bloom ve diğerleri, 1980). İlkokul çocuklarının hala gelişmekte olan bağlaç bilgilerini (Cain et al., 2005) göz önünde bulundurarak, çocukların bağlaçları entegre etme sistemleri yetişkinlerden farklı olabileceğini düşünebiliriz. Bunun dışında, bağlaç işlemlemesinin çocuklar için daha zor olabileceğini ifade eden üç temel sebepten bahsedebiliriz. Öncelikle, söylemi anlama, birçok cümleyi hızlı ve anlam bütünlüğü içerecek şekilde anlama ve akılda tutmayı gerektirir. Bu da gelişmiş kısa süreli ve çalışma belleği aralığına ihtiyaç

olduğu anlamına gelir. Bu beceriler ergenlik ve sonrasında gelişmeye devam etmektedir (Davidson et al., 2006). İkinci olarak, bağlaçların birçok kullanım yeri ve amacı vardır. Çocuklarda temel olarak bazı bağlaç anlamlarını bilseler bile etkin bir bağlaç kullanımı gelişmiş dil becerisi gerektirir. Bu yüzden bazı kullanımlar çocuklar için anlamlandırması zor olabilir. Son olarak, (2b)'de bahsedildiği gibi, *ama, fakat, buna rağmen* gibi bağlaçlar çözümleyici için var olan öngörüleri tamamen tersine çevirme sinyali verir. Bunu yapabilme gelişmiş bir baskılama becerisi gerektirir. Bu becerinin de ergenlik dönemleride halen gelişmete olduğu bilinmektedir (Davidson vd., 2006). Bahsi geçen gelişimsel becerileri ve çocukların anlama becerisini ölçen çalışmaların sonucunu düşünerek çocukların bağlaçları duydukları anda nasıl anlamlandırdıklarını incelemek gelişimsel olarak işlemleme sisteminin nasıl çalıştığı hakkında aydınlatıcı olabilir. Bu çalışma (I) çocukların nedensel ve ödünleyici bağlaçarı duydukları anda nasıl anlamlandırdığını anlamayı ve (II) bu bağlacı kullanarak anlamı belirsiz olan bir zamir üzerine çıkarım yapma becerilerini incelemeyi hedeflemektedir.

Çalışma

Yukarıda ifade edilen amaçlar doğrultusunda çaşılmanın cevaplamak istediği soruları şu şekilde belirtebiliriz:

1. Çocuklar da yetişkinler gibi nedensel ve ödünleyici bağlaçları duydukları anda entegre edip, bağlacın anlamına göre öngörüde bulunabiliyorlar mı?
2. Bağlacın anlamına göre söylem ilişkilerini anlayıp çıkarım yapabiliyorlar mı?

İlk soruya yanıt aramak için bir göz izleme deneyi dizayn edildi. Göz izleme denylerinde katılımcılardan cümleleri dinlerken bir ekrana bakmaları istenir. Bu çalışmalarda katılımcıların ekran üzerindeki göz haretekleri kaydedilerek katılımcıların hangi milisaniyelerde nereye ne kadar baktıkları incelenir. Bu hareketlerin cümle işlemleme stratejileri hakkında bilgi verdiği öne sürülmüştür (Altmann ve Kamide, 1999). Bu çalışma bu göz hareketlerini analiz ederek katılımcıların bağlacı duydukları anda nasıl işlemlediklerini anlamayı hedeflemektedir. İkinci soruyu yanıtlamak için her cümlenin sonunda bir soru soruldu. Bu soruyu doğru yanıtlayabilmek için katılıncıların bağlacın anlamına göre çıkarım

yapması beklendi. Buna göre katılımcıların nedensel bağlacı duyduğunda ilk öngörüleri ile uyumlu objeye bakmaya devam ederken ödünleyici bağlacı duyduklarında uyumsuz obje hakkında öngörüde bulunacaklarını beklemekteyiz.

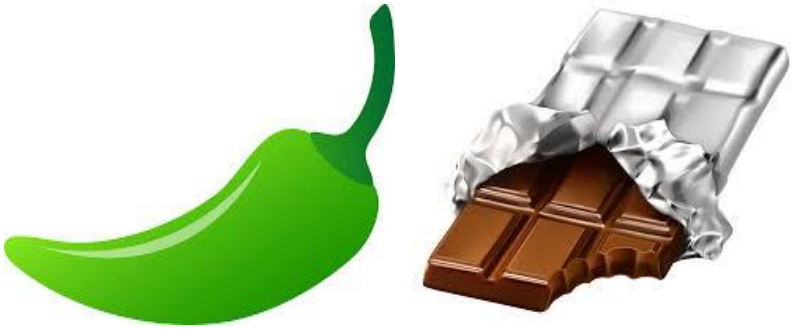
Katılımcılar

Bu çalışmada anadili Türkçe olan 23 çocuk (yaş ortalaması 4;5, 11 kız, 12erkek) ve 15 yer almıştır. Veri bir anaokulunda ve ODTÜ Dil ve Bilişsel Gelişim Laboratuarında toplanmıştır. Katılımcılar herhangi bir işitme ya da görme problemi bildirmemiştir. Çocuk katılımcılar için ebeveynleri bir izin formu imzalamıştır. Deney cümleleri çocukların yaş grubuna göre hazırlandığı için yetişkin katılımcılara çocuklar için hazırlanan bir çalışmada kontrol grubu olarak yer aldıkları bilgisi verilmiştir.

Deney Cümleleri

Göz izleme çalışması için Köhne-Fuetterer vd. (2021) ve Rabagliati vd. (2018) çalışmalarındaki cümleler Türkçe'ye adapte edildi. Önceki çalışmalar çocukların daha az aşina olduğu söz diziminde öngörüde bulunurken zorlandığını gösterdiği için en sık kullanılan özne-nesne-yüklem söz dizimini kullanıldı. Ama cümle (3)'te ifade edildiği gibi bu söz diziminde hedef obje bağlaçtan hemen sonra geldiği için öngörüde bulunmak için yeterli zaman bulunmuyor. Katılımcılara bağlaçtan sonra gelecek obje hakkında tahminde bulunabilmeleri için (4)'te ifade edilen haliyle bağlaçtan sonra objenin ismini söylemek yerine işaret zamiri olara *şunu*'yu kullanıldı. Bu sayede hem katımcıların cümle sonuna gelmeden oluşturduğu öngörüleri gözlemlenebildi hem de cümleden sonra gelen "Sence hangisini yedi?" sorusu ile bağlacın anlamına göre *şunu*'nun hangi objeye işarettiği hakkında çıkarım yapabilme becerisini incelenmiş oldu.

(3) … ama/bu yüzden çikolatayı yedi.
(4) … ama/bu yüzden şunu yedi.



Resim 1. Örnek resim

Katılımcılar 18 deneysel, 4 adet çeldirici olmak üzere toplamda 22 adet cümle grubu dinlemiştir. Çocukl katılımcılara bazı hikayeler dinleyecekleri söylendi ve sonrasında sorulan sorulara elleri ile işaret ederek cevap vermeleri istendi ve araştırmacı çocukların işaret ettiği objeye göre butona bastı. Yeişkin katılımcılar cevaplarını butona basarak verdiler. Katılımcılar, nedensel bağlaç olarak *bu yüzden*, ödünleyici bağlaç olacak *ama* ile bağlanmıs¸ kısa cümleleri dinlediler ve bu sırada bilgisayar ekranındaki iki resime baktılar. Cümle grupları yapılmak, yenilmek, içilmek istenen şeyi niteleyen bir sıfatı içeren birinci cümleden (5a) ve ardından *ama* ya da *bu yüzden* ile bağlanmış sonucu beliten ikinci cümleden oluşur (5b). Bu cümleleri dinlerken çocuklar ekranda bir adet sıfat ile uyumlu nesne (örn. tatlı sıfatı için çikolata resmi) ve sıfat ile uyumsuz bir nesne (örn. tatlı sıfatı için bir biber resmi) gördü (Resim 1). Bu iki cümlenin ardından çocuklardan, sonuç olarak ne olduğunu bağaca göre karar verme mekanizmalarını test etme amacı ile iki resimden birini seçmeleri istendi (5c).

(5) a. Ali tatlı bir şey yemek istedi.
b. Bu yüzden/Ama şunu yedi.
c. Sence Ali hangisini yedi?

Bu deneye ek olarak çocukların ve yetişkinlerin çalışma ve kısa süreli bellek alanı ve ayrıca baskılama yeteneklerini ölçmek için iki ayrı aktivite daha yapıldı. Bellek testleri için sayı uzam görevi kullanıldı. Bu testte katılımcılardan duydukları sayı dizisini ileri ya da geri yönde tekrar etmesi istendi. Baskılama becerileri için ise mutlu-üzgün testi kullanıldı. Bu testte ilk kısımda katılımcılar ekranda gördükleri yüzleri mutlu ya da

üzgün olarak tanımlarlar. İkinci kısımda katılımcılar gördükleri yüzün tam tersini söylerler (örn. Mutlu yüz görünce üzgün demeleri bekenir.).

Tahminler

Önceki çalışmalara dayanarak (Altmann & Kamide, 1999), katılımcılar ilk cümlede sıfatı duydukları için bu kısımda sıfat ile uyumlu olan nesneye bakacaklardır. Ardından, nedensel bağlaç *bu yüzden* olağan nedensel çıkarımı pekiştirdiği için, katılımcıların nedensel bağlacı duyduklarında sıfat ile uyumlu bağlaca bakmaya devam edeceklerini ve sorulan soruda bu tahminlerini kullanarak sıfat ile uyumlu olan nesneyi seçeceklerini öngörüyoruz. Aksine ama bağlacı olağan nedensel öngürüyü reddedip, gelecek olan cümlenin bu öngörü ile çelişen bir anlam içerdiğini belirttiği için katılımcıların ama bağlacını duyduklarında sıfat ile uyumlu cümleye bakmayı bırakıp uyumsuz cümleye daha çok bakması beklenir. Önceki çalışmalar yetişkinlerin bunu bağlacı duyduktan hemen sonra yapabildiğini göstermiştir (Köhne-Fuetterer et al., 2021). Yetişkinlerin (5c)'de sorulan soruda da *ama* ile değişmiş olan öngörülerini kullanarak sıfat ile uyumsuz nesneyi seçmelesi beklenmektedir. Edinim çalışmalarını ve bu çalışma için yapılan öntesti göz önünde bulundurursak, çocuklar *ama* bağlacının anlamını bildikleri için eğer yetişkinler gibi işlemliyorlarsa aynı şekilde bağlacı duydukyan sonra sıfat ile uyumsuz objeye bakmaları beklenir. (5c)'de sorulan soruya da aynı şekilde cevap vermeleri beklenebilir ama çocuklardan bu şekilde çıkarım yapmalarını isteyen çalışmaların ödünleyici bağlaçlarda yetişkinler gibi bir performans sergileyemediğini göstermiştir (Dragon, vd., 2015). Online ve offline çalışmalarda çocukların gösterdiği değişken performans çalışmaların yapısından kaynaklandığını ileri sürmüştür (Huang ve Snedeker, 2015). Online çalışmalarda otomatik olarak gelişen dil işlemleme süreci incelenir. Buna karşın offline çalışmalar katılımcılardan direkt bir şekilde çıkarım yapmalarını ister. Bu çalışmalarda katılımcılar bir butona basar, bir yeri gösteriri ya da nesnelerin yerini değiştirir. Bu testler dil işlemleme sürecinin haricindeki başka süreçleri de dahil etmektedir. Bunları göz önünde bulundurarak bu çalışmalar gerçek zamanlı işlemleme hakkında yeterince bilgi vermeyebilir.

İşlemlemenin yanısıra çıkarım yapma becerisini etkileyebilecek olan çalışma ve kısa süreli bellek ve baskılama yetenekleri de test edildi. Çalışma belleği bigileri hafızada tutabilme, yeni bilgiler ve eski bilgileri bağdaştırma ve bunları kullanarak problem çözebilme becerisini kapsar. Bağlaçları anlamak ve işlemlemek de önceki bilgilerin hatırlanması ve bağlaca göre yeni bilgilerle birleştirilmesini gerektirir. Çalışma belleğinin kapsamının halen gelişiyor olması çocukların bağlaçları kullanarak çıkarım yapmalarını zorlaştırıyor olabilir. Aynı zamanda *ama* gibi ödünleyici bağlaçlar varolan öngörüleri baskılayıp bu öngörülerle çelişen bir anlam ile söylem bütünlüğü kurulacağına işaret eder. Bu yüzden çocuklarda gelişmekte olan baskılama becerileri, *ama* gibi bağlaçların nedensel bağlaçlardan daha zor anlaşılmasına ve işlemlenmesine yol açıyor olabilir.

Deney Sonuçları

Katılımcıların saniyelere göre değişen objelere bakma oranını gösteren grafiğe göre bağlaçlar çocukların yetişkinler gibi bağlacın anlamına göre öngörüde bulunabildiğini göstermiştir. Buna göre her iki bağlaç durumunda da katılımcılar ilk cümlede sıfat ile uyumlu olan objeye bakmışlardır (örn. Tatlı sıfatı için çikolata resmine bakmışlardır). Her iki yaş grubu da *bu yüzden* bağlacını duyduklarında uyumlu objeye bakmaya devam etmiş ve cümle sonuna kadar bakışlarını bu obje üzerinde tutmuştur. Ama bağlacını duyduklarında ise gözlerini bağlaç ile uyumsuz olan objeye çevirmişlerdir (örn. Tatlı sıfatı için çikolata resmine bakarken gözlerini biber resmine çevirmişlerdir.). Buna karşın, yetişkinler cümle sonuna kadar uyumsuz nesneye daha çok bakmaya devam ederken çocuklar cümle bitiminde bakışlarını tekrar sıfat ile uyumlu nesneye çavirmiştir. Çocukların cümle sonunda bu şekilde bir işlemleme şekli göstermesi anlama yetisini ölçen sorulara verdikleri yanıtlar ve bellek yetenekleri göz önünde bulundurularak tartışılacaktır.

Bakma oranlarında cümlenin duyulduğu sırada yaş ve bağlaç durumunun etkisi olup olmadığını istatiksel olarak test etmek için Generalized Additive Model (GAM) analizi kullanıldı. Katılımcıların resimlere bakış oranları bağımlı değişken olarak alınmıştır. Yaş (çocuk ve yetişkin) ve bağlaç türü (nedensel ve ödünleyici) bağımsız değişkendir.

Zaman içerisinde, katılımcıların cümleleri dinlediği sırada, değişen göz hareketleri incelenmiştir. Bağlacın etksini görebilmek adına bağlaçtan sonraki kısım analiz edilmiştir. Sonuçlar yaşın ve bağlacın bakışlar üzerinde önemli bir etkisi olmadığını göstermiştir. Buna göre her iki grubun da bağlacı duyduktan sonra benzer şekilde hedef objeye daha çok bakmıştığını söyleyebiliriz. Sonuç olarak çocuklar da yetişkinler gibi hem nedensel hem de ödünleyici bağlaç anlamını duyduktan hemen sonra öngörüsel bir şekilde işlemlemiştir.

Çocukların göz hareketlerinde yetişkin gibi davranmasına karşın çıkarım sorularına verdikleri yanıtlar ki hem nedensel hem de ödünleyici bağlaç koşullarında çocuklar yetişkinlerden çok daha zatıf bir performans gösterdiğini ortaya koymuştur. Buna et olarak yetişkinlerde iki bağlaç koşulu arasında önemli bir fark olmazken çocuklar nedensel bağlaç koşulunda ödünleyici bağlaca göre çok daha zayıf bir performans sergilemiştir. Bu sonuç çocukların *ama* bağlacını kullanarak *şunu* ile atıfta bulunulan nesne hakkında çıkarım yapamayıp sıfat ile çıkarım yapmayı tercih ettiklerine işaret etmektedir. Çocukların ödünleyici bağlaç koşulunda yaşadığı zorluk daha önceki offline çalışmalar ile uyumludur. Bu bağlaçların yetişkinlere benzer bir şekildre işlemlenmesine ragmen çocukların görece zayıf performansı gelişmekte olan bilişsel fonksiyonları (örn. baskılama yetenekleri) ya da yetişkinlere göre daha düşük olan kısa süreli hafıza ve çalışma hafızası becerileri ile ilgili olabilir.

Göz izleme çalışmasına ek olaran katılımcıların bilişsel becerilerini ölçmek için yaptığımız çalışmaların sonucu bu becerilerin ergenlik dönemlerine kadar devam ettiğini öne süren çalışmlara ile uyumludur. İşlemsel bellek ($t(19.068) = -3.7267$, $p<0,01$), kısa süreli bellek ($t(22.838) = -4.0882$, $p < 0,001$) ve baskılama ($t(61.978) = -2.6904$, $p < 0,01$)) testlerinde çocuklar yetişkinlere göre daha zatıf bir performans sergilesmiştir. Bu sonuç çocukların çıkarım yapmaları gereken sorulardaki yetişkinlere göre daha zayıf olan performanslarını açıklayabilir.

Bu çalışma temel olarak çocukların nedensel ve ödünleyici bağlaçları gerçek zamanlı olarak nasıl işlemlediğini incelemeyi hedeflemiştir. Çocukların bağlaç edinimini ve nasıl anladıklarını inceleyen çalışmalar birbiri ile çelişen sonuçlar ortaya koymuştur. Edinim süreçlerini inceleyen çalışmalar bağlaçların karmaşıklığına göre bir edinim sırası olduğunu ve bu sıraya göre çocukların 2 be 3 yaşlarında bağlaçları kullanabildiğini göstermiştir (Bloom vd., 1980). Buna karşın bağlaçların anlamlandırılmasını inceleyen çalışmalar çocukların 5-6 ve 10 yaşlarında dahi yetişkinler gibi bir performans sergiyeyemediğini ortaya koymaktadır (Spenader, 2017; vd., 2017). İlkokul yaşlarında halen devam eden gelişmenin yanısıra çalışmalar çocukların bağlaçları kelime öğrenmek için bir çıkarım aracı olarak kullanabildiğini göstermiştir (Sullivan vd., 2019; Sullivan ve Barner, 2016). Benzer şekilde bunu test eden başka bir çalışma ödünleyici bağlaçları çocukların 3 ve 4 yaşlarında daha iyi bir performans sergilediğini ancak 5 ve 6 yaşlarında çıkarım aracı olarak kullanamadığını ve ilerleyen yaşlarda bu şekilde kullanabildiğini göstermiştir (Rabagliati vd., 2018). Anlama süreçlerini inceleyen bütün bu çalışmalar katılımcıların cümleleri dinledikten sonra verdikleri cevapları analiz etmiştir. Bu yüzden yukarıda da bahsedildiği gibi offline çalışmalar dil işlemleme dışında başka işlemlemeleri de kapsadığı için gerçek zamanlı işleme ile ilgili yeterli bilgi veremiyor olabilir. Bunlara ek olarak yetişkinlerin bağlaçları öngörüsel bir şekilde işlemledğini öne süren çalışmalarda da nedensel ve ödünleyici bağlaçlar karşılaştırıldığında, cümle sonlarındaki anlam sorularında ödünleyici bağlaçlarda daha zayıf bir performans gözlemlenmiştir (Köhne-Fuetterer et vd., 2021). Bu sonuç hem ödünleyici bağlaçların negative anlam taşıdığı için daha karmaşık olmasından ve bu karmaşıklığa eşlik eden anlam sorularının çıkarım yapma süreçlerinde gerektirdiği bellek ve baskılama yükü olabilir. Bu ekstra işlemlemeleri dahil etmeden sadece bağlaçları incelemek için bu çalışmada bir göz izleme çalışması dizayn edildi (Visual World Eye Paradigm Eye Tracking). Bu sayede katılımcıların bağlacı duyduktan sonra nasıl bir işlemleme stratejisi izlediği gerçek zamanlı olarak incelenebildi. Bu çalışmada bir nedensel (bu yüzden) bir ödünleyici bağlaç (ama) incelenmiştir. Katılımcılar bu bağlaçları içeren cümleleri dinlerken iki obje içeren bir ekrana bakmışlardır ve bağlaca göre hangi objeye ne kadar baktıklarını incelemek için ekran üerincdeki göz hareketleri kaydedilmiştir. Bakma oranları bağlaç öncesinde ilk cümlede duyulan sıfat ile uyumlu nesneye bakmaya başladıklarını göstermiştir.

Nedensel bağlaç (bu yüzden) duyulduğunda iki yaş grubu da bu nesneye bakmaya devam etmiştir. Ödünleyici bağlaç duyulduğunda ile katılımcılar sıfat ile uyumsuz olan nesneye bakmışlardır. GAM analiz sonuçları da bağlaçtan sonra iki yaş grubunun iki bağlaç koşulunda da hedef nesneye benzser şekilde baktığını göstermiştir. Çocuklar da yetişkinler gibi nesnenin adı duyulmamasına rağmen bağlacı duymaz kullanıp bahsi geçen obje hakkında cümle bitmeden önce öngörüde bulunmuştur.

Benzer gerçek zamanlı işlemleme stratejilerine rağmen cümle sonlarında sorulan, bağlaca göre çıkarım yapmalarını gerektiren soruya verilen yanıtlar iki yaş grubunda ve bağlaç koşullarında değişiklik göstermiştir. Çocuklar bu sorulara her iki bağlaç koşulunda da yetişkinler gibi cevap verememişlerdir. İki bağlaç koşulu karşılaştırıldığında ise ödünleyici bağlaç koşulunda çocuklar daha fazla yanlış cevap vermişlerdir. Bu sonuç negative anlam taşıyan bağlaçların diğerlerine göre daha geç edinildiğini ileri süren çalışmalar ile uyumludur.

Sonuç

Bu çalışma çocukların yetişkinler gibi nedensel ve ödünleyici bağlaçları duyar duymaz anlamlandırıp söylem ile ilgili öngörülerde bulunabildiğini göstermiştir. Buna karşın çıkarım sorularında çocuklar daha zayıf bir performans göstermiştir. Göz izleme çalışması sadece otomatik olarak gerçekleşen dil işlemlenmesini gerçek zamanlı olarak göstermiştir ancak çıkarım sorularında çocuklar önceki bilgilerini kullanmak, bağlaç bilgisini hatırlamak ve seçim yapmak gibi ekstra görevleri yerine getimişlerdir. Ki bu görevleri tamamlamak çalışma belleği ve baskılama yetileri gerektimektedir. Bu iki veri toplama metodundaki farklılıklar göz önünde bulundurarak, bu çalışmada çocuklar gerçek zamanlı işlemleme sırasında yetişkinlerden farklı bir yol izlememiş olsalar da çıkarım yaparken aynı şekilde davranmamalarının sebebi bu çalışmada da ifade edilen gelişmekte olan bilişsel becerileri olabilir. Sonraki çalışmalar bu bilişsel becerilerin nasıl geliştiğini incelemek için daha geniş bir yaş grubunu test edebilir. Buna ek olarak çocukların bu bilişsel gelişimindeki bireysel farklılıklarının bağlaçları nasıl işlemledikleri üzerindeki etkisi araştırılabilir. Bu çalışma bilişsel becerilerin dil

gelişimindeki önemini gösteren çalışmalara ek olabilir. Çocuklar için eğitim programlarının hazırlanmasında dil öğretimini pekiştirmek için bilişsel gelişimin desteklenmesi çok önemli olabilir. Buna ek olarak, bu çalışmanın sonuçları ikinci dil öğrenimi alanında da kullanılabilir. Bağlaçların karmaşıklık yapısı öğrenme süreçlerini etkileyebileceği için programlamada buna dikkat edilebilir. Ayrıca bağlaçların anlam ilişkileri hakkında bilgi vermesine ve öngörülere yol açmasına dayanarak ikinci dil öğrencilerinin de bağlaç anlamlarında yola çıkarak söylem ilişkilerini çözüp, yeni kelimeler öğrenmesi mümkün olabilir.

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