THE COMPREHENSION AND PRODUCTION OF COUNTERFACTUALS BY INDIVIDUALS WITH SCHIZOPHRENIA

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ABSTRACT

THE COMPREHENSION AND PRODUCTION OF COUNTERFACTUALS BY INDIVIDUALS WITH SCHIZOPHRENIA

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Counterfactuals (*If Mary had studied hard, she would have passed the exam)* are complex linguistic structures that require morphosyntactic, semantic and pragmatic prerequisites along with cognitive abilities such as counterfactual reasoning, theory of mind, working memory and inhibition. Although the comprehension and production of counterfactuals have been extensively investigated in neurotypical populations, research on the processing of counterfactuals remains scarce in clinical populations. Schizophrenia, a psychiatric condition associated with executive dysfunction and language impairment, provides a suitable context for the examination of counterfactuals. The present study thus aimed to investigate the comprehension and production of counterfactuals in Turkish (*Dersine çalışsaydı sınavı geçerdi*) by individuals with schizophrenia. 40 Turkish-speaking individuals with schizophrenia in symptomatic remission and 40 matched healthy controls completed a truth-value judgment task to test their comprehension, and a dialogue completion task to test their production of counterfactuals. Results indicated that individuals with schizophrenia performed significantly worse in both comprehension and production of counterfactuals with lower accuracy rates compared to the control

participants, indicating a deficit in counterfactual processing. Further analyses revealed that education was a significant predictor in the schizophrenia group for improved comprehension and production of counterfactuals. These findings suggest that counterfactual comprehension and production deficits should be considered a key target in cognitive/linguistic rehabilitation programs for individuals with schizophrenia, and highlight the potential role of education in mitigating linguistic and cognitive impairments associated with the disorder.

Keywords: Counterfactuals, schizophrenia, language impairment

ÖZ

KARŞI OLGUSALLARIN ŞİZOFRENİ TANILI BİREYLER TARAFINDAN ANLAŞILMASI VE ÜRETİLMESİ

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Karşı olgusallar ifadeler (Dersine çalışsaydı sınavı geçerdi) biçim-sözdizimsel, anlamsal ve edimbilimsel önkoşullarının yanı sıra karşı olgusal muhakeme, zihin kuramı, çalışma belleği ve ket vurma gibi bilişsel yetileri de gerektiren karmaşık yapılardır. Karşı olgusalların anlama ve üretme süreçleri tipik gelişim gösteren bireylerde kapsamlı olarak araştırılmış olsa da, klinik popülasyonlarda bu yapıların işlemlenmesine yönelik araştırmalar sınırlıdır. Yürütücü işlev bozuklukları ve dil bozukluğu ile ilişkili bir psikiyatrik durum olan şizofreni, karşı olgusalların incelenmesi için uygun bir bağlam sunmaktadır. Bu çalışma, şizofreni tanısı almış bireylerde Türkçedeki karşı olgusal cümlelerin anlama ve üretme örüntülerini incelemeyi amaçlamıştır. Çalışmaya semptomatik remisyonda olan ve anadili Türkçe olan 40 şizofreni tanılı birey ve 40 sağlıklı birey katılmıştır. Katılımcıların karşı olgusalların anlama örüntülerini anlamak için Doğruluk Değeri Yargı Görevi, üretim becerilerinin ölçümü için ise Diyalog Tamamlama Testi katılımcılara uygulanmıştır. Bulgular, şizofreni grubunun her iki görevde de kontrol grubuna kıyasla anlamlı düzeyde daha düşük performans gösterdiğini ve karşı olgusal işlemlemede bir bozulma olduğunu ortaya koymuştur. Ek analizler, şizofreni grubunda karşı olgusal

anlama ve üretme performansının eğitim düzeyiyle anlamlı biçimde ilişkili olduğunu göstermiştir. Bu bulgular, karşı olgusal anlama ve üretme bozukluklarının, şizofreni tanılı bireyler için bilişsel/dilsel rehabilitasyon programlarında temel bir hedef olarak ele alınması gerektiğini, ve eğitimin, bozukluğa eşlik eden dilsel ve bilişsel yetersizlikleri hafifletmedeki potansiyel rolünü ortaya koymaktadır.

Anahtar Kelimeler: Karşı olgusallar, şizofreni, dil bozukluğu

To my loved ones

and

Those who never give up, even under oppression

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I am immensely grateful to my beloved family. I thank my mother Tülay Yılmaz for always supporting me (to the extent that helping me to find participants for the control group), my father Fırat Yılmaz for providing whatever I needed to help me achieve my goals and dreams, and my older sister Hilal Özenç for her support, and even guidance as a kid to help me figure out what I want to do in my life (practically I owe my career to her). I love you all very much.

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LIST OF ABBREVIATIONS

ASD	Autism Spectrum Disorder
CF	Counterfactual
CFT	Counterfactual Thinking
CIT	Counterfactual Inference Test
FTD	Formal Thought Disorder
GLMM	Generalized Linear Mixed Model
HFASD	High-Functioning Autism Spectrum Disorder
PANSS	Positive and Negative Syndrome Scale
PTCFs	Past Tense Counterfactuals
SLI	Specific Language Impairment
TD	Typically Developing
TMT	Trail Making Test
ToM	Theory of Mind

CHAPTER 1

INTRODUCTION

1.1. Counterfactuals

Conditionals are statements that are composed of the relationship between two propositions: protasis (p) and the apodosis (q) (Comrie, 1986). Such statements have a crucial role in communication since they involve talking about a hypothetical scenario and the consequences of it. An "if p then q" statement consists of two clauses: the antecedent where the hypothetical scenario is given, and the consequent where the result of the hypothetical scenario is mentioned. Conditionals can be categorized into *indicative/factual* conditionals and *subjunctive/counterfactual* conditionals. Indicative conditionals are used to talk about situations that happened in real life or are likely to happen as in (1).

(1) If Mary studies hard, she will pass the exam.

On the other hand, counterfactuals denote conceptual or imaginary alternatives that refer to situations that may have happened but did not happen in reality (Starr, 2021). In other words, counterfactuals talk about what might have happened in an alternative situation, which entails a possible world proposed to the factual world. An example of a counterfactual sentence can be seen in (2).

(2) If Mary had studied hard, she would have passed the exam.

Counterfactual sentences entail negation of the antecedent clause (Anderson, 1951). Thus, the sentence *If Mary had studied hard, she would have passed the exam* denotes the meaning that Mary did not study hard enough and, consequently, failed.

The structure of counterfactual statements may vary from language to language. Counterfactuals are usually associated with the subjunctive mood (von Fintel, 2012; Karawani, 2014). However, the subjunctive mood may not always convey a counterfactual meaning (Iatridou, 2000, 2014). For instance, as Aktepe (2022) stated, the subjunctive mood does not have a counterfactual meaning in French. For this reason, von Fintel & Iatridou (2020) suggested that for a sentence to infer a counterfactual meaning, the verb must be x-marked. X-marking is the requirement that the verb must be composed of a certain morphological structure in order for the counterfactual meaning to occur. For instance, English requires the antecedent to be inflected in the past tense, the consequent to be in the perfect form, and the structure must be able to be inverted.

In Turkish, counterfactuals and indicatives are differentiated with the help of linear morpheme order. For instance, indicatives are marked with the conditional suffix *-ysA* along with temporal verbal inflection *(-dI, -r, -AcAk).* In indicatives, the temporal suffix is first attached to the root of the verb, followed by the addition of the conditional suffix *-ysA* to the verb conjugation as in (3).

(3)	Onur	bavulu	taşı-dı-ysa	yorulur.
	Onur-Nom	suitcase-Acc	carry-Past-Cond	tired-Aor
	If Onur has carried the suitcase, he will be tired.			

For counterfactuals, Turkish requires the conditional marker- sA to be affixed before the tense marker as in (4).

(4)	Onur	bavulu	taşı-sa-ydı	yorulurdu.
	Onur-Nom	suitcase-Acc	carry-Cond-Past	is tired-Aor-Past
	If Onur had carried the suitcase, he would have been tired.			

Turkish counterfactuals are considered to be morphosyntactically complex structures for speakers due to the compact combination of the tense markers and the conditional marker, as well as changes in the position of the conditional marker leading to changes in meaning (Yarbay-Duman et al., 2016). Counterfactuals are also

semantically and cognitively complex statements due to dual meaning representation (Fauconnier, 1994; Johnson-Laird & Byrne, 2002). A counterfactual statement such as *If I had wings I would be able to fly* proposes two representations of the event: the counter-to-the-fact state of having wings and being able to fly, and the actual state of not having wings and therefore not being able to fly. Kulakova and Nieuwland (2016a) stated in their review that the triggering of dual meaning representation in language comprehension is one of the defining features of counterfactuals. According to the findings of Urrutia (2012), the two representations are activated simultaneously, suggesting that dual meaning representation might cause a processing cost since the comprehenders need to inhibit one of the representations.

Along with the morphosyntactic/semantic difficulty, for speakers to comprehend and produce counterfactual statements, they must meet various cognitive requirements such as counterfactual reasoning, theory of mind, inhibition and working memory (Aktepe, 2022). Counterfactual reasoning enables one to shift from the factual world to alternative possibilities. It is one of the vital skills for humans since it provides assistance to learn from past experiences, plan or predict the upcoming event, regulate adaptive behavior and make judgements emotionally or socially such as blaming someone or regretting a past action (van Hoeck et al., 2015). It has been proposed that counterfactual reasoning is composed of three stages, which are activation, inference and adaptation, as illustrated in Figure 1.1 (Byrne, 2002; Epstude and Roese, 2008). In the activation stage, the prior events are activated and a mental simulation of the event is created. This activation triggers mental simulations of counter-to-the-fact scenarios including different circumstances and outcomes. The counterfactual simulations trigger the interpretion of the factual event and adaptive behavior for planning and problem-solving. Counterfactual reasoning plays an important role in comprehending counterfactual statements since it enables one to simulate alternative possibilities in mind.

The comprehension of counterfactuality is highly relevant to theory of mind (ToM), a socio-cognitive skill enabling humans to understand others' state of mind. The comprehension of counterfactuals requires perspective-taking since counterfactuals

require the understanding of a perspective that is contrary to reality: the perspective of the *possible* world. Similar to counterfactuals, ToM situations involve information regarding both one's reality and another person's reality, beliefs, and intentions. Therefore, it can be suggested that ToM necessitates a dual comprehension process involving multiple mental states, just as counterfactuals do (Ferguson et al., 2010). Considering the resemblance of the processes of these two cognitive functions, ToM is even interpreted as "a special case of counterfactual thinking" (Leslie, 1987; Riggs et al., 1998).

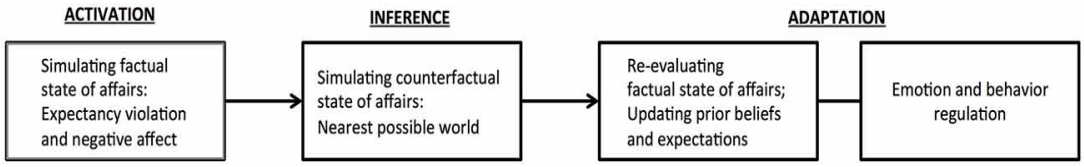

Figure 1.1. Stages of counterfactual reasoning (van Hoeck et al., 2015)

One of the core components of executive functions is inhibition, the skill to suppress irrelevant stimuli for a goal-oriented task or process. MacLeod (2007) defines inhibition as the stopping or overriding of a cognitive process as a whole or in sections, with or without intention. In terms of the comprehension of counterfactuals, inhibition is another important cognitive function since it enables the comprehender to suppress a factual event and engage in the alternative possibility that is proposed through the counterfactual statement. For instance, to comprehend the statement *If she had studied, she would have passed the exam*, the automatic tendency to focus on the factual scenario -she did not study enough and she failed- must be inhibited by the speaker.

The comprehension of counterfactuals also relies on working memory, which can be defined as the capacity to hold and manipulate information temporarily during the course of a neurocognitive task such as comprehension, learning, and reasoning (Baddeley, 1986). Counterfactuals require one to generate multiple alternative scenarios and keep these alternatives in mind, which is highly dependent on one's working memory capacity. As counterfactual statements necessitate various cognitive requirements, individuals with certain conditions affecting neurocognitive functions may find it challenging to understand or use counterfactual structures.

1.2. Schizophrenia and Language Impairment

The ability to use and understand language is almost effortless in humans, even when they are in their developmental stages. This unique capacity for encoding and decoding language might be disrupted due to certain neurocognitive deficits. Schizophrenia is a medical condition which is characterized by impairment in various executive functions which are necessary for the accurate use and processing of counterfactual expressions during communication. According to the diagnostic criteria specified in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-V, American Psychiatric Association, 2013), the typical symptoms of schizophrenia are the following: delusions –false beliefs related to reality-, hallucinations –distorted perceptions of sensory stimuli that are not actually present-, disorganized speech, grossly disorganized or catatonic behavior and negative symptoms such as decreased emotional expressions (McCutcheon et al., 2020). The symptoms of schizophrenia are categorized into positive symptoms such as delusions, hallucinations and disorganized speech, indicating a distortion or excess in the functioning, and negative symptoms such as poverty of speech (alogia) or decreased emotional expression, indicating a deterioration or decrease in functioning.

Individuals with schizophrenia have been reported to have impairment in various executive functions, including inhibition, working memory, and theory of mind abilities (Badcock et al., 2002; Brüne, 2005; Forbes et al., 2009; Frith, 2004; Galaverna et al., 2012; Lee and Park, 2005). Not only cognitive abilities but also components of language are affected negatively in patients with schizophrenia. In fact, language impairment is one of the main features of the condition (DeLisi, 2001). In the literature, individuals diagnosed with schizophrenia are predominantly associated with impairment in the communicative aspects of language (Champagne-Lavau and Stip, 2010; Marini et al., 2008; Mazza et al., 2008). However, schizophrenic patients have been found to exhibit lower performance in complex morphosyntactic structures or use less complex structures compared to healthy individuals (Walenski et al., 2010; Ziv et al., 2022). Moreover, neuroscientific studies have pointed at an impairment of the frontal-basal ganglia in individuals with schizophrenia, which suggests a possible difficulty in processing rule-governed

information such as grammar (Ullman, 1998; Walenski et al., 2007; Walenski et al., 2014).

1.3. Significance of the study

Although the processing of counterfactuals has been widely studied in adults and children, such studies are scarce in atypical populations. Schizophrenia is one of the conditions that has not been widely investigated within the scope of the processing of counterfactuals. The investigation of counterfactuals in this specific mental health condition can shed light on the processing of counterfactuals since, as indicated earlier, schizophrenia is a disorder where multiple aspects of cognition are impaired, such as reasoning and theory of mind. Due to the fact that counterfactual reasoning and theory of mind abilities are prerequisites for comprehending a counterfactual sentence, and patients with schizophrenia are reported to have deficits in these cognitive functions, schizophrenia is an ideal condition to investigate counterfactuality.

Although language patterns of individuals with schizophrenia have been studied extensively in the literature, research is largely limited to the investigation of pragmatic abilities. Rule-governed aspects of language such as phonology, syntax, morphology and semantics have been relatively less investigated. Against this background, this present study aimed to shed light on the morphosyntactic and semantic abilities of individuals diagnosed with schizophrenia.

In the psychiatry literature, counterfactuality has been examined in schizophrenia in terms of counterfactual reasoning/thinking abilities (Hooker et al., 2000; Contreras et al., 2016; Contreras et al., 2017; Albacete et al., 2017; Tagini et al., 2021). However, previous schizophrenia research has not handled the concept of counterfactuality as a linguistic phenomenon. This study will be the first to examine the comprehension and production patterns of counterfactual structures by individuals diagnosed with schizophrenia.

1.4. Research Questions and Hypotheses

Against this background, the current study investigated the comprehension and production of counterfactuals by individuals diagnosed with schizophrenia. It aimed to answer the following research questions:

1. Can patients with schizophrenia comprehend and produce counterfactuals despite their morphosyntactic, semantic and cognitive complexity?

2. To what extent are counterfactual comprehension and production scores in individuals with schizophrenia associated with clinical severity (symptom severity, duration of condition), cognitive performance (executive functions), and demographic characteristics (age and education)?

On the basis of the findings reported in earlier studies, it was hypothesized that patients with schizophrenia would display a poorer performance in the comprehension of counterfactuals compared to indicative conditionals due to their cognitive and semantic complexity. For production, it was predicted that schizophrenia patients would produce fewer conditional sentences due to the morphosyntactic complexity. It was further predicted that individuals with schizophrenia would produce morphologically less complex sentence structures to convey counterfactual meaning. For the second research question, it was hypothesized that scores in counterfactuals would be influenced by clinical and cognitive traits of patients, since executive dysfunction would lead to decreased abilities in the language domain.

CHAPTER 2

LITERATURE REVIEW

2.1. The Processing of Counterfactuals in Typical Adults

The processing of counterfactuals has been the focus of extensive empirical research in typical populations. The majority of studies has focused on the cognitive load that is created by the dual meaning involved, whether propositional truth-value affects the comprehension of such sentences, and the pragmatic basis of processing counterfactual information.

2.1.1. Studies on Dual Meaning Representation of Counterfactuals

With the aim of better understanding how counterfactuals are processed, researchers investigated the underlying mechanisms that contribute to their complexity. One of the key research focus has been on the dual meaning representation, which certain cognitive theories have attempted to explain by proposing that humans comprehend such sentences by keeping two representations in mind. Fauconnier's (1994) Mental Space Framework suggests that counterfactuals are mental space builders that carry information from the "parent" space that entails factual information. Johnson-Laird and Byrne's (2002) Mental Model Theory proposes that counterfactuals require the construction of two separate mental models: one for the imagined scenario and one for the factual state of the event. Studies on dual meaning representation in counterfactuals generally test Mental Model Theory, since it formulates clearer and more testable predictions compared to The Mental Spaces Framework (Kulakova & Nieuwland, 2016a). The review by Kulakova and Nieuwland (2016a) synthesizes a broad range of experimental studies investigating the processing of counterfactuals specifically on dual meaning representation the simultaneous activation of a

suppositional and an implied factual representation. Offline studies, including sentence verification and recognition tasks provide evidence for dual meaning representation, though often criticized for task demands (Carpenter, 1973; Fillenbaum, 1974; Thompson & Byrne, 2002). Apart from offline studies, online behavioral methods such as self-paced reading and eye-tracking (Stewart et al., 2009; Ferguson, 2012) and EEG studies (Kulakova et al., 2014; Nieuwland & Martin, 2012) suggest that counterfactuals entail higher cognitive load, possibly due to their complexity stemmed from dual meaning. Moreover, fMRI studies (Nieuwland, 2012; Kulakova et al., 2013) show greater activation in areas linked to semantic processing and mental imagery during counterfactual comprehension.

In one of the prominent studies testing the Mental Model Theory, Kulakova et al. (2013) investigated the neural correlates of counterfactual sentence processing. The main aim was to understand whether counterfactual sentences, which contradict reality, require different brain regions to be activated compared to the processing of hypothetical sentences, which align with reality. To test this, the researchers conducted an fMRI experiment where 21 German participants read or listened to conditional sentences in both counterfactual and hypothetical conditions. All written and spoken stimuli consisted of German sentences, where a factual sentence such as "Der Motor ist heute aus (The motor is switched off today)" was followed by either a counterfactual conditional "Wenn der Motor heute an wäre, würde er dann Treibstoff verbrauchen? (If the motor was switched on yesterday, did it burn fuel?)" or a hypothetical conditional "Wenn der Motor gestern an war, hat er dann Treibstoff verbraucht? (If the motor was switched on yesterday, did it burn fuel?)". In the stimuli, the antecedent in the counterfactual contradicted the preceding factual statement, whereas hypotheticals did not. The results showed that accuracy rates were high across both conditions. As for the reaction times, counterfactuals yielded slower reaction times, indicating a higher level of cognitive effort. The fMRI results reported a significantly greater activation in the right cuneus (occipital cortex) and marginally in the right caudate nucleus (basal ganglia) when participants processed a counterfactual sentence compared to a hypothetical conditional sentence, regardless of modality. Since the right cuneus is associated with visual processing/mental imagery, and the caudate nucleus with the suppression of competing information, it

can be concluded that counterfactuals simultaneously engage both actual and supposed events, which is consistent with the Mental Model Theory. This study also reveals that counterfactual thinking involves enhanced mental imagery and integration effort.

Urrutia et al. (2012) aimed to explore the neural mechanisms underlying the comprehension of counterfactuals, specifically those describing actions varying in physical effort. The researchers investigated whether sentences denoting counterfactual actions activated motor-related regions in the brain similar to those activated by sentences denoting factual actions. Moreover, they aimed to examine whether counterfactual processing required additional control mechanisms due to multiple action -factual and counterfactual- representations. To answer their research questions, they ran an fMRI study to measure brain activation as 18 Spanish-speaking participants read 120 factual or counterfactual sentences in Spanish, which either mentioned high-effort or low-effort actions. An action execution task was also conducted to localize the regions that are involved in real physical effort, which involved squeezing a soft toy ball repeatedly for this specific task. The findings revealed activation in the inferior parietal lobule when both counterfactual and factual sentences described actions of high effort compared to actions of low effort, which indicates object-directed motor planning regardless of the factuality of the statement. Another significant finding of this study was that counterfactual statements recruited a unique neural network intersecting the supplementary motor area (SMA). This network encapsulates the medial pre-motor and pre-frontal cortex, responsible for selecting and inhibiting the representation of alternative actions, and parahippocampal/temporal regions involved in the retrieval of episodic memories. The results are interpreted as evidence for dual meaning representation in counterfactuals since the findings show that such statements require both simulation of factual action representation and managing the competing representations.

2.1.2. Studies on The Role of Propositional Truth- Value on Counterfactual Comprehension

Another key factor influencing the processing of counterfactuals apart from dual meaning representation is how propositional truth-value interferes with the processing of counterfactual statements. Nieuwland and Martin (2012) examined the role of propositional truth-value –whether a statement is true or false- in the comprehension of counterfactual sentences using ERPs. The study specifically focused on whether the comprehension of counterfactuals is interrupted by real-world knowledge or is processed without any interference. 30 Spanish-speaking participants were subjected to the experiment, where they read counterfactual and real-world sentences varying in truth-value for each sentence type. For instance, participants saw a Spanish sentence that meant "If NASA had not developed its Apollo Project, the first country to land on the moon would have been Russia", which is counterfactually true, whereas "would have been America" is counterfactually false. The findings revealed that false statements elicited larger N400s compared to the true statements in both counterfactuals and real-world sentences, indicating that the processing of counterfactuals is sensitive to real-world knowledge.[1] The critical finding reported in this study is that this pattern did not differ across sentence types, which suggests that the comprehension was "guided" by the logic of the context rather than "interrupted" by real-world knowledge. This finding supports the view that comprehenders can rapidly map language onto suppositional scenarios when the context is clear and constraining enough. As a result, the findings show that propositional truth-value has an immediate effect on semantic processing, both when a sentence mentions actual or imagined scenarios.

Nieuwland (2013) conducted another study on how the brain processes counterfactual information, which included biologically or physically unrealistic scenarios. The main question of the study was whether comprehenders are immediately sensitive to the propositional truth-value of unrealistic counterfactual statements. In their previous study, Nieuwland and Martin (2012) found that real-

[1] The N400 response is a negative deflection of ERP that emerges around 200-300 milliseconds after a semantically anomalous stimuli is perceived and reaches a peak at 400 milliseconds (Lau et al., 2008)

world knowledge did not delay the effect of truth-value when processing counterfactuals. However, it is noted in this study that the relevant information given in the sentence "If NASA had not developed its Apollo Project, the first country to land on the moon would have been Russia/America surely'' may have drawn on pre-existing real-world knowledge (e.g., of the 'Space Race' between the USA and the USSR), which would make them easier to interpret. Moreover, counterfactual reasoning theories suggest that the alignment between the counterfactual and the actual world has a facilitative effect on counterfactual comprehension (Byrne, 2007; Lewis, 1973). Therefore, Nieuwland aimed to investigate whether similar effects of truth-value would emerge when an unrealistic event must be computed as in the clause "If dogs had gills…". For this purpose, two ERP experiments were conducted. Experiment 1 required participants to read only the consequent clauses without preceding context such as "dobermans would breathe under water". Such clauses were judged as false by the participants and, therefore, elicited larger N400 responses, which suggested that unrealistic statements are processed as semantically anomalous when no supportive context is provided. In Experiment 2, the same statements were given with their antecedent clauses entailing counterfactuality as in "If dogs had gills…" and providing a plausible supportive context for the consequent clause. The findings showed that both in counterfactual and real-world conditions, false statements (e.g, Dobermans would breathe under poison) elicited larger N400 responses than the true ones. The magnitude and timing of the N400 effect were similar across both contexts. These results suggest that the comprehenders integrated counterfactual context rapidly and evaluated the truth-value, aligning with the imagined world. Nieuwland concludes that the semantic processing of counterfactuals is not solely governed based on real-world truth but also propositional truth within the given context -even when the context involves biologically or physically implausible events.

2.1.3. Pragmatic and Discourse-Based Studies on Counterfactuals

Apart from structural and semantic dimensions, counterfactuals also involve processes at pragmatic and discourse levels, since they require the interpretation of contextual cues, speakers' intentions, and narrative structure (Thompson & Byrne,

2002; Byrne, 2007). In their review, Kulakova and Nieuwland (2016a) examined how counterfactual contexts influence the processing of subsequent narrative information. Several behavioral and neurophysiological experiments suggest that counterfactuals affect how readers integrate upcoming information. For instance, Santamaría et al. (2005) found that readers processed negated factual sentences more quickly after counterfactuals, suggesting facilitation of implied factual meaning. Moreover, evidence from eye-tracking studies by Ferguson (2012) showed that factual inconsistencies were more readily detected than inconsistencies following counterfactuals, possibly due to increased working memory load when maintaining dual representations. Additionally, Ferguson and Cane (2015) demonstrated that only participants with high working memory capacity showed neural sensitivity to inconsistency in counterfactual narratives. Studies also explored the impact of real-world knowledge which reported mixed findings, sometimes counterfactual-consistent information overrode factual expectations, while in other cases world knowledge did (Ferguson et al., 2008; Nieuwland & Martin, 2012).

de Vega et al. (2007) aimed to explore readers' comprehension of counterfactuals when they are embedded within narratives, focusing on the mechanisms of discourse updating and the accessibility of memory. The central goal was to examine whether readers update their mental representations when presented with counterfactual scenarios, or they suppress this information due to previously constructed factual information. Situation model theory proposes that readers continuously build and revise mental models based on what happens in a narrative (Zwaan & Radvansky, 1998). For factual statements, new events can be directly integrated to the mental model. On the contrary, the integration can be more complex for counterfactuals since they denote information that contradicts factual information, and readers have two meanings represented for actual and imagined events. Therefore, the researchers hypothesized that counterfactuals may disrupt or cancel the updating process when encountered a new event. Three experiments were conducted using self-paced reading tasks and a probe identification task. In Experiment 1**,** 60 participants who were native speakers of Spanish read short narratives with an embedded sentence containing either a factual or counterfactual new event, followed by a sentence describing either the result of the new event or the continuation of the prior context.

Using a self-paced reading task, the researchers measured participants' reading time of the final sentence, which served as a test of whether they updated their mental representations. The analysis of the reading time revealed a consistency effect: participants read final sentences faster when they were consistent with the prior context. In factual narratives, if the final sentences described a new event, they were read quickly, which shows that readers had updated their mental model to incorporate the new information. In counterfactual narratives, if the final sentences describe an old event, they were read quickly, which suggests that the readers had not updated their mental representation to incorporate the imagined scenario. Instead, they maintained their focus on the original factual situation. This implies that counterfactuals temporarily cancel or delay discourse updating of the mental representations of the described events, keeping the factual scenario accessible in memory. Experiment 2 was designed to explore how readers' attentional focus shifts as they encounter a factual or counterfactual information embedded in narratives. In this experiment, 40 Spanish-speaking participants were assigned to read short stories which contained an initial factual scenario followed by a critical sentence which was either a factual or a counterfactual. Upon seeing the critical sentence, participants had to complete a probe-recognition task to evaluate the accessibility of either the initial (factual) event or the new (counterfactual) event. The findings demonstrated that the initial event was more accessible, and therefore recognized faster, in counterfactual stories compared to factual ones. From this finding, it can be concluded that the original scenario remained the most salient representation in readers' minds when presented with counterfactuals. On the other hand, the new event was equally accessible in both factual and counterfactual conditions. This suggests that counterfactual information was temporarily processed but not incorporated into the ongoing mental representation. In other words, this finding supports the idea that counterfactuals temporarily permit dual meaning representation by allowing both actual and imagined scenarios to coexist in working memory. However, despite the momentary consideration of the imagined event, readers do not update their overall understanding of the situation to treat the counterfactual information as part of what actually happened. Finally, Experiment 3 tested whether counterfactual information that is momentarily considered by the reader is eventually suppressed. This experiment added a delay before testing memory accessibility to

observe whether counterfactual information remains accessible. Similar to Experiment 2, 77 Spanish-speaking participants again read short narratives that included an initial factual event, followed by a critical sentence which was either factual or counterfactual. The stimuli differed from Experiment 2 in that the structure of the sentences was modified so that the key action was not presented at the end of the critical sentence. Moreover, a neutral filler sentence was added right before the probe. Participants completed the probe-recognition task by responding whether words from the initial or final parts of the narrative appeared in the text. Experiment 3 revealed that the new/final information was recognized slower when it appeared within counterfactual contexts compared to factual ones. This indicates that the imagined scenarios are less accessible upon a brief delay, whereas the recognition of old/initial information was equally accessible in both counterfactual and factual contexts. The results demonstrate that counterfactual content is actively suppressed from working memory and is not maintained as part of the mental model. Taken together, the experiments support the "modified update-canceling hypothesis", which proposes that readers represent both factual (p & q) and counterfactual (¬p & ¬q) meanings, but the counterfactual meaning is suppressed over time and therefore, the narrative reverts to the factual baseline.

Kulakova and Nieuwland (2016b) investigated whether pragmatic skills, such as understanding others' communicative intentions, facilitate the construction of counterfactual meaning during comprehension. The fact that counterfactuals mention unreal scenarios poses a communicative difficulty since they violate the maxim of truthfulness, which stresses that the speaker should not say what they believe to be false (Grice, 1975). Therefore, the study was based on the hypothesis that pragmatic skills would affect the semantic processing of counterfactuals. The researchers conducted an EEG experiment where 30 native English-speaking participants read either counterfactual (If sweets were made out of sugar) or hypothetical sentences (If sweets are made out of sugar). Each sentence had a critical word (e.g., sugar) that was either true or false based on world knowledge. Finally, declarative sentences (As sweets are made out of sugar) were used as controls. In terms of pragmatic abilities, participants' pragmatic abilities were measured using the Communication subscale of the Autism Spectrum Quotient (AQ-Comm; Baron-Cohen et al., 2001) to evaluate

deficits in language use within social contexts. The study revealed that counterfactual antecedents elicited larger N400 responses compared to hypothetical ones when the critical word was factually true. Moreover, participants with stronger pragmatic abilities showed greater modulation of the N400, which indicates better integration of counterfactual cues. This finding shows that individual differences in pragmatic skills predict the magnitude of the N400 effect. In other words, the construction of counterfactual meaning heavily relies on the socio-communicative abilities of the individual. This study indicates that pragmatic skills have a significant role in neurocognitive processes and provides implications for understanding counterfactual reasoning deficits where pragmatic deficits are common, such as in autism spectrum disorder and schizophrenia.

2.1.4. Studies on Counterfactuals in Typically Developing Children

Across the developmental literature on counterfactual reasoning, a multitude of studies have been investigating when and how typically developing children acquire the ability to comprehend and produce counterfactuals. Crutchley (2004) investigated the production of counterfactuals in children between the ages of 6-11. In this study, Crutchley used the last three questions of the Assessment of Comprehension and Expression 6–11 (ACE 6-11) (Adams et al, 2001), which was developed to measure the language development of children between the ages of 6 and 11. In this task, participants were shown drawings depicting an undesirable situation (a rabbit escaping from its cage, someone missing the bus, etc.). In the drawings, the counterfactual thought of the person experiencing the undesired situation is also depicted with a bubble (the rabbit being in its cage, the person catching the bus, etc.). Looking at the undesired situation and the counterfactual thought that the person has about the undesired situation, the participants were expected to create counterfactual sentences such as “If the child had arrived at the bus station on time, he would not have missed the bus”. A practice item was used to teach participants how they should interpret the pictures and create a sentence based on them. The participants were expected to describe two pictures by making a counterfactual sentence in the way they learned in the practice session. The findings showed that children's use of counterfactual expressions was largely similar to that of adults – although not

entirely grammatically correct. The grammatical errors made by children extended until the age of 11, which shows that children's grammatical abilities are still in the process of development, especially in the case of complex structures such as conditionals. Crutchley (2013) further reported that the production of PTCFs (past tense counterfactuals) remains challenging even into late childhood due to their syntactic complexity and low frequency in input. Nippold et al. (2020, 2022) extended this research in the studies of adolescents, showing that even 16-year-olds struggled with morphosyntactic accuracy in PTCF constructions, particularly in producing the correct past participle forms. In the same vein, Badger and Mellanby (2018) provided longitudinal data showing that production of conditionals precedes comprehension, and that mastering past counterfactual conditionals is rare before age 8. Together, these studies converge on the idea that counterfactual reasoning in children emerges primarily but is constrained by both cognitive development and linguistic mastery, and continues through adolescence, especially in cases of complex grammatical constructions like PTCFs.

As for real-time evidence, Aktepe (2022) investigated whether four-year-old Turkish-speaking children can incrementally use morphosyntactic cues for counterfactual reasoning at a level similar to that of adults. The study also aimed to examine whether negative outcomes generate more counterfactual thoughts. For this purpose, he conducted an eye-tracking experiment using the visual world paradigm. In the experiment, participants - 23 children and 18 adults- saw a visual containing two referents (e.g. car and a bicycle) with a context sentence such as "Garajda araba ve bisiklet var/vardı (There are/were a car and a bicycle in the garage)." and heard either an indicative such as "Can bisikleti sürerse işe geç kalacak (If John rides the bicycle, he will be late for the job)" or a counterfactual statement such as "Can bisikleti sürseydi işe geç kalacaktı (If John had ridden the bicycle, he would have been late for the job). Each statement was presented with two levels: positive (If John had ridden the bicycle, he would have been late for the office) and negative outcomes (If John had driven the car, he would have been on time for the office), creating four conditions: CN (counterfactual negative), CP (counterfactual positive), IN (indicative negative) and IP (indicative positive) Finally, each item was followed by a comprehension question about the action that is/was done by the agent of the

sentence (Which one do you think John will ride/rode?). The eye-tracking data revealed that children, like adults, shifted their gaze towards the target referent upon hearing morphosyntactic cues. Even though children had an overall lower accuracy rate compared to adults, their accuracy rate exceeded 75%, except for the CN condition, which was interpreted as a satisfactory comprehension of conditionals. The CN condition was also challenging for adults, indicating the cognitive demand for processing counterfactuals for adults as well. Moreover, both children and adults performed better on indicatives than counterfactuals, which is another indicator of the cognitive difficulty required by counterfactuals. The author concluded that even four-year-old children have adult-like ability to use morphosyntactic information to comprehend counterfactuals.

2.2. The Processing of Counterfactuals in Atypical Populations

The processing of counterfactuals has been extensively examined within neurotypical populations, highlighting its reliance on both the linguistic structures and higher-order cognitive functions. In individuals with neurocognitive impairments, linguistic functions are likely to be disrupted due to deficits in executive function, which might cause such individuals to demonstrate different patterns in the processing of counterfactual information. Despite the growing number of studies investigating counterfactual reasoning in atypical populations, empirical evidence still remains limited.

2.2.1. Aphasia and Specific Language Impairment

Studies investigating the processing of counterfactuals in aphasia and specific language impairment (SLI) have focused on how morphosyntactic deficits influence the comprehension and production of counterfactuals. Yarbay-Duman et al. (2016), for example, examined whether cognitive complexity in counterfactuals contributes to sentence comprehension deficits in Turkish-speaking patients with Broca's aphasia. Since Broca's aphasia is characterized by morphosyntactic impairment along with cognitive deficits, Yarbay-Duman et al. hypothesized that counterfactuals would be more difficult to comprehend by individuals with Broca's aphasia. To test their

hypothesis, the researchers used a sentence-picture matching task. Pictures were designed based on three conditions: non-conditionals (Gömleği ütüledi ve dolaba astı/He ironed the shirt and hung it in the closet), indicative conditionals (Gömleği ütülediyse dolaba asar /If he has ironed the shirt, he will hang it in the closet), and counterfactual conditionals (Gömleği ütüleseydi dolaba asardı/ If he had ironed the shirt, he would have hung it in the closet). Participants were shown 15 pictures for each condition, and each picture was accompanied by three distractor pictures. The experimenter read sentences for each picture, and the participants were asked which picture depicted the sentence that had been read. Participants were expected to point to the picture they thought best described the sentence (the shirt is not ironed and not hung in the closet, the shirt is ironed and hung in the closet, a dress is ironed and hung in the closet, a dress is not ironed and not hung in the closet). As a result of the study, individuals with Broca's aphasia reported to have found conditional sentences more difficult to comprehend compared to the non-conditionals than the control group. Moreover, participants produced more errors in counterfactual conditionals than in factual conditionals, which suggests that comprehension deficits in Broca's aphasia are not solely based on morphosyntactic impairment but also on the cognitive demands of processing counterfactual events.

The same research question was asked by Yarbay-Duman et al. (2015) for children with SLI. The method used was identical to the one used for patients with Broca's aphasia. However, the difference between this study and the study examining individuals with Broca's aphasia is that both comprehension and production skills were examined in children with SLI. Upon the sentence-picture matching task for comprehension, a sentence repetition task was used to test production. The experimenter read the sentences used in the sentence-picture matching task to the participants and asked them to repeat the sentences. Findings showed that children with specific language impairments had more difficulty understanding conditional structures than typically developing children. However, this difference was not observed in the sentence repetition task.

Zimmerer et al. (2019) investigated how individuals with aphasia comprehend embedded clauses that include either factive (presupposed true) or non-

factive/counterfactive (presupposed false) information. The study aimed to explore whether the comprehension of such structures is impaired in aphasia, whether counterfactive clauses cause a greater challenge in processing, and how comprehension relates to verbal and non-verbal cognitive capacities. 21 English-speaking aphasic participants were recruited in the study along with 30 controls. The researchers used a sentence-picture matching task where participants were supposed to match sentences with images relying on the factive or counterfactive content of the sentence. Sentences used four matrix construction types: "Know" and "It is clear" construction for factives as in [He knows [that it is warm outside]], and "Think" and "It only seems" construction for counterfactives as in [It only seems [that it is warm outside]]. The results showed that comprehension accuracy for counterfactives was strongly associated with non-verbal reasoning abilities and syntactic comprehension, which is evidence for the increased cognitive load for the interpretation of counterfactives. Moreover, these two predictors accounted for independent variance, suggesting that counterfactive interpretation is based on both linguistic processing and propositional reasoning, and therefore cognitively more challenging than the interpretation of factives.

2.2.2. Parkinson's Disease and Huntington's Disease

Neurodegenerative conditions such as Parkinson's and Huntington's Disease also provide important insights into how executive function and frontal lobe impairment impact counterfactual reasoning. McNamara et al. (2003) investigated whether counterfactual thinking is impaired in individuals with Parkinson's disease and to what extent this impairment can be related to frontal lobe dysfunction, which is a common symptom of the condition. To this end, participants were asked to complete a battery of tests designed to assess counterfactual thinking, general cognitive ability, frontal lobe function and social communication abilities. To test counterfactual thinking, a self-report task was used in which participants were asked to remember a negative personal event and generate "if only" or "what if" thoughts. Secondly, Counterfactual Inference Test (CIT) (Hooker et al., 2000), which is a forced-choice task that measures inferences based on counterfactual reasoning was conducted. The test required participants to generate counterfactually-driven inferences based on a

situation such as “John gets into a car accident while driving on his usual way home. Bob gets into a car accident while trying a new way home.” Then, a question was asked regarding which person would think “if only” thoughts more, such as “Who thinks more about how his accident could have been avoided?”. For the general cognitive measures, animal category verbal fluency test and Mini-Mental State Examination (MMSE) (Folstein et al., 1975) were administered. To test frontal lobe function, the Stroop Inference Test (Bench et al., 1993) and the Tower of London Task (Shallice, 1982) were used. Finally, pragmatic protocol was used to assess social communication skills. The findings showed that patients with Parkinson’s disease generated fewer counterfactual thoughts than the control group, and had poorer scores in CIT, which indicates an impairment in the generation and application of counterfactual reasoning. The impairment was not attributed to general cognitive deficits, decreased verbal fluency. However, patients’ performance on counterfactual tasks was correlated with lower frontal lobe function measures and social communication tests. Overall, the study supports the authors’ hypothesis that deficits in counterfactual reasoning in Parkinson’s disease are especially linked to frontal lobe dysfunction.

Solca et al. (2015) examined the capacity for counterfactual thinking in patients with Huntington’s Disease, which is a neurodegenerative disorder accompanied by motor, cognitive, and behavioral impairments. Since the condition causes executive dysfunctions and prefrontal atrophy, the authors hypothesized that individuals with Huntington’s disease would demonstrate impairment in the generation and use of counterfactual thoughts. Three CFT (counterfactual thinking) assessments were executed: the Spontaneous Counterfactual Generation Test, where participants generated counterfactual thoughts based on a negative personal event, the Counterfactual Inference Test (CIT) (Hooker et al., 2000), and a decision-making task which measures the influence of anticipated counterfactual regret or behavior. The results revealed that patients with Huntington’s disease generated fewer spontaneous counterfactual thoughts compared to the healthy group, performed worse on CIT. No group differences were observed in the decision-making task. Researchers also noted that the spontaneous CFT generation of individuals with Huntington’s disease positively correlated with frontal lobe-dependent cognitive

measures such as phonemic verbal fluency, Trail Making Test A, and short and long-term verbal memory tests. These findings indicate a unique deficit in both generating and applying counterfactual reasoning related to frontal-executive dysfunction.

2.2.3. Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) presents a unique case for the processing of counterfactuals, since the challenges primarily stem from theory of mind deficits rather than impairment in language or executive functions. In the study of Scott et al. (1999), the counterfactual thinking abilities of children with ASD were investigated. Participants consisted of three groups: 15 children diagnosed with ASD, 14 children with moderate learning disabilities (MLD) and 15 typically-developed children, matched in terms of verbal mental age between 4 to 5 years. The experiment consisted of two conditions: counterfactual only (CO) and counterfactual plus pretence (CP). Children were exposed to both conditions individually in separate sessions. In the CO condition, participants heard five counterfactual syllogisms in English (e.g., All cats bark, Rex is a cat.). Immediately afterward, the participant was asked a conclusion question about the syllogism (e.g., Does Rex bark?). In the CP condition, after answering the reality check questions, the participants were subjected to pretence training. The aim here was to trigger children's imagination. After the training session, participants heard five syllogisms and were expected to respond to conclusion questions, just like in the CO condition. As a result of the study, it was reported that children with autism spectrum disorder performed quite well in the CO condition, but their performance decreased when imagination was triggered.

Grant et al. (2004) aimed to explore the cognitive components underlying difficulties on standard false belief tasks experienced by children with ASD. They examined the roles of counterfactual conditional reasoning, belief understanding, and inferential reasoning. They tested three groups of English-speaking children consisting of 25 participant per-group: those with ASD, moderate intellectual disability, and typically developing peers. A set of tasks that varied in cognitive demand were used: physical-state counterfactual conditional reasoning tasks, which required simulating hypothetical outcomes based on altered physical facts such as “If fish couldn’t swim,

could they live in the sea?", nonstandard false belief tasks (inferred belief and explicit false belief tasks), which did not require inference or counterfactual reasoning, and standard false belief tasks, which required both mental state attribution and inferential processing. Their findings revealed that children with autism were significantly impaired on physical-state counterfactual conditional reasoning tasks and standard false belief tasks, but performed comparably to controls on nonstandard false belief tasks. This pattern indicates that children with ASD simply lack a conceptual understanding of belief. Instead, the study showed that performance deficits on false belief tasks stem from deficits in counterfactual conditional reasoning and inferential reasoning, especially when tasks require integrating multiple cognitive abilities.

Begeer et al. (2014) inquired how children with high-functioning autism spectrum disorder (HFASD) understand emotions based on counterfactual reasoning compared to typically developing (TD) children aged 6-12. Counterfactual emotions such as regret, relief, disappointment, and contentment are strongly influenced by counterfactual reasoning since they trigger thoughts on how events could have turned out differently. The researchers categorized counterfactual emotions into two dimensions: direction (upward, comparing reality to a better alternative such as regret and disappointment, and downward, comparing reality to a worse alternative such as relief and contentment) and agency (simple emotions, which require first-order evaluation of an outcome, and second-order emotions, which require understanding how past actions or intentions lead to an outcome). Children were presented with eight stories in the CF-emotion task where two protagonists experience similar outcomes, but one of them had the counterfactual alternative that would have caused a better (upward) or worse (downward) outcome. Based on this task, participants judged how protagonists would feel (better, worse or the same) and explained why. The findings showed that both children with HFASD and TD children performed better in simple CF-emotions compared to the second-order CF-emotions. However, children with HFASD performed significantly worse compared to TD children on downward CF-emotions (relief and contentment). No group differences were found for upward CF-emotions (regret and disappointment). The researchers noted that while TD children's responses were correlated with Theory of

Mind, children with HFASD scores were correlated with IQ. The findings demonstrate that children with HFASD can engage in counterfactual reasoning in structured contexts. However, they experience difficulties with applying counterfactual reasoning to emotional understanding, especially when evaluating downward counterfactual scenarios (relief and contentment) where the actual outcome is positive but could have been worse.

More recent studies focused on counterfactual processing in adults with ASD. Black, et al. (2018) focused on how adults with ASD comprehend counterfactual statements using eye-tracking during an anomaly detection task. For this reason, two experiments were conducted where 25 English speaking adults with ASD and control group recruited. In the first experiment, everyday counterfactual scenarios such as "If Joanne had remembered her umbrella, her hair would have been dry" were used, while the second experiment involved counterfactuals about historical events that required suppressing factual world knowledge, as in "If the Titanic had not hit an iceberg, it would have survived". In both experiments, adults with ASD demonstrated intact counterfactual comprehension, showing comparable or even faster anomaly detection than typically developing adults. In Experiment 1, ASD participants detected inconsistencies earlier and showed greater reading disruption for anomalous critical words, suggesting efficient integration of discourse-level information. In Experiment 2, both groups successfully processed counterfactual anomalies, though ASD participants showed subtle differences in their strategy, such as increased re-reading rather than deficits in comprehension. The authors argued that previous findings of impairment may reflect developmental delays or methodological limitations. Overall, the study provided evidence that high-functioning adults with ASD are capable of processing counterfactuals using slightly different but effective strategies. Ferguson et al. (2022) also investigated whether adults with ASD struggle with comprehending counterfactual language, particularly in switching between factual and counterfactual mental models. Using an ERP design, they compared 24 adults with ASD and 24 typically developed adults as they read two-sentence scenarios in factual and counterfactual contexts. Despite group-level impairment in theory of mind and cognitive flexibility in the ASD group was observed, ERP results showed that both groups demonstrated typical N400 effects,

which meant both groups could detect semantic anomalies when a scenario remained in the same world (factual or counterfactual) and successfully shifted interpretation when required to switch from a counterfactual to a factual context. Overall, the results suggested that autistic adults are capable of maintaining and updating mental representations based on linguistic context.

2.3. Language Impairment in Schizophrenia

Language impairment constitutes a core domain of dysfunction in schizophrenia (DeLisi, 2001). According to the Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM–5; American Psychiatric Association, 2013), disorganized speech, such as derailment and incoherence, is a Criterion A symptom of schizophrenia. A large body of research has sought to disentangle the linguistic basis of the condition by revealing the deficits manifested in multiple domains involving the disruption of formal thought organization, breakdown of pragmatic and discourse abilities, and rule-governed anomalies in language. Formal Thought Disorder (FTD) is one of the core symptoms of schizophrenia that mainly affect language abilities, where disruptions in the structure of the form of thought are reflected in speech (Kerns & Berenbaum, 2002). Although it is highly associated with schizophrenia, FTD can be observed in other psychotic disorders as well such as schizoaffective disorder, mania, or even in highly creative individuals with no psychiatric history (Andreasen, 1979; Radanovic et al., 2013). Specifically, FTD includes deviations in organization, coherence, and logical flow of thoughts. This leads to derailment, which means going off-topic in one's speech, incoherent manifestation of ideas and poverty of speech. FTD falls under both positive feature symptoms, such as irrationality and neologisms -newly coined words or expressions- and negative symptoms, such as poverty of speech. Since FTD affects several aspects of the language domain, it has been considered to be crucial to investigate to what extent FTD and language impairments observed in schizophrenia interact. For instance, to explore the relationship between FTD and language impairments reported in schizophrenia, Rodriguez-Ferrera et al. (2001) used a comprehensive battery of eight different linguistic tests in their study. These tests assessed syntactic comprehension (TROG and Modified Token Test), semantic comprehension (Pyramids and Palm

Trees Test), naming (Boston Naming Test) and expressive speech (picture description task). Along with the linguistic tests, patients were rated for FTD by using the the Thought, Language and Communication Scale developed by Andreasen (1979). General intellectual function was also measured using Wechsler Adult Intelligence Scale (WAIS IQ), Mini-Mental State Examination (MMSE) and National Adult Reading Test (NART). Researchers found that poor performance of schizophrenic patients on language tests is associated with general intellectual impairment. All of the patients' language scores showed a correlation with WAIS IQ and MMSE scores. Specifically, three language tests were associated with FTD, which are semantic comprehension, syntactic comprehension and picture description tests. Multiple regression analyses further suggested that semantic and expressive tests predicted FTD scores regardless of IQ scores, suggesting a linguistic deficit directly linked to FTD. The study results support that FTD is significantly related to a semantic deficit, especially in the formation of coherent narratives or integrating conceptual knowledge. On the other hand, findings demonstrate that syntactic operations and naming abilities are relatively preserved in schizophrenia, regardless of the severity of FTD. To conclude, this study provides evidence that language impairments in schizophrenia are not only related to the decrease general cognitive functioning, but also FTD, especially in semantic processing. Moreover, the review by Ehlen et al. (2023) systematically examined linguistic alterations in individuals with schizophrenia, highlighting disruptions in language comprehension and production. Drawing on 143 studies from 2010 to 2022, the authors outlined how formal thought disorder is reflected in impairments across lexico-semantic, syntactic, and pragmatic domains. Lexico-semantic findings show patterns of reduced N400 responses, suggesting disrupted semantic network functioning. Syntactic deficits, particularly in processing complex sentence structures, are frequently observed and associated with FTD and working memory impairments. Pragmatic language use is notably affected, with deficits in interpreting idioms, metaphors, and irony, often due to impaired contextual integration. These deficits interfere with coherence and violate conversational maxims, undermining effective communication.

A growing body of research analyzed linguistic impairments of spontaneous speech in individuals with schizophrenia to identify the specific language domains

disordered due to the condition. Marini et al. (2008) aimed to report microlinguistic (lexical and morphosyntactic) and macrolinguistic (pragmatic and discourse-level) deficits of individuals with schizophrenia, along with their neuropsychological correlates. For this purpose, they assessed 77 Italian-speaking patients' narratives using a picture-story description task. The narratives were elicited using a single-picture stimulus, describing a picnic scene by the lake, and two cartoon stories - "flower pot" and "quarrel"- with six pictures each. The former cartoon depicted a man hit by a flower pot while walking his dog, whereas the latter depicted a quarrel between a couple. Their analysis focused on verbal productivity and lexical and morphosyntactic organization for microlinguistic analysis, and informativeness and textual organization for macrolinguistic analysis. The researchers found that individuals with schizophrenia were severely impaired in their macrolinguistic abilities in at least one of their narratives. The macrolinguistic deficits included decreased lexical and thematic informativeness and increased global and local coherence errors. Microlinguistic deficits were also reported, such as increased semantic paraphasias and grammatical errors. The authors also suggested that macrolinguistic impairment may stem from discourse-level issues such as planning, organizing, and maintaining coherent discourse, which are functions that necessitate higher-order cognitive skills such as working memory, attention, and sequencing. Regression analyses further suggested that neuropsychological functions are predictors for certain linguistic impairments. To illustrate, cognitive impairment scores (Mini-Mental State Examination, MMSE) were related to semantic paraphasias, attention measures (non-perseverative errors on the Wisconsin Card Sorting Test) to paragrammatic errors, global coherence errors to executive function measures (Trail Making Test B) and lexical informativeness to logical reasoning performance (Raven's Matrices). Overall, the study concluded that the language production of individuals with schizophrenia was impaired mainly at the macrolinguistic (discourse) level, which might be linked to a decreased ability to use pragmatic cues and deficits in cognitive functions.

A recent study conducted by Bozdağ et al. (2025) explored the linguistic characteristics of Turkish-speaking individuals with schizophrenia compared to healthy controls. The authors aimed to identify language-based biological markers

for formal thought disorder. 50 schizophrenia patients and 50 healthy controls underwent a semi-structured interview. The interviews were recorded, transcribed and analyzed using CLAN software. The analysis investigated lexical (type/token ratio, average word frequency), syntactic (mean length of utterance, number of utterances), phonological (speech rate, silent and filled pauses) and discourse-based (coherence, question-response similarity, sentence prediction loss) elements in participants' speech. The results showed that patients with schizophrenia generated fewer lexical items with less variance. However, they demonstrated a higher type/token ratio and content-to-function word ratio. The phonological analysis revealed that patients' speech was slower, included more salient pauses and produced shorter utterances compared to the healthy control group. As to the discourse-based analysis, patients' coherence and semantic alignment between the interview questions and responses were significantly decreased. Moreover, sentence prediction loss was higher in the patient group, which shows that the responses given by patients were less predictable in terms of meaning. Regression analyses further demonstrated that the severity of negative symptoms was a predictor of the decreased coherence in discourse, increased sentence prediction loss, slowdown in speech, and decrease in average word frequency. Longer duration of condition also correlated with such linguistic deficits. Finally, sociodemographic factors such as older age and reduced educational background were predictors for slower, less coherent and less predictable speech. The researchers also noted that discourse coherence and sentence prediction loss can be an indicator of Formal Thought Disorder, and therefore can be used in the identification of it. Overall, the results demonstrate that language-specific features of speech disturbances in schizophrenia are universal across languages.

Though the literature mainly reports findings on impaired semantic and pragmatic abilities, research also points at the deficits of structure-based units of language associated with the condition. Walenski et al. (2010) investigated the errors in the production of past tenses of different verb types in English by 43 schizophrenic patients and 42 controls, who were native speakers of English. In this study, participants were subjected to a past-tense production task containing 60 verbs. In this task, three different types of verbs were used according to their conjugation types: 20 of them were conjugated in the irregular past tense, 20 were conjugated in

the regular past tense, and 20 were verbs conjugated in the new and regular past tense produced for the study. Compared to healthy controls, patients diagnosed with schizophrenia showed a greater deficit in producing the past tense of regular verbs compared to irregular verbs. The findings support the dual system model, which shows that patients with schizophrenia have impaired grammatical processing but relatively intact processing of word information. The dual system model suggests that language skills involve two different cognitive systems: one is used for grammatical processing and the other is used for lexical knowledge (Ullman, 1998). In the context of schizophrenia, this model suggests that while patients have problems with grammatical processing, early learned vocabulary processing remains relatively intact. In short, this model aims to explain the language deficits observed in schizophrenia by claiming that patients have more difficulty producing the past tenses of regular and novel verbs that require grammatical processing, compared to irregular verbs that rely more on lexical knowledge in English. In addition, patients with more severe formal thought disorder have been shown to exhibit poorer performance in regular and new past tenses, and a relationship between thought disorder and grammatical impairment in schizophrenia has been suggested. In conclusion, this study points to a specific grammatical processing impairment in schizophrenia.

More recently, Ziv et al. (2022) discussed the application of natural language processing techniques in mental health research, especially in the investigation of schizophrenia and other psychotic disorders. In this regard, the study aimed to investigate how morphologically diverse the language used by schizophrenia patients is compared to the healthy population using natural language processing techniques. The study focused on three different areas: the use of parts of speech, inflection, and inward and outward focus. Participants were asked to tell a short story based on 14 images retrieved from the Thematic Apperception Test (TAT; Murray, 1943). Participants explained what happens in the images, the feelings of the people in the images, and how the story ends. The Hebrew language morphological tagger developed by Ben-Gurion University was used to analyze the linguistic features of the narratives. This tagger provides information about word types, lemma (the base form of a word), and person and tense for verbs. The analysis included calculating

the occurrences of various morphological features (nouns, verbs, adjectives, etc.), lemma-token ratio (LTR), and type-token ratio (TTR), which measure lexical diversity. A higher LTR indicates less word inflection and potential linguistic poverty, while a higher TTR indicates greater lexical diversity. As a result of the analysis, three main differences emerged in the language use of patients diagnosed with schizophrenia compared to the healthy control group. First, patients with schizophrenia exhibited more basic language structures with fewer verbs, adjectives, and adverbs. Secondly, as an impact of associative thinking, the consistency of expression in speech has been interrupted. Finally, participants demonstrated a self-centered perspective by using more first-person pronouns in their narratives. The study overall reported that schizophrenic individuals used less complex and less diverse structures in their speech**.**

2.4. Counterfactual Reasoning in Schizophrenia

Given that language impairment and executive dysfunction are associated with schizophrenia, engaging in counterfactual reasoning to make sense of counterfactual information is particularly challenging for this clinical group. Even though research on the processing of counterfactual conditional statements in patients with schizophrenia is, to the best of the author's knowledge, non-existent, a considerable number of studies on counterfactual reasoning have been conducted as a way to understand the underlying mechanisms of general deficits observed due to the condition, theory of mind abilities of patients with schizophrenia, and behavioral intention activation.

2.4.1. Deficits in Counterfactual Reasoning

Hooker et al. (2000) investigated the counterfactual thinking abilities of schizophrenic patients. Participants were subjected to tests assessing cognitive ability and social competence to test their counterfactual thinking abilities. In the first counterfactual measure, patients were asked to remember a negative personal event they had experienced in the recent past, and then they were expected to express how the event they experienced could have turned out differently, in the thought pattern

of "if only" or "if only that were". The second counterfactual measure was the Counterfactual Inference Test (CIT). In this test, participants were presented with scenarios in which two individuals experienced similar consequences under different conditions. Participants were expected to make inferences about which individual in these scenarios produced more "if only" thoughts about the event. Compared with the control group, patients with schizophrenia reported fewer counterfactual thoughts about their personal experiences and performed poorer in making counterfactual inferences about social events based on scenarios. One of the possible reasons has been shown to be the presence of formal thought disorder in schizophrenia, which affects reasoning skills and can interfere with the process of creating and using counterfactuals. Additionally, the faulty connection between affect and cognition in schizophrenia may have contributed to impairment in counterfactual thinking. In general, the findings of the study show that counterfactual thinking processes are impoverished in patients with schizophrenia and therefore, their social functionality is affected negatively.

Contreras et al. (2016) investigated the influence of the causal order effect on counterfactual thought generation and their ability to make inferences from hypothetical situations. They conducted three experiments to answer their research questions. First, an experiment designed to evaluate the causal order effect was conducted. This experiment aimed to understand how participants perceived and attributed causality in a scenario where an individual heard that a store had a discount for a limited number of stereo systems. The individuals encountered four obstacles on his/her way to the store: a) a speeding ticket, b) a flat tire, c) a traffic jam, and d) elderly people crossing the street. Due to these obstacles, the individual arrived late and learned that the last stereo system had been sold out only a few minutes ago. Participants were presented with the four successive events and were asked to determine which event was the most likely cause of the negative outcome described in the scenario. Participants were also asked to provide a rationale explaining why they thought the event they selected was the primary cause. In the second experiment, the generation of counterfactual thoughts was examined by asking the participants to write down possible alternative ways to reach on time to purchase a stereo sound system. These alternatives could be completely new and

original ideas, such as "I wish I had called and made a reservation in advance" or they could be about the unfortunate events in the scenario, such as "I wish I hadn't been speeding." Finally, to measure the ability to make counterfactually derived inferences, Contreras et al. used the "Counterfactual Inference Test" developed by Hooker et al. (2000). As a result of this study, it was reported that patients with schizophrenia showed difficulty attributing causal sequences in scenarios, produced fewer counterfactual thoughts and produced fewer counterfactually derived inferences compared to the control group. The study suggested that there is a global deficit in counterfactual reasoning in schizophrenia, thus the deficit might be considered as a future aim in the treatment of schizophrenia.

Later, Albacete et al. (2017) investigated counterfactual reasoning in schizophrenia patients in symptomatic remission using the same experimental materials Contreras et al. (2016) used, with the same procedural steps. The study revealed that the patients generated fewer counterfactual thoughts and counterfactual inferences. Different from the findings of Contreras et al. (2016), though, patients in remission did not demonstrate a significant deviance from the control group in causality attribution. Their findings, overall, suggested that patients show a deficit in counterfactual reasoning even if they are in remission. Albacete et al. (2017) also found that deficits in counterfactual reasoning are negatively related to the Positive and Negative Syndrome Scale (PANSS) scores of the patients and the duration of the condition.

2.4.2. Counterfactual Reasoning and Theory of Mind

Counterfactual reasoning has been comprehensively studied as a way to examine Theory of Mind abilities of patients with schizophrenia, especially through sarcasm comprehension, since sarcasm includes understanding the speaker's counterfactual intention (what is said in literal terms versus what is actually meant). Leitman et al (2006) investigated schizophrenia patients' ability to infer counterfactual information by evaluating sarcasm perception to understand the theory of mind (ToM) abilities of the patients. They assessed sarcasm perception with the help of the attitudinal subtest of the Aprosodia Battery (APT) (Orbelo et al. 2005), which includes 10 semantically

neutral sentences. The sentences were recorded both in a sincere or a sarcastic tone, making participants hear 20 utterances in total. Upon hearing the utterances, participants were asked to state whether the speaker was being sincere or sarcastic. The findings of the study suggested that patients with schizophrenia had great difficulty in detecting sarcasm, and, therefore, in decoding counterfactual intention. Kern et al. (2009) also investigated sarcasm comprehension for processing counterfactual information, and the results were consistent with the findings of Leitman et al. (2006). Kern et al. (2009) examined ToM deficits for processing counterfactual information in people with chronic schizophrenia and schizoaffective disorder. They assessed the comprehension of sarcasm and lies using Part III of the Awareness of Social Inference Test (TASIT), which is a measure for ToM. Part III of the test included 16 videos where lies or sarcasm are depicted. Participants were instructed to watch the videos and answer 4 forced-choice (yes/no) questions. In the first question, participants were supposed to think about what one character aims to make the other character think or feel. In the second question, participants were asked to understand the message that one of the characters was trying to convey. In the third question, they were asked to understand the character's underlying beliefs. Finally, the fourth question asks about the emotional state of the character. The findings of the study suggested that patients' performance was significantly poorer in the comprehension of sarcasm but not in lies. The authors postulated that the discrepancy between sarcasm and lies might stem from the fact that sarcasm requires the use of exaggerated facial expressions, gestures, and tone of voice, whereas telling lies requires neutral expressions since the aim is to hide the facts. This finding showed that patients with schizophrenia might have ToM impairment in specific aspects, such as understanding paralinguistic cues, rather than a global ToM impairment.

2.4.3. Counterfactual Reasoning and Behavioral Intention Formation

Another focus of the literature on counterfactual reasoning was based on the link between counterfactual thinking and activating behavioral intentions. Roese et al. (2008) investigated whether counterfactual thinking (e.g. If only I had studied harder) activates intention formation (e.g. I will study harder next time) for behavior

regulation. The article proposes three links in the cognitive pathway of counterfactual thinking to behavior as in Figure 2.1. In schizophrenia, link 1 is impaired (Hooker et al., 2000) whereas link 3 is intact (Brandstätter et al., 2001). This study aimed to investigate whether link 2 -counterfactual to intention- is impaired in schizophrenia patients.

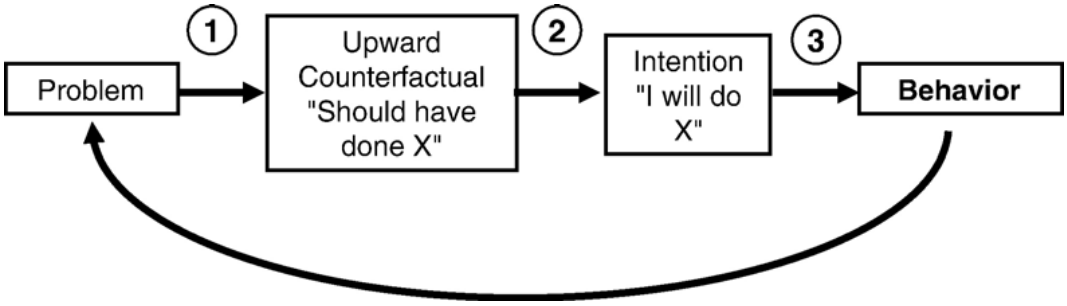

Figure 2.1. Cognitive pathway from counterfactual thinking to behavior

A semantic priming task was used in a sequential priming paradigm to assess the automatic activation of intentions by a counterfactual thought using reaction time as their dependent variable. Shorter reaction time indicated that there was a facilitation effect by counterfactual activation. 15 participants were introduced to 45 trials involving a judgment task in which they were supposed to give yes or no responses to an intention. The prime judgment task involved a question about a negative event (e.g., spilled food on the shirt). Upon a 2-second delay, participants saw a statement (e.g. eaten more carefully). The manipulation included three conditions: counterfactual (should have condition), control (word-counting judgment), and a baseline (no judgment). Participants pressed a key if they agreed with the statement. The target task included an intention judgment semantically related to the prime judgment task. The study showed that the link between counterfactual thinking and the formation of behavioral intentions is impaired in schizophrenia. The study proposed that a rehabilitative approach to activate counterfactual thinking would be ineffective since the link between counterfactuals and intentions is blocked. Contrary to this finding, Contreras et al. (2017) found a normal activation of the formation of behavioral intentions in schizophrenia patients. With the same research questions, they aimed to re-evaluate the claim that link 2 in the CFT pathway is impaired in schizophrenia by using an improved version of the semantic priming paradigm used

by Roese et al. (2008) and increasing the sample size up to 37 patients and controls. Participants were presented with 32 experimental trials structured in three stages. In stage 1, they read a description of a negative everyday event (e.g, I have missed the train). In stage 2, a prime statement appeared, which is either a counterfactual statement (e.g, I should have) or a neutral statement (a factual cue such as "It has five words"). The original experiment used by Roese et al. (2008) used a word-counting judgement task, which adds cognitive load to the procedure. Contreras et al. (2017) modified this task into simply reading the statement as in the counterfactual condition so that the cognitive load of the two procedures was similar. In stage 3, a statement representing behavioral intention appeared on the screen, which was either semantically related to the previously described action or not (e.g, got out of bed sooner). Participants were expected to press a key labelled as "Yes" or "No" to show whether the behavioral intention was appropriate for the negative everyday event. Both judgment accuracy and reaction times were measured. As a result, it was reported that both patient and control groups gave more accurate and rapid answers when they were presented with the counterfactual priming condition. Though the patient group had more errors, their performance also improved when shown counterfactual statements. Furthermore, reaction time analysis revealed that responses were around 8% faster with counterfactual primes in both groups, which demonstrates a preserved facilitation effect. Interestingly, there was no significant associations between task performance and clinical variables (severity of symptoms, duration of condition, cognitive scores). This indicated that the facilitation effect observed in counterfactual thinking is independent of general neurocognitive impairments in schizophrenia. Overall, the findings of this study suggested that the cognitive mechanism underlying Step 2 of the counterfactual thinking pathway is intact in patients with schizophrenia, challenging the earlier findings in the literature.

CHAPTER 3

METHOD

3.1. Participants

40 patients diagnosed with schizophrenia (M = 37:7; Range = 22-67; 16 females, 24 males), who were native speakers of Turkish, participated in this study voluntarily. All patients were recruited from the Psychiatry clinic of Ankara Etlik City Hospital and were in symptomatic remission to control for the effect of symptom severity on participants' responses. Patients were diagnosed using SCID-V (Structured Clinical Interview for DSM-5 Disorders). Positive and negative symptoms were measured using Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987; Kostakoğlu et al., 1999). Moreover, age and educational background-matched 40 healthy individuals with no psychiatric or neurological condition participated in the study (M = 37:15; Range = 19-55; 22 females, 18 males). Participants in both groups were at least high school graduates. All participants were naive with respect to the aim of the experiment. Participants who took part in the experiments were different from those who participated in the pilot experiments. The thesis was approved by the Human Subjects Ethics Committee of METU and the Scientific Research Evaluation and Ethics Committee of Ankara Etlik City Hospital (see Appendix C and D). Written consent was obtained from all participants.

3.2. Materials

Two experiments were conducted to investigate the patients' ability to comprehend and produce conditional sentences. A truth-value judgement task consisting of 16 questions, 8 of which were filler items, was used to measure comprehension. This test was designed based on Aktepe's (2022) eye-tracking experiment. To test

production, a dialogue completion test with 16 questions, 8 of which were filler questions, was developed.

3.2.1. Comprehension: Truth-Value Judgement Task

The comprehension experiment consisted of 16 multiple-choice questions which included a contextual sentence, two pictures of the objects mentioned in the contextual sentence, the target sentence, and three options.

The comprehension experiment started with a sentence that included contextual information as in (1).

(1) Context-setting sentence

Mutfak-ta	kahve	ve	süt	var-Ø.
Kitchen-Loc	coffee-Nom	and	milk-Nom	exist-Aor

There is coffee and milk in the kitchen.

Beneath the sentence, two pictures depicted the objects mentioned in the contextual sentence, e.g. coffee and milk.

Figure 3.1. Example of a context-setting sentence and visuals

The contextual sentence and the pictures were followed by the target sentence which included either a factual or a counterfactual sentence as in (2a) and (2b)

(2a) Indicative conditional sentence

Enes	süt	iç-ti-yse	uyu-r.
Enes-Nom	milk-Nom	drink-Past-Cond	sleep-Aor

If Enes has drunk milk, he will sleep.

(2b) Counterfactual conditional sentence

Enes	süt	iç-se-y-di	uyu-r-du.
Enes-Nom	milk-Nom	drink-Cond-Past	sleep-Aor-Past

If Enes had drunk milk, he would have slept.

Figure 3.2. Example of a target sentence

Following the target sentence, participants were presented with three options that mentioned the likely outcomes based on the target sentence. In the experiment, participants were expected to choose which outcomes would likely occur based on the contextual sentence, pictures, and the conditional sentence. Participants were expected to mark each possible outcome as "Possible", "Impossible" or "Uncertain".

"Enes süt içtiyse uyur." cümlesini söyleyen kişiye göre, aşağıdaki seçeneklerin gerçekleşme ihtimalini **olabilir**, **olamaz** ya da **kararsızım** olarak işaretleyiniz.

Enes süt içmedi ve uyumadı.	□ Olabilir	□ Olamaz	□ Kararsızım
Enes süt içti ama uyumadı.	□ Olabilir	□ Olamaz	□ Kararsızım
Enes süt içti ve uyudu.	□ Olabilir	□ Olamaz	□ Kararsızım

Figure 3.3. Example of the truth value judgement of the possible outcomes based on the target sentence

The possible outcomes in each option were written based on the Conditional Truth Table presented in Table 1:

Table 3.1. Truth Table for the Conditional

p	q	$p \rightarrow q$
True	True	True
True	False	False
False	True	True
False	False	True

According to the conditional truth table, the antecedent (P) and the consequent (Q) of a conditional statement $(P \rightarrow Q)$ can each take one of the following truth values: true or false. Considering these two truth values, the antecedent and the consequent can form four combinations. In line with these combinations, an entire conditional statement can take the following truth values: true or false. While 3 of these combinations yield a truth value of true, one combination yields a truth value of false. The combinations of truth values for P and Q are as follows:

1) Both clauses can take the value true. As a result of this combination, the conditional $P \rightarrow Q$ is true. This is because when both P and Q are true, the relationship between P and Q is satisfied.

2) The antecedent can take the truth value true and the consequent can take the truth value false. In this combination, the truth value of $P \rightarrow Q$ is false because the logical implication that *Q* should follow *P* is violated.

3) The antecedent can take the value false and the consequent can take the value true. As a result of this combination, the conditional sentence takes the value true because, according to propositional logic, when *P* is false, $P \rightarrow Q$ is *vacuously true* regardless of the truth value of *Q*.

4) Both clauses can take the value false. Similar to the third combination, the value of the conditional statement is true, because if *P* is false, the truth value of *Q* does not affect the truth value of $P \rightarrow Q$, making it *vacuously true*.

The options that gave possible outcomes were written based on the conditional truth table since the meanings of indicative conditional sentences may change according to the possibilities depending on whether the antecedent is true or not (Byrne and Johnson-Laird, 2010). For instance, Yarbay-Duman et al. (2016) claimed in their experiment with individuals diagnosed with aphasia and children diagnosed with specific language disorder that the sentence "If he ironed the shirt, he will hang it in the closet" corresponded only to the picture in which the shirt was ironed and hung in the closet among the four pictures, and ignored other possibilities. However, the sentence "If he ironed his shirt, he hangs it in the closet" does not give clear information about the condition being met and the result being realized. In other words, when a sentence with this structure is encountered, a scenario in which the shirt is not ironed can be considered since there is no clear information that the shirt is ironed. In the conditional truth table, the values that the antecedent and the consequent clause can take, and therefore the possibilities of an indicative conditional sentence, are clearly shown. For this reason, creating the possible outcomes for indicative conditional sentences according to the conditional truth table for the experiment could give a more accurate result as to how participants interpret the sentences in this structure.

Of these four combinations, the combination where *P* takes the truth value of false and *Q* takes the truth value of true was not included in the experiment as a result of the pilot experiment conducted with 12 healthy and adult participants, because the participants did not show a clear pattern in the comprehension of this combination. Therefore, each indicative or counterfactual sentence given in the experiment was given with three options representing the possibilities that could occur as a result of each conditional sentence. In indicative conditionals, participants were asked to accept combinations in which both *P* and *Q* take the same truth value -true, true and false, false- as "Possible", and to accept the combinations in which *P* takes the truth value true and *Q* takes false as "Impossible" or "Uncertain". In counterfactuals, they were supposed to accept only the combination where both *P* and *Q* take the truth value false as "Possible" since there is only one actual outcome of a counterfactual sentence.

3.2.2. Production: Dialogue Completion Task

A dialogue completion task consisting of 16 questions was created for the production experiment. In this experiment, participants first had to read a short scenario consisting of 3-4 sentences as in (3a):

(3a) *Ebru bugün derste sunum yapacak. Çıkmadan önce üzerine kahve döküldüğü için evden geç çıktı. Ebru'nun babası sunuma yetişip yetişemeyeceği hakkında endişeli. Ebru'nun annesi ve babası durum hakkında konuşuyorlar. (Ebru is going to have a presentation in class today. She left home late because she spilled coffee on herself before leaving. Her father is worried about whether she will be able to make it to the class to give her presentation. Her mother and father are talking about the situation.*)

After reading the scenario, participants saw a dialogue composed of two lines between two characters mentioned in the scenario. The last sentence of each dialogue consisted of an indicative or a counterfactual conditional. A sample dialogue can be given in (4a):

(4a) *Baba: Umarım dersine yetişir (The father: I hope she will make it to the class.*)

Anne: Merak etme. Taksiye bindiyse yetişir.(The mother: Don't worry. If she has taken the cab, she will make it to the class.)

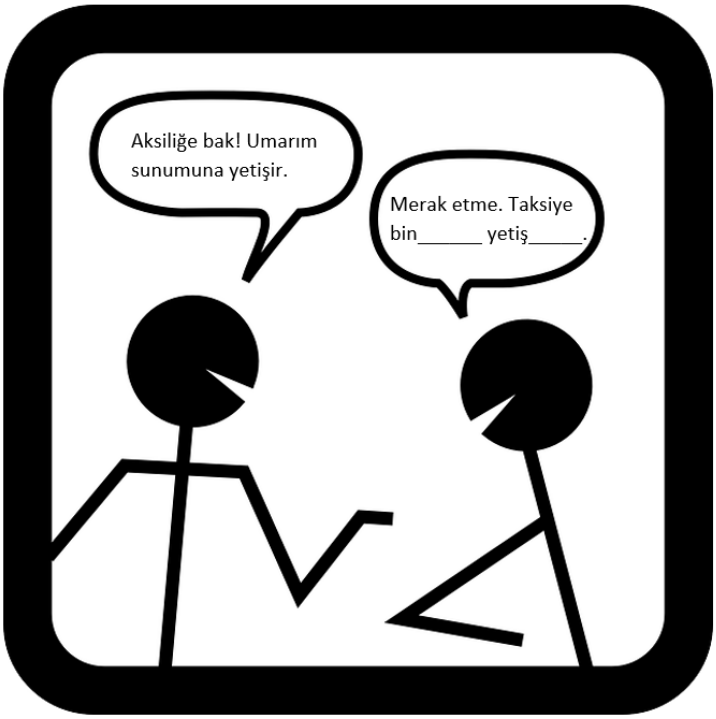

Figure 3.4. Example of the dialogue completion task

In the dialogue, the conditional marker *–sA* or *-ySa* and the past tense marker *–dI* were not attached to the verbs of these sentences. The participants were expected to attach these suffixes to the correct verb in the correct order. Participants received a score of "1" if they created an indicative *(bindiyse yetişir)* or a counterfactual *(binse(ydi) yetişirdi)* conditional sentence appropriate to the context, and a score of "0" if they created a non-conditional structure *(bindi ve yetişti)* or encoded the morpheme sequence in the wrong order *(e.g. binseydi, instead of bindiyse).*

3.3. Procedure

3.3.1. Clinical Assessments

Before the experiment, the Structured Clinical Interview for DSM-5 (SCID-5-CV) was administered to the participants by clinicians at the Psychiatry clinic of Ankara Etlik City Hospital for the diagnosis of the patients. This interview was also utilized to eliminate other mental disorders and intellectual disabilities. Then, the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987; Kostakoğlu et al., 1999) was administered to the patients to measure their positive and negative symptoms. Participants who had intense positive symptoms were not included in the experiment since positive symptoms such as hallucinations or delusions would affect the participants' performance. Upon diagnosis and evaluation of the severity of the symptoms, Trail Making Tests A and B (TMT-A & B) were administered to control the effects of neurocognitive functions. While TMT-A aims to test visuo-perceptual skills such as visual search and motor speed skills, TMT-B measures higher-level cognitive functions such as working memory and task-switching (Bowie and Harvey, 2006). Both part A and B include 25 circles on a sheet of paper. In TMT-A, participants were asked to connect the encircled numbers from 1 to 25 in ascending order by drawing lines between them. Before this test, the patient was expected to count from 1 to 10 to make sure that the patient knew the numbers in the correct order. Then, a practice question was given in which the encircled numbers must be connected from 1 to 8. In TMT-B, participants were expected to connect numbers and letters in the alternating order (e.g., 1-A-2-B-3-C). Before this test, participants were asked to count the letters in the Turkish alphabet to ensure they knew the letters correctly. After the clinical evaluation was completed, the main experiment (see below) was conducted in a single session. Before the experiment, participants were asked to sign a voluntary participation and consent form. In this form, instructions regarding the experiment were presented to the participants in written and verbal form.

3.3.2. Main Experiment

After participants filled in the voluntary participation form, socio-demographic, family, and personal health histories were taken. In the experiment, the participants were given two practice materials for each experiment and they were helped to get used to the experiment. If necessary, practice questions were repeated a second time. The experimental material was presented to the participants in written form on paper. Participants were expected to mark each option as "Possible", "Impossible" or "Uncertain" depending on each sentence they read. Upon answering the questions, participants were expected to explain their answers to make sure that they understood the task and answered the questions accordingly. Their explanations were also used to understand participants' reasoning behind their answers. The production experiment included two practice items to help participants get used to the experiment. Practice questions were repeated a second time when necessary. As in the comprehension experiment, production experiment materials were given to the participants in written form. During the experiment, participants were expected to read the scenarios and the dialogues, add the suffixes that needed to be attached to the verb in the last sentence of the dialogue in the correct order, and complete them according to the scenario. Specifically, participants were expected to add the past tense suffix -dI to the verb followed by the conditional suffix –sA if they encountered an indicative conditional. When it was necessary to complete the sentence with a counterfactual expression, they were expected to add the suffix –sA and then –dI to the verb. The clinical evaluation and the experiments lasted approximately 25 minutes for patients and 15 minutes for the control group. The order of the items, practice questions, and the experiments were counterbalanced across participants to control for question order bias.

CHAPTER 4

RESULTS

4.1. Descriptives

Table 4.1 presents the participants' total scores, mean accuracy scores and standard deviations across sentence types (indicative vs. counterfactual) and task types (comprehension vs production) within and between groups (patient versus control).

Table 4.1. Descriptive statistics by group, sentence type and test type

group	sentence_type	test_type	total_score	mean_score	std_dev
control	indicative	comprehension	142.	0.891	0.236
control	counterfactual	comprehension	131	0.822	0.309
control	indicative	production	115	0.719	0.451
control	counterfactual	production	134	0.838	0.370
patient	indicative	comprehension	109	0.681	0.357
patient	counterfactual	comprehension	81	0.506	0.420
patient	indicative	production	95	0.594	0.493
patient	counterfactual	production	89	0.556	0.498

The mean scores between the control group and patient group across task and sentence types showed that the control group consistently outscored the patient group. In the comprehension task, the mean score for the control group was 0.0891 for indicatives and 0.822 for counterfactuals, while the patient group had lower mean scores of 0.681 for indicatives and 0.506 for counterfactuals. In the production task, the mean scores for indicatives were 0.719, and 0.838 for counterfactuals, whereas

the patient group had mean scores of 0.594 for indicatives and 0.556 for counterfactuals, indicating reduced accuracy in the patient group overall. As for the sentence type, counterfactuals gave lower mean scores than indicatives in the patient group. In the control group, lower scores in counterfactuals was also observed in the comprehension task (0.822 for counterfactuals, 0.891 for indicatives). However, the production task yielded a different pattern. Indicatives elicited lower mean scores of 0.719, compared to counterfactuals, with a mean score of 0.838.

4.2. Results: Group Differences by Sentence Type

To examine whether there was a difference in the comprehension and production scores of counterfactuals between the schizophrenia group and the healthy group, a series of linear mixed models for comprehension, and generalized linear mixed models for production were conducted in a stepwise manner using R statistical programming language. For the first model, an analysis based on sentence type was conducted by separating indicatives and counterfactuals using the models below, to specifically investigate the comprehension and production of counterfactuals:

model_cf <- lmer(score ~ group + (1 | Participant_ID) + (1 | question_ID)

model_ind <- lmer(score ~ group + (1 | Participant_ID) + (1 | question_ID)

A linear mixed-effects model was fit to analyze the comprehension of counterfactuals. The model revealed a significant main effect of group on counterfactual comprehension (β = -0.3156, *SE* = 0.0613, *t*= –5.145, $p < .001$), indicating greater difficulty in counterfactual comprehension by individuals with schizophrenia. Indicatives also yielded the same pattern (β = –0.2093, *SE* = 0.0456, *t* = –4.584, $p < .001$), showing that indicatives were also more difficult to comprehend for the schizophrenia group compared to the control group.

Table 4. 2. Results of the linear mixed-effects model comparing sentence type for comprehension

Sentence Type	Estimate	Std. Error	t-value	p-value
Counterfactual	-0.3156	0.0613	-5.145	< 0.001
Indicative	-0.2093	0.0456	-4.584	< 0.001

To examine whether the accuracy in the production of counterfactuals differs than indicatives, a generalized linear mixed effects model (GLMM) was fitted due to the binary outcome of the data, using the following models:

model_pro_cf <- glmer(score ~ group + (1 | Participant_ID) + (1 | question_ID)
model_pro_ind <- glmer(score ~ group + (1 | Participant_ID) + (1 | question_ID),

As in the analysis for the comprehension of counterfactuals, the model included group (patient vs. control as a fixed effect and random intercepts for participants and items (questions). Results demonstrated a significant main effect of group on production accuracy (β = –2.053, *SE* = 0.536, *z* = –3.829, *p* < .001), indicating greater difficulty in producing counterfactual statements for the schizophrenia group compared to the control group. As for indicatives, there was no main effect between groups (β = –1.020, *SE* = 0.618, *z* = –1.650, *p* = .099), which suggests that the production of indicatives might be relatively preserved in schizophrenia group.

Table 4.3. Results of the generalized linear mixed-effects model comparing sentence type for production

Sentence Type	Estimate	Std. Error	z-value	p-value
Counterfactual	-2.053	0.536	-3.829	< .001
Indicative	-1.020	0.618	-1.650	.099

4.3. Results: Comprehension Experiment

A linear mixed-effects model was fitted to explore the effects of group (schizophrenia vs. control) and sentence type (counterfactual vs. indicative) and their

interactions on accuracy scores in the truth value judgement task designed to test comprehension of counterfactuals. Clinical (PANSS and duration of condition), cognitive (TMT A and B) and demographic variables (age, gender and education level) were included as covariates to investigate whether these variables affect participants' scores. Random intercepts for both participants and question items were modeled. The model used for the analysis is as follows:

*model <- lmer(score ~ group * sentence_type + gender + age + duration_of_condition + education + panss_positive + panss_negative + panss_general + tmt_a + tmt_b + (1 | Participant_ID) + (1 | question_ID)*

The overall model revealed no significant main effect of group (*β = –0.088, SE = 0.153, t = -0.577, p = .566*), indicating that patients with schizophrenia did not differ significantly from controls in their comprehension scores. The main effect of sentence type approached significance (*β* = –0.069, *SE* = 0.035, t = -1.962 *p* = .065), suggesting a trend toward lower performance in counterfactual sentences compared to indicative ones. Importantly, the interaction between group and sentence type was significant (*β = –0.106, SE = 0.046 t = -2.330, p = .020*), indicating that patients with schizophrenia showed a decline in comprehension performance when processing counterfactuals relative to controls.

Table 4.4. Results of the linear mixed-effects model for comprehension test

Predictor	Estimate	Std. Error	t-value	p-value
Group	-0.088	0.153	-0.577	0.566
Sentence Type	-0.069	0.035	-1.962	0.065
Group*Sentence Type	-0.106	0.046	-2.330	0.020

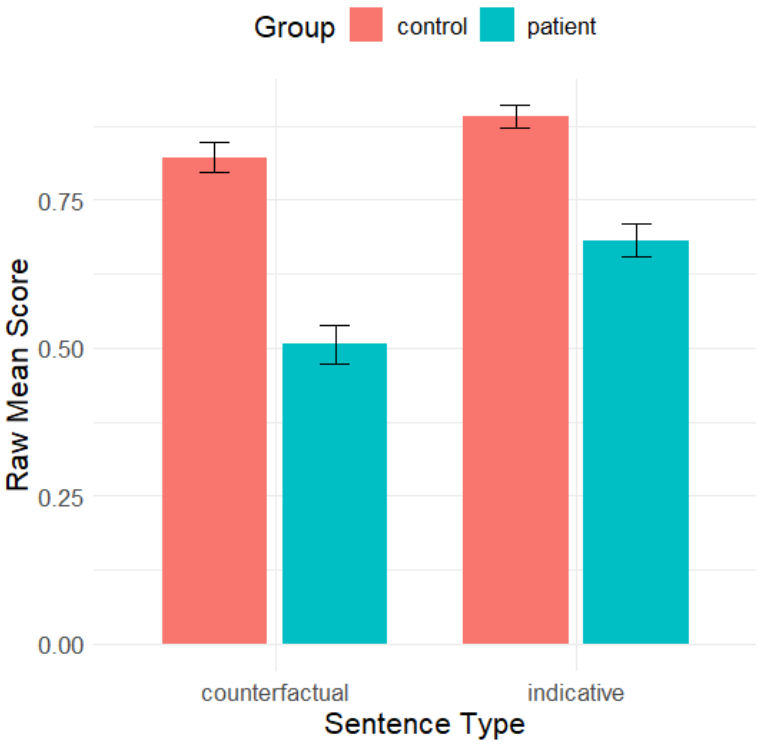

Figure 4.1. Mean score comparisons of sentence type between schizophrenia and control group for comprehension

As for the clinical, cognitive and demographic covariates, higher educational level (bachelor's degree) significantly predicted better performance in comprehension *(β = 0.1752, SE = 0.0481, t = 3.643, p < .001).* Symptom severity (PANSS) and cognitive test (TMT A and B) performance showed marginal associations with lower accuracy in comprehension scores (both *p*s ≈ .057)

Table 4.5. Results of the linear mixed-effects model for the effects of clinical, demographic and cognitive covariates on comprehension test

Predictor	Estimate	Std. Error	t-value	p-value
age	-0.0014	0.0023	-0.586	0.560
duration of condition	0.0006	0.0040	0.139	0.890
education (bachelor)	0.1752	0.0481	3.643	<0.001
PANSS positive	0.0054	0.0074	0.733	0.466
PANSS negative	-0.0160	0.0083	-1.935	0.057
PANSS general	0.0061	0.0056	1.095	0.278

Table 4.5. (continued)

TMT-A	-0.0006	0.0018	-0.317	0.752
TMT-B	-0.0015	0.0008	-1.936	0.057

4.4. Results: Production Experiment

In the production task, a generalized linear mixed-effects model (GLMM) with a binomial logit link was employed due to the binary outcome variable to assess the effects of group, sentence type and their interaction on production scores. Same covariates and random effects were included as in the comprehension model were included. The model used for GLMM is provided below:

*model_glmm <- glmer(score ~ group * sentence_type + gender + age + duration_of_condition + education + panss_positive + panss_negative + panss_general + tmt_a + tmt_b + (1 | Participant_ID) + (1 | question_ID)*

Contrary to comprehension, there was a main effect of sentence type (*β = 0.880, SE = 0.387, z = 2.276, p = .023)*, which suggests that participants performed better on counterfactuals than on indicatives. However, a significant interaction was observed between group and sentence type (*β = –1.095, SE = 0.412, z = -2.656, p = .008*), which shows that patients had a substantial decrement in their production performance on counterfactuals compared to controls.

Table 4.6. Results of the generalized linear mixed model for the production test

Predictor	Estimate	Std. Error	z-value	p-value
Group	0.263	1.242	0.212	0.832
Sentence type	0.880	0.387	2.276	0.023
Group*Sentence type	-1.095	0.412	-2.656	0.008

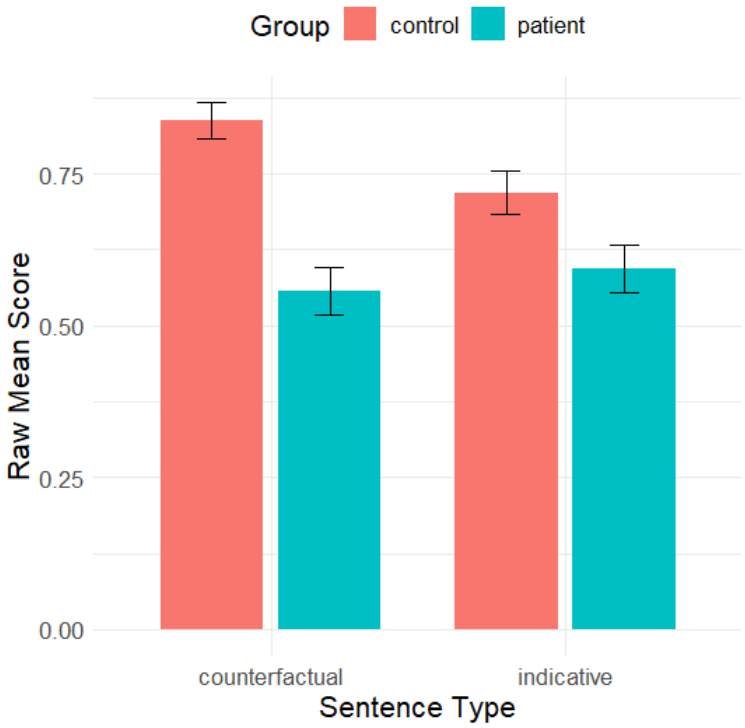

Figure 4.2. Mean score comparisons of sentence type between schizophrenia and control group for production

Among the covariates, educational level was a strong predictor of better performance. Participants who have completed a bachelor's degree (β = 1.728, *SE* = 0.426, z = 4.060 $p < .001$) or who had received education in a bachelor's programme for a certain amount of time *(β = 1.412, SE = 0.528, z = 2.675, p = .007)* had a better performance than participants with high school education. Clinical or cognitive covariates did not predict production scores (*ps* > .40).

Table 4. 7. Results of the generalized linear mixed model for the effects of clinical, demographic and cognitive covariates on production test

Predictor	Estimate	Std. Error	z-value	p-value
age	-0.014	0.015	-0.720	0.471
duration_of_condition	-0.004	0.032	-0.144	0.885
educationbachelor_drop	1.412	0.528	2.675	0.007
educationbachelor	1.728	0.426	4.060	$p < .001$
PANSS positive	-0.049	0.059	-0.834	0.404

Table 4.7. (continued)

PANSS negative	-0.027	0.065	-0.425	0.670
PANSS general	0.012	0.046	0.274	0.784
TMT-A	-0.003	0.014	-0.225	0.822
TMT-B	-0.004	0.006	-0.676	0.498

4.5. Additional Analyses: Group-Specific Models

Additional analyses were conducted separately for the schizophrenia and control groups to analyze how sentence type affected performance on both comprehension and production. The models included the same predictors as in the main analysis.

4.5.1. Results: Control Group

To analyze the control group separately for the comprehension test, a subset consisting of the control group was created, labeled as "group 1". Then, a linear mixed model was fit using the following model:

model_group1 <- lmer(score ~ sentence_type + gender + age + education + tmt_a + tmt_b + (1 | Participant_ID) + (1 | question_ID), data = group1_data)

In the control group, the linear mixed-effects model revealed a significant effect of sentence type. The control group performed worse on counterfactual items compared to indicative ones (β = –0.069, *SE* = 0.030, *t* = –2.29, *p* = .023). No other predictors, including age, gender, education, or TMT-A/B scores reached statistical significance (all *ps* > .19).

Table 4.8. Results of the linear mixed model for the control group in comprehension test

Predictor	Estimate	Std. Error	t-value	p-value
Sentence type	-0.069	0.30	-2.29	0.023
age	-0.001	0.002	-0.479	0.635

Table 4.8. (continued)

educationbachelor_drop	-0.066	0.055	-1.189	0.243
educationbachelor	0.038	0.044	0.859	0.396
TMT-A	-0.0009	0.0028	-0.342	0.734
TMT-B	-0.002	0.0019	-1.331	0.192

To analyze the healthy control group separately, labelled as group 3, in the production test, a generalized linear mixed model was fit with using the model provided below:

model_group3 <- glmer(score ~ sentence_type + gender + age + education + tmt_a + tmt_b + (1 | Participant_ID) + (1 | question_ID), data = group3_data, , family = binomial)

The results showed that sentence type had a significant effect among controls: the odds of a correct response were significantly higher for counterfactual items compared to indicative ones, (*β = 0.841, SE = 0.306, z = 2.74, p = .006)*. Education also showed a significant positive effect: participants with a bachelor's degree were more likely to respond correctly (*β* = 1.322, *SE* = 0.598, z = 2.209, *p* = .027). Other predictors, including cognitive measures, were not significant (*ps* > .10).

Table 4.9. Results of the generalized linear mixed model for the control group in production test

Predictor	Estimate	Std. Error	z-value	p-value
Sentence type	0.841	0.306	2.74	0.006
age	-0.021	0.025	-0.834	0.404
educationassociate_degree	-0.769	0.830	-0.927	0.354
educationbachelor_drop	1.198	0.731	1.639	0.101
educationbachelor	1.322	0.598	2.209	0.027
tmt_a	-0.011	0.033	-0.342	0.732
tmt_b	0.009	0.024	0.398	0.690

4.5.2. Results: Schizophrenia Group

To analyze the patient group separately from healthy controls for the comprehension test, a subset was created labeled as “group 2”. A linear mixed model was fit using the model below:

model_group2 <- lmer(score ~ sentence_type + gender + age + duration_of_condition + education + panss_positive + panss_negative + panss_general + tmt_a + tmt_b + (1 | Participant_ID) + (1 | question_ID), data = group2_data)

For the schizophrenia group, the effect of sentence type was stronger in comprehension. Participants scored significantly lower on counterfactual items than indicative ones *(β = –0.175, SE = 0.041, t = –4.32, p = .005*). Moreover, education was significantly associated with performance: those who had dropped out of bachelor’s-level education (β = 0.373, *SE* = 0.111, t = 3.350, *p* = .002) and those with a bachelor’s degree (*β = 0.412, SE = 0.102 t = 4.051, p < .001*) outperformed the reference group (high school graduates). No significant associations were found for PANSS scores or TMT-A/B scores in this group (*ps* > .19).

Table 4.10. Results of the linear mixed model for the patient group in comprehension test

Predictor	Estimate	Std. Error	t-value	p-value
Sentence type	-0.175	0.041	-4.32	0.005
age	-0.006	0.005	-1.186	0.245
duration_of_condition	0.005	0.006	0.887	0.382
educationbachelor_drop	0.373	0.111	3.350	0.002
educationbachelor	0.412	0.102	4.051	p < .001
PANSS positive	-0.0017	0.008	-0.201	0.842
PANSS negative	-0.0042	0.010	-0.423	0.675
PANSS general	0.0078	0.006	1.260	0.218

Table 4.10. (continued)

TMT A	-0.0017	0.002	-0.733	0.469
TMT B	-0.0011	0.0009	-1.316	0.198

To separately analyze the schizophrenia group, labelled as group 4, in the production test, another generalized linear mixed model was fit with the following model:

model_group4 <- glmer(score ~ sentence_type + gender + age + duration_of_condition + education + panss_positive + panss_negative + panss_general + tmt_a + tmt_b + (1 | Participant_ID) + (1 | question_ID), data = group4_data, , family = binomial)

Schizophrenia group showed no significant effect of sentence type in the production test (*β = –0.227, SE = 0.407, z = –0.56, p = .578).* However, educational attainment again emerged as a robust predictor. Participants with bachelor's degrees (*β = 2.722, SE = 0.721 z = 3.778, p < .001*) and those who had dropped out of such programs (*β = 1.989, SE = 0.791, z = 2.515, p = .012*) demonstrated significantly better performance compared to those with only a high school education. No significant associations were found for PANSS, TMT scores, or age (*ps* > .16).

Table 4. 11. Results of the generalized linear mixed model for the patient group in production test

Predictor	Estimate	Std. Error	z-value	p-value
Sentence type	-0.227	0.407	-0.56	0.578
age	-0.052	0.037	-1.377	0.168
duration_of_condition	0.022	0.044	0.510	0.609
educationbachelor_drop	1.989	0.791	2.515	0.012
educationbachelor	2.722	0.721	3.778	*p < .001*
panss_positive	-0.077	0.058	-1.337	0.181
panss_negative	0.0252	0.069	0.364	0.716
panss_general	0.0156	0.044	0.355	0.722

Table 4.11. (continued)

tmt_a	0.0004	0.016	0.030	0.975
tmt_b	-0.002	0.006	-0.398	0.690

To conclude, a significant interaction revealed that patients performed significantly worse on counterfactuals than the control group both in comprehension and in production. Educational attainment consistently emerged as a robust predictor of performance across both tasks and groups. Although negative symptom severity (PANSS negative) and executive function measures (TMT-B) marginally predicted lower scores in comprehension, clinical symptom severity and executive functioning measures did not significantly and consistently contribute to patients' performance.

CHAPTER 5

DISCUSSION

This study aimed to investigate counterfactual sentence comprehension and production in individuals with schizophrenia in comparison to the healthy individuals. The study mainly focused on two research questions: (1) Can individuals with schizophrenia comprehend and produce counterfactuals although these structures are morphosyntactically, semantically and cognitively complex? and (2) If so, do clinical (symptom severity and duration of condition), cognitive (executive functions) and demographic (age and education) traits affect patients' scores across sentence and task types? It was hypothesized that counterfactuals would elicit reduced scores in the patient group due to cognitive, semantic, and morphosyntactic cost compared to the control group. Furthermore, for the patient group, the hypothesis clinical and cognitive traits would negatively affect performance on counterfactuals in both tasks due to the executive dysfunction characterized with schizophrenia.

5.1. Counterfactual Deficits: Schizophrenia versus Control Group

One of the main findings of the current study is that individuals with schizophrenia showed impaired counterfactual reasoning compared to the control group, especially in the comprehension task. This finding is consistent with the existing body of literature suggesting that counterfactual reasoning deficit is observed in schizophrenia (Hooker et al., 2002; Leitman et al., 2006; Contreras et al., 2016; Albacete et al., 2017). As mentioned previously, counterfactuals require the simulation of alternative events, which means that cognitive abilities such as theory of mind, counterfactual reasoning, working memory and inhibition, all of which are reported to be impaired in schizophrenia (Hooker et al.,2000; Badcock et al., 2002;

Frith, 2004; Brüne, 2005; Lee and Park, 2005; Forbes et al., 2009; Galaverna et al., 2012; Contreras et al., 2016). Therefore, lower scores in counterfactuals in the comprehension experiment can be a result of impaired executive function, and more specifically, counterfactual reasoning deficit in schizophrenia. Although this study did not investigate theory of mind, it is probable that individual differences in theory of mind abilities may have also contributed to counterfactual comprehension performance, since theory of mind and counterfactual reasoning share common demands such as perspective-taking and simulating suppositional scenarios (Ferguson et al., 2010). Therefore, the observed deficit in the comprehension of counterfactuals might not only stem from counterfactual reasoning deficits, but also impairment in theory of mind as well, necessitating the incorporation of theory of mind assessments in future studies on counterfactual sentence comprehension.

The difficulty associated with counterfactual comprehension in individuals with schizophrenia might not only stem from executive dysfunction, but also pragmatic impairments. Counterfactuals can be pragmatically demanding since they mention scenarios which are untrue, and therefore violate the maxim of quality (Kulakova & Nieuwland, 2016b). Counterfactuals also violate Maxim of Quantity, which stresses being informative no more or less than it is required (Grice, 1975), since they require inferring scalar implicatures. Scalar implicatures are expressions which are interpreted based on a scale of informativeness –from less informative to more informative, such as *some vs. all* or *may vs. must*-. Counterfactuals contain modal verbs such as would, might or could to express uncertainty, which are considered to be less informative since they talk about possibilities. On the other hand, non-modal statements that talk about certain events (e.g. She passed the exam) are more informative. When the speaker chooses an informatively weaker modal form (e.g., She would have passed), the stronger form (She passed the exam) is falsified, which give rise to the negated meaning in counterfactuals. The use of modal verb signals that the event is counter-to-the-fact although the speaker does not overtly mention the falsity of the event, which can be considered as the violation of Maxim of Quantity since the speaker uses a less informative structure that requires the listener to infer negation implicitly instead of explicitly stating the factual situation. Nieuwland et al. (2010) suggest that individuals with pragmatic deficits may have

difficulty in detecting the violation of conversational maxims and therefore less likely to infer implied meanings as in scalar implicatures. Therefore, our results that the greater difficulty experienced in counterfactuals in the schizophrenia group can be explained with the pragmatic deficits of the participants as well.

While comprehension results pointed out to a clear counterfactual impairment in the patient group, the production task gave a different pattern. Within patient group, participants' performance did not differ between counterfactuals and indicatives in production. However, when compared to the control group, schizophrenia group was less accurate in counterfactual production. This finding bring about questions regarding the underlying cause of the impairment in production. The reduced scores can be either an outcome of counterfactual reasoning deficit, or the morphological difficulty associated with counterfactuals. It must be noted that production experiment gave various sentence structures, and certain responses reflected counterfactual meaning, suggesting that the participant understood counterfactual scenario at the semantic level, but could not encode counterfactuality at the morphological level. For instance, certain participants produced sentences using negation marker *–ma* "İşi bitmedi, gelmedi" or "Zamanında çıkmıyor, yetişmiyor" instead of –sA as the counterfactual marker. Since counterfactual information entails negation (Anderson, 1951), such responses can be interpreted as successful interpretation of a counterfactual scenario. However, the participant might have used simpler/more commonly used sentence structures as a linguistic production strategy due to cognitive constraints or morphological difficulties. Literature shows that language production in schizophrenia is often negatively influenced by formal thought disorder, causing reduced syntactic complexity and less morphological variance (Kuperberg, 2010; Walenski et al., 2010; Ziv et al., 2022), which can affect generation of complex sentence structures. Therefore, patients with schizophrenia might have relied on semantically similar but grammatically simpler or more commonly produced alternatives to express counter-to-the-fact scenarios due to cognitive limitations. Further qualitative investigations must be conducted on sentences produced by patients to clarify the distinction between semantic and morphological distinction in counterfactual sentence generation.

The current study also revealed that counterfactuals yielded to lower accuracy scores in healthy control group compared to indicatives, indicating the demanding cognitive nature of counterfactuality even in typical populations. However, production of counterfactuals was more successful in the control group, giving an asymmetrical result. This result might suggest that comprehension and production require different cognitive demands. While comprehension requires working memory, logical reasoning and mental models when counterfactuals are processed, sentence production requires formulaic constructions and understanding pragmatic cues, which might offer evidence to the dissociation of comprehension and production as two separate mechanisms. Another explanation for the asymmetry between comprehension and production in the control group can be related to the extent of contextualization of the two experiments. In the present study, the production experiment gave more contextual cues through narrative support, which may have facilitated the counterfactual sentence generation. However, the comprehension experiment included less pragmatic support, increasing ambiguity.

5.2. The Predictive Role of Education, Clinical and Cognitive Factors

In the current study, educational level was to most consistent and robust predictor of improved performance in both comprehension and production within groups. Participants who had fully or partially completed a bachelor's degree outperformed participants with high school education. This finding aligns with the cognitive reserve theory (Stern, 2002) which proposes that educational experiences enhance neural efficiency and compensatory mechanisms, enabling individuals to perform more effectively on cognitively challenging tasks (Barulli & Stern, 2013) The fact that participants who had dropped out of bachelor-level programs outperformed the reference group demonstrates that even an incomplete exposure to tertiary education can lead to better cognitive skills. This is likely due to the fact that higher education contexts include cognitively complex tasks.

Another explanation for education being a robust predictor in the current study is that individuals with higher educational levels are more likely to have mental health awareness and literacy, and better access to health services. Early interventions in

psychosis, such as coordinated specialty care (CSC) and psychoeducation, seem to decrease the duration of untreated psychosis and therefore effectively hinder potential cognitive harm (Bird et al., 2010). Moreover, socioeconomic factors correlated with education may explain the performance differences. Individuals with higher education levels often have access to more cognitively stimulating environments. These broader life-course exposures can enhance overall cognitive development and test-taking efficacy (Hackman et al., 2010; Noble et al., 2005). Thus, education may act not only as a direct cognitive enhancer but also represents various socio-environmental advantages. In sum, these findings support the notion that higher levels of education, even if not completed, are associated with better cognitive-linguistic performance. This underscores the critical role of educational attainment not only as a marker of knowledge but also as a contributor to the development of higher-order cognitive and linguistic abilities.

Contrary to our hypothesis, clinical variables such as symptom severity and condition duration and cognitive measures such as TMT-A and B were not significant predictors of the comprehension and production of counterfactuals. This finding can be explained with the fact that clinical severity in our sample was not various enough to reveal individual differences. Moreover, though TMT-A and TMT-B are valid measures to test executive function, they do not separately measure executive functions that are critical for counterfactual comprehension and production such as reasoning, inhibition, working memory, which decreases the sensitivity of capturing the underlying cognitive causes that might affect counterfactual comprehension and production.

CHAPTER 6

CONCLUSION

The present study aimed to investigate the comprehension and production patterns of counterfactuals in individuals with schizophrenia, whether their comprehension and production of such statements deviate from healthy individuals, and whether the decreased scores are an end product of deteroriated clinical properites (condition severity and duration of condition), executive dysfunction (TMT scores) and demographic properties (age, education, gender). A truth-value judgement task for comprehension, and a dialogue completion task for production were implemented to inquire into the current research questions. Research on counterfactual reasoning in schizophrenia population suggested that counterfactual reasoning is globally impaired in the condition (Hooker et al., 2000; Contreras et al., 2016). Built on the findings of such research, it was aimed to examine whether counterfactual reasoning deficits would bring about difficulties in comprehending and producing counterfactuals. Results from linear mixed models for comprehension revealed a significant interaction between group and sentence type, indicating lower accuracy scores for counterfactuals in schizophrenia group. This finding supported the results of the literature, suggesting that counterfactual reasoning is specifically impaired in schizophrenia. The findings from generalized linear mixed model for production showed that patients with schizophrenia had also decreased performance in counterfactuals compared to the control group. Among the covariates, educational level emerged as a robust predictor of better scores across both tasks, suggesting that exposure to educational settings may preserve cognitive functions necessary for processing complex sentences such as counterfactuals. Moreover, higher education level may predict better access and awareness to mental health problems, which would decrease the possible effects of the condition on cognitive functions.

6.1. Implications for Future Research and Limitations

The findings of the present study have several implications. Even though it is evident that individuals with schizophrenia have an impaired comprehension and production of counterfactuals, the reason behind this impairment could not been specifically identified due to both complex nature of the structure and the condition. Therefore, a more nuanced experimental design is necessary that separately investigates dual meaning processing and pragmatic deficits in the comprehension of counterfactuals in schizophrenia by assessing cognitive skills critical for counterfactual comprehension and production such as theory of mind, counterfactual reasoning, working memory and inhibition. In addition, this study shows that comprehension and production abilities do not have parallel patterns both in the patient and control groups, indicating that further research is needed to better understand the mechanisms of comprehension and production. The observed impairment in counterfactual comprehension and production in the schizophrenia group highlight the need to incorporate language-based and complex reasoning tasks into rehabilitation programs. Moreover, the predictive role of education demonstrates that education possibly alleviates cognitive and linguistic deficits in individuals with schizophrenia, and therefore, should be considered as key components of early intervention programs. Future studies should focus on intervention in less-educated patient populations to explore whether education improves counterfactual reasoning, and therefore comprehension and production of such sentences. Neuroimaging methods can provide a more precise analysis by revealing the neural correlates of counterfactual deficits.

The present study has certain limitations. The sample size was relatively small, which may have limited statistical power. Therefore, a larger sample size could give more generalizable findings. Moreover, certain cognitive measures were not separately controlled such as theory of mind. Further studies should include assessing such cognitive functions since they might provide better explanation of the results. Formal thought disorder should be also controlled in patients with schizophrenia, since severity of FTD might affect results in language-related tests.

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APPENDICES

A. PRACTICE ITEMS

TEST 1

Her bir soruda verilen duruma ve cümleye göre, verilen seçeneklerin gerçekleşme ihtimallerini işaretleyiniz.

ÖRNEK SORU 1

Durum: Gölde balık ve yosun var.

"Oğulcan balığı yakaladıysa sevinir." cümlesini söyleyen kişiye göre, aşağıdaki seçeneklerin gerçekleşme ihtimalini **olabilir**, **olamaz** ya da **kararsızım** olarak işaretleyiniz.

Oğulcan balığı yakaladı ve sevindi.	□ Olabilir	□ Olamaz	□ Kararsızım
Oğulcan balığı yakalamadı ve sevinmedi.	□ Olabilir	□ Olamaz	□ Kararsızım
Oğulcan balığı yakaladı ama sevinmedi.	□ Olabilir	□ Olamaz	□ Kararsızım

ÖRNEK SORU 2

Durum: Can'ın arabası ve bisikleti var.

"Can bisikleti sürseydi işe geç kalırdı." cümlesini söyleyen kişiye göre, aşağıdaki seçeneklerin gerçekleşme ihtimalini **olabilir**, **olamaz** ya da **kararsızım** olarak işaretleyiniz.

Can işe bisikletle gitti ve işe geç kaldı.	□ Olabilir	□ Olamaz	□ Kararsızım
Can işe bisiklete gitti ama işe geç kalmadı.	□ Olabilir	□ Olamaz	□ Kararsızım
Can işe bisikletle gitmedi ve işe geç kalmadı.	□ Olabilir	□ Olamaz	□ Kararsızım

TEST 2

Aşağıdaki sorular için verilen duruma ve diyaloğa göre diyaloğun son cümlesini tamamlayınız.

ÖRNEK SORU 1

Durum:

Ebru bugün derste sunum yapacak. Çıkmadan önce üzerine kahve döküldüğü için evden geç çıktı. Ebru'nun babası sunuma yetişip yetişemeyeceği hakkında endişeli.

Yukarıdaki bilgilere göre aşağıdaki diyaloğun son cümlesini en uygun biçimde tamamlayınız.

Baba: Aksiliğe bak! Umarım sunumuna yetişir.

Anne: Merak etme. Taksiye bin_____ yetiş_____.

ÖRNEK SORU 2

Durum:

Ekin bir araba satın almak istiyor. Ancak parası araba almaya yetmiyor. Sena ve Zeynep bu durum hakkında konuşuyorlar.

Yukarıdaki bilgilere göre aşağıdaki diyaloğun son cümlesini en uygun biçimde tamamlayınız.

Sena: Ekin neden araba almadı? Para biriktirdiğini sanıyordum.

Zeynep: Tüm maaşını gereksiz şeylere harcadı. Parasını biriktir_____ al_____.

B. EXPERIMENTAL ITEMS

Durum 1: Sokakta kediler ve köpekler yaşar.

"*Hilal köpeği gördüyse kaçar.*" cümlesini söyleyen kişiye göre, aşağıdaki seçeneklerin gerçekleşme ihtimalini **olabilir**, **olamaz** ya da **kararsızım** olarak işaretleyiniz.

Hilal köpeği gördü ama kaçmadı.	□ Olabilir	□ Olamaz	□ Kararsızım
Hilal köpeği gördü ve kaçtı.	□ Olabilir	□ Olamaz	□ Kararsızım
Hilal köpeği görmedi ve kaçmadı.	□ Olabilir	□ Olamaz	□ Kararsızım

Durum 3: Menüde tavuk ve pasta var.

"Mert tavuğu yeseydi doyardı." cümlesini söyleyen kişiye göre, aşağıdaki seçeneklerin gerçekleşme ihtimalini **olabilir**, **olamaz** ya da **kararsızım** olarak işaretleyiniz.

Mert tavuğu yedi ama doymadı.	□ Olabilir	□ Olamaz	□ Kararsızım
Mert tavuğu yedi ve doydu.	□ Olabilir	□ Olamaz	□ Kararsızım
Mert tavuğu yemedi ve doymadı.	□ Olabilir	□ Olamaz	□ Kararsızım

Durum 5: Apartmanda merdiven ve asansör var.

"Onur merdiveni kullansaydı terlerdi." cümlesini söyleyen kişiye göre, aşağıdaki seçeneklerin gerçekleşme ihtimalini **olabilir**, **olamaz** ya da **kararsızım** olarak işaretleyiniz.

Onur merdiveni kullandı ve terledi.	□ Olabilir	□ Olamaz	□ Kararsızım
Onur merdiveni kullanmadı ve terlemedi.	□ Olabilir	□ Olamaz	□ Kararsızım
Onur merdiveni kullandı ama terlemedi.	□ Olabilir	□ Olamaz	□ Kararsızım

Durum 7: Mutfakta kahve ve süt var.

"Enes süt içtiyse uyur." cümlesini söyleyen kişiye göre, aşağıdaki seçeneklerin gerçekleşme ihtimalini **olabilir**, **olamaz** ya da **kararsızım** olarak işaretleyiniz.

Enes süt içmedi ve uyumadı.	□ Olabilir	□ Olamaz	□ Kararsızım
Enes süt içti ama uyumadı.	□ Olabilir	□ Olamaz	□ Kararsızım
Enes süt içti ve uyudu.	□ Olabilir	□ Olamaz	□ Kararsızım

Durum 9: Odada klima ve ısıtıcı var.

"Umut klimayı açtıysa serinler." cümlesini söyleyen kişiye göre, aşağıdaki seçeneklerin gerçekleşme ihtimalini **olabilir**, **olamaz** ya da **kararsızım** olarak işaretleyiniz.

Umut klimayı açtı ve serinledi.	□ Olabilir	□ Olamaz	□ Kararsızım
Umut klimayı açmadı ve serinlemedi	□ Olabilir	□ Olamaz	□ Kararsızım
Umut klimayı açtı ama serinlemedi.	□ Olabilir	□ Olamaz	□ Kararsızım

Durum 11: Deniz'in bavulu ve çantası var.

"Deniz bavulu taşısaydı yorulurdu." cümlesini söyleyen kişiye göre, aşağıdaki seçeneklerin gerçekleşme ihtimalini **olabilir**, **olamaz** ya da **kararsızım** olarak işaretleyiniz.

Deniz bavulu taşımadı ve yorulmadı.	□ Olabilir	□ Olamaz	□ Kararsızım
Deniz bavulu taşıdı ve yoruldu.	□ Olabilir	□ Olamaz	□ Kararsızım
Deniz bavulu taşıdı ama yorulmadı.	□ Olabilir	□ Olamaz	□ Kararsızım

Durum 13: Alp'in kazağı ve tişörtü var.

"Alp tişört giydiyse üşür." cümlesini söyleyen kişiye göre, aşağıdaki seçeneklerin gerçekleşme ihtimalini **olabilir**, **olamaz** ya da **kararsızım** olarak işaretleyiniz.

Alp tişörtü giydi ama üşümedi.	◻ Olabilir	◻ Olamaz	◻ Kararsızım
Alp tişörtü giydi ve üşüdü.	◻ Olabilir	◻ Olamaz	◻ Kararsızım
Alp tişörtü giymedi ve üşümedi.	◻ Olabilir	◻ Olamaz	◻ Kararsızım

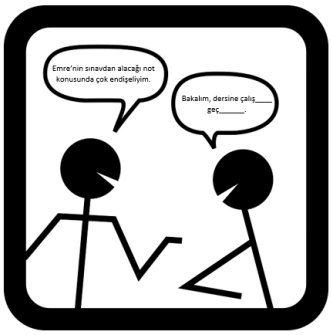
Durum 15: Masada kitap ve gazete var.

"Esra kitabı okusaydı eğlenirdi." cümlesini söyleyen kişiye göre, aşağıdaki seçeneklerin gerçekleşme ihtimalini **olabilir**, **olamaz** ya da **kararsızım** olarak işaretleyiniz.

Esra kitabı okumadı ve eğlenmedi.	◻ Olabilir	◻ Olamaz	◻ Kararsızım
Esra kitabı okudu ve eğlendi.	◻ Olabilir	◻ Olamaz	◻ Kararsızım
Esra kitabı okudu ama eğlenmedi.	◻ Olabilir	◻ Olamaz	◻ Kararsızım

DURUM 1

Emre bugün çok önemli bir sınava giriyor. Emre sınavdayken annesi ve babası durum hakkında konuşuyorlar. Annesi Emre'nin alacağı not konusunda endişeli.



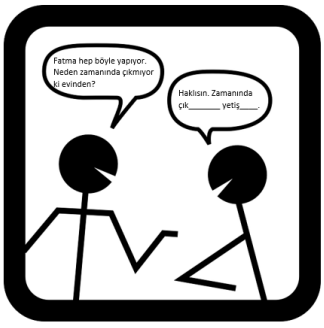
Yukarıdaki bilgilere göre aşağıdaki diyaloğun son cümlesini en uygun biçimde tamamlayınız.

Anne: Emre'nin sınavdan alacağı not konusunda çok endişeliyim.

Baba: Bakalım, dersine çalış_____ geç_____.

DURUM 3

Fatma, arkadaşları Ece ve Ayşe'yle basketbol maçı izlemeye gidecek. Ece ve Ayşe, salonda Fatma'yı bekliyor. Fatma geç kaldığı için arkadaşları sinirli.



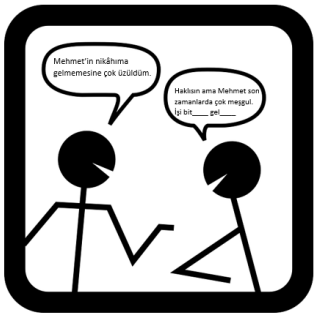
Yukarıdaki bilgilere göre aşağıdaki diyaloğun son cümlesini en uygun biçimde tamamlayınız.

Ece: Fatma hep böyle yapıyor. Neden zamanında çıkmıyor ki evinden?

Ayşe: Haklısın. Zamanında çık_____ yetiş_____.

DURUM 5

Mehmet, Eda'nın nikâhına gelmedi. Eda bu konuda çok üzgün. Eda bu durumu Anıl'a anlatıyor.



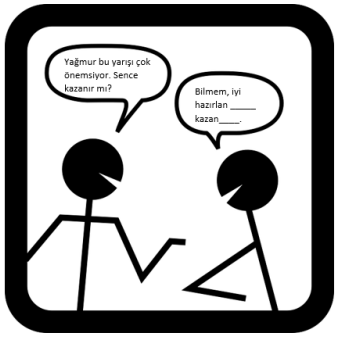
Yukarıdaki bilgilere göre aşağıdaki diyaloğun son cümlesini en uygun biçimde tamamlayınız.

Eda: Mehmet'in nikâhıma gelmemesine çok üzüldüm.

Anıl: Haklısın ama Mehmet son zamanlarda çok meşgul. İşi bit_____ gel_____.

DURUM 7

Yağmur koşu yarışına katılacak. Arkadaşları Sıla ve İlker yarışı izlemeye gidiyorlar. Yarış öncesinde Sıla ve İlker konuşuyorlar.



Yukarıdaki bilgilere göre aşağıdaki diyaloğun son cümlesini en uygun biçimde tamamlayınız.

Sıla: Yağmur bu yarışı çok önemsiyor. Sence kazanır mı?

İlker: Bilmem, iyi hazırlan _____ kazan_____.

DURUM 9

Mustafa ehliyet kursuna gidiyor. Direksiyon sınavından kaldığı için ikinci kez sınava giriyor. Mustafa sınavdayken Aslı ve Hasan durum hakkında konuşuyorlar.

Yukarıdaki bilgilere göre aşağıdaki diyaloğun son cümlesini en uygun biçimde tamamlayınız.

Aslı: Umarım bu sefer sınavı geçer ve ehliyetini alır.

Hasan: Göreceğiz. Alıştırma yap_____ al_____.

DURUM 11

Selin Almanya'da bir üniversiteye kabul ediliyor. Ancak burs bulamadığı için Türkiye'de bir üniversiteye gidiyor. Ahmet ve Betül durum hakkında konuşuyorlar.

Yukarıdaki bilgilere göre aşağıdaki diyaloğun son cümlesini en uygun biçimde tamamlayınız.

Ahmet: Selin Almanya'da bir okulu kazanmıştı. Neden gitmedi?

Betül: Burs bulamadığı için Almanya'daki okula başlayamadı. Burs kazan_____ başla_____.

DURUM 13

Elif hastalandığı için doktora gidiyor. Doktor, ona ilaçları kullanmasını ve daha sonra tahlil yaptırmak için tekrar gelmesini söylüyor. Elif hastaneye tekrar gittikten sonra ev arkadaşları Merve ve Özlem konuşuyor.

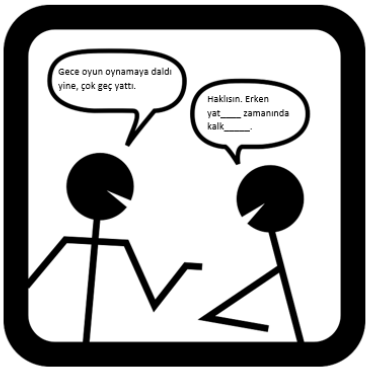
Yukarıdaki bilgilere göre aşağıdaki diyaloğun son cümlesini en uygun biçimde tamamlayınız.

Merve: Acaba değerleri iyi çıkacak mı?

Özlem: Bilmem, ilaçlarını kullan_____ iyi çık_____.

DURUM 15

Kerem sabah erken kalkıp kütüphaneye gitmeyi planlıyor. Ancak gece çok geç yattığı için zamanında kalkamıyor. Burak ve Melis, Kerem hakkında konuşuyorlar.

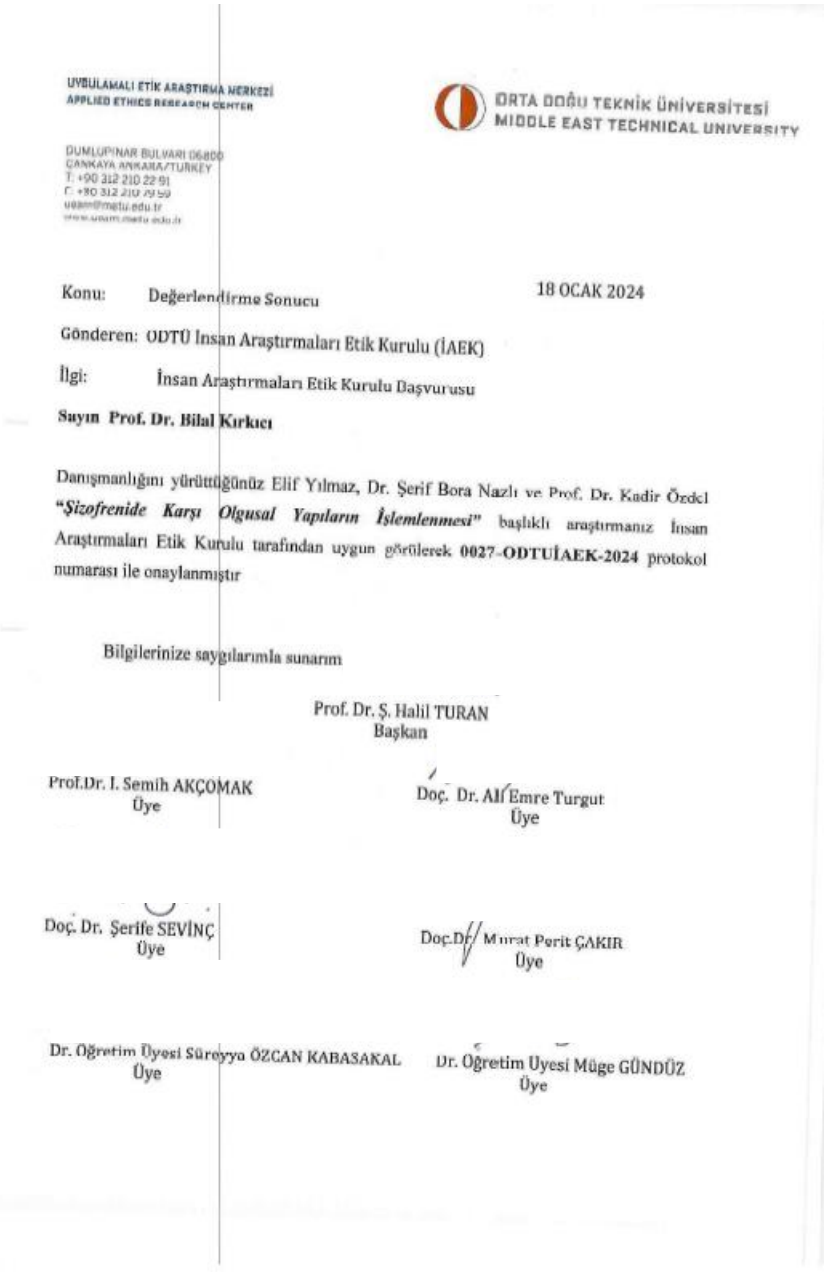


Yukarıdaki bilgilere göre aşağıdaki diyaloğun son cümlesini en uygun biçimde tamamlayınız.

Burak: Gece oyun oynamaya daldı yine, çok geç yattı.

Melis: Haklısın. Erken yat_____ zamanında kalk_____.

C. APPROVAL OF THE METU HUMAN SUBJECTS ETHICS COMMITTEE



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ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

Konu: Değerlendirme Sonucu

18 OCAK 2024

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Prof. Dr. Bilal Kırkıcı

Danışmanlığını yürüttüğünüz Elif Yılmaz, Dr. Şerif Bora Nazlı ve Prof. Dr. Kadir Özdel ***"Şizofrenide Karşı Olgusal Yapıların İşlemlenmesi"*** başlıklı araştırmanız İnsan Araştırmaları Etik Kurulu tarafından uygun görülerek **0027-ODTUİAEK-2024** protokol numarası ile onaylanmıştır

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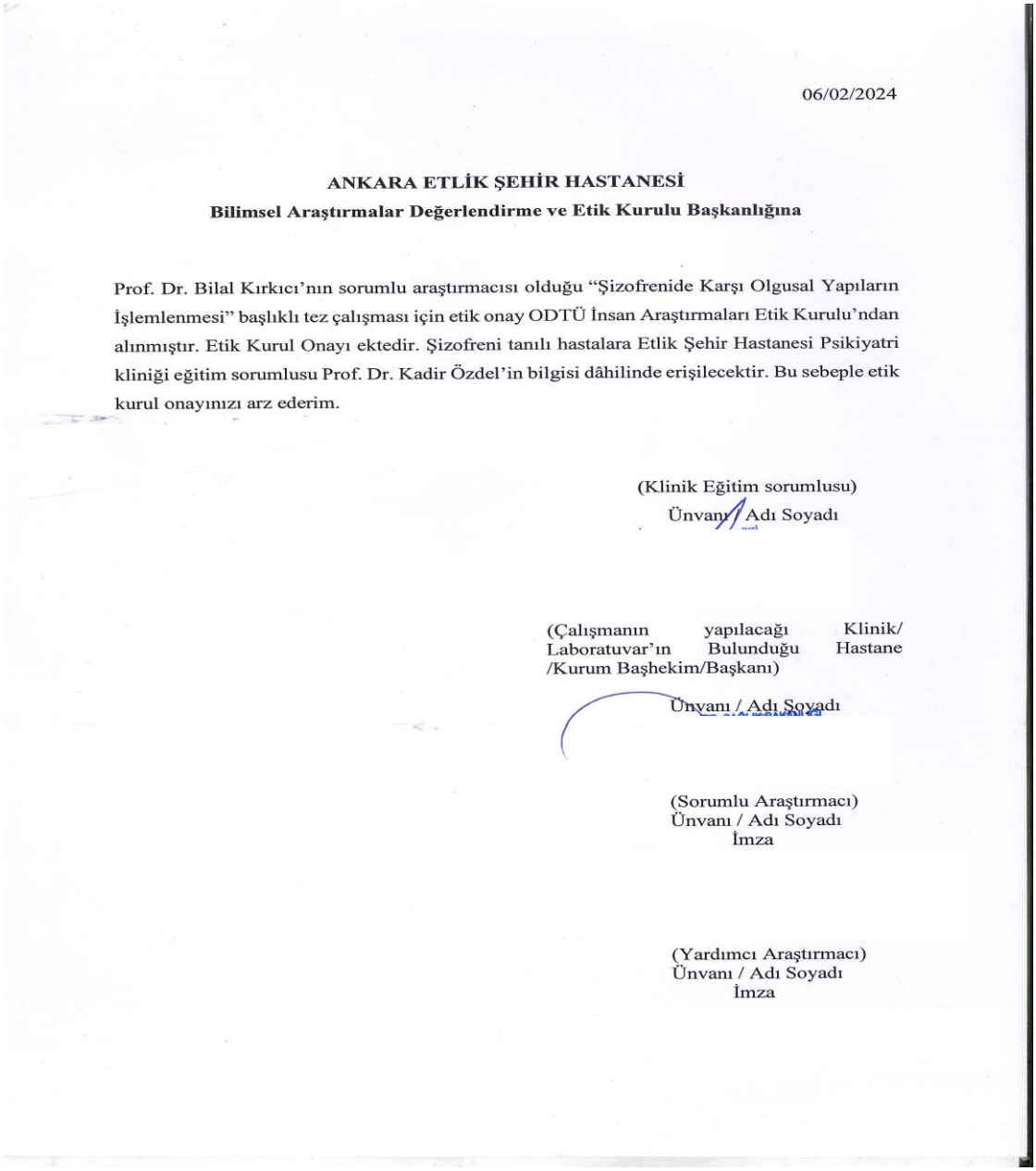
Dr. Öğretim Üyesi Müge GÜNDÜZ
Üye

D. APPROVAL OF THE ANKARA ETLİK CITY HOSPITAL ETHICS COMMITTEE



06/02/2024

ANKARA ETLİK ŞEHİR HASTANESİ
Bilimsel Araştırmalar Değerlendirme ve Etik Kurulu Başkanlığına

Prof. Dr. Bilal Kırkıcı'nın sorumlu araştırmacısı olduğu "Şizofrenide Karşı Olgusal Yapıların İşlemlenmesi" başlıklı tez çalışması için etik onay ODTÜ İnsan Araştırmaları Etik Kurulu'ndan alınmıştır. Etik Kurul Onayı ektedir. Şizofreni tanılı hastalara Etlik Şehir Hastanesi Psikiyatri kliniği eğitim sorumlusu Prof. Dr. Kadir Özdel'in bilgisi dâhilinde erişilecektir. Bu sebeple etik kurul onayınızı arz ederim.

(Klinik Eğitim sorumlusu)
Ünvanı / Adı Soyadı

(Çalışmanın yapılacağı Klinik/ Laboratuvar'ın Bulunduğu Hastane /Kurum Başhekim/Başkanı)
Ünvanı / Adı Soyadı

(Sorumlu Araştırmacı)
Ünvanı / Adı Soyadı
İmza

(Yardımcı Araştırmacı)
Ünvanı / Adı Soyadı
İmza

E. TURKISH SUMMARY / TÜRKÇE ÖZET

Giriş

Koşul cümleleri, iki önermenin ilişkisine dayalı olarak yapılandırılan ifadelerdir: ön koşul (protasis, p) ve sonuç (apodosis, q) (Comrie, 1986). Bu tür ifadeler, varsayımsal bir senaryo ve bu senaryonun olası sonuçları hakkında konuşmayı içerdikleri için iletişimde önemli bir rol oynar. Koşul cümleleri iki cümlecikten oluşur: varsayımsal senaryonun sunulduğu *öncül cümleciği* ve bu varsayımsal durumun sonucunun belirtildiği *sonuç cümleciği*. Koşul cümleleri, bildirici (indicative) koşul cümleleri ve karşı olgusal (counterfactual) koşul cümleleri olarak sınıflandırılabilir. Bildirici koşul cümleleri, gerçekleşmesi muhtemel durumlar hakkında konuşmak için kullanılır. Buna karşılık, karşı olgusal ifadeler, gerçekleşmemiş ancak gerçekleşmiş olabilecek kavramsal veya hayali alternatiflere gönderme yapar (Starr, 2021). Başka bir deyişle, karşı-olgusallar, gerçek dünyaya alternatif olarak önerilen olası bir dünyada ne olabileceği hakkında konuşur. Bildirici koşullu ve karşı olgusal koşullulara (1) ve (2)'yi örnek gösterebiliriz:

(1) Onur arabayla gittiyse işe zamanında yetişir. (bildirici koşullu)

(2) Onur arabayla gitseydi işe zamanında yetişirdi. (karşı olgusal koşullu)

Karşı olgusal cümleler, öncül cümleciğin olumsuzlanmasını içerir (Anderson, 1951). Bu nedenle, "Onur arabayla gitseydi işe zamanında yetişirdi" cümlesi, Onur'un işe arabayla gitmediğini ve içe geç kaldığını ima etmektedir.

Türkçe'de şart cümleleri, *-(y)sA* koşul belirteci ile zamansal fiil çekiminin (-DI, -r, -AcAk) art arda eklenmesi ile oluşturulur. Bildirici şart cümlelerinde (3)'de gösterildiği gibi önce zamansal fiil çekimi fiilin köküne dizilir, ardından fiil çekimine -ysA şart eki eklenir.

(3) Gömleği ütüle–di–yse dolaba asar.

Karşı olgusal koşul cümlelerinde ise (4)'de gösterildiği gibi koşul işaretleyicisi önce fiilin köküne eklenir ve koşul işaretleyicisine geçmiş fiil çekimleri eklenir.

(4) Gömleği ütüle–se-ydi dolaba asardı.

Türkçede karşı olgusallar, biçimbirim açısından kompakt bir yapıya sahip olması ve koşul belirtecinin yerinin değişmesi ile ortaya çıkan anlam farklılığı sebebiyle konuşucular için karmaşık yapılar olarak değerlendirilmektedir (Yarbay-Duman vd., 2015). Bununla birlikte, karşı olgusal ifadelerin iletişimde kullanılabilmesi için karşı olgusal muhakeme, ket vurma yetisi, çalışan bellek ve zihin kuramı becerileri gibi birçok bilişsel gereksinimin konuşucular tarafından sağlanabilmesi gerekmektedir (Aktepe, 2022). Dolayısıyla, karşı olgusal ifadelerin iletişimde kullanılması, bozulmamış dil becerilerini ve birçok bilişsel gereksinimi beraberinde getirir.

Şizofreni, bilişsel bozuklukların beraberinde dil bozukluğunun da yaygın olarak görüldüğü bir durumdur (DeLisi, 2001). Şizofrenideki dil bozukluğunun genel olarak iletişimsel boyutta olduğu bilinse de, dilin biçimbirim ve sözdizim bileşenlerinde de bozulma olduğu rapor edilmiştir (DeLisi, 2001). Bilişsel yetiler açısından ise, şizofrenide karşı olgusal yapıların kullanılması için gerekli olan bilişsel fonksiyonlarda bozukluk gözlemlenmiştir. Şizofreni tanılı hastaların karşı olgusal düşünce üretiminde sağlıklı bireylere kıyasla oldukça kötü performans gösterdikleri rapor edilmiştir (Contreras et al., 2016; Hooker et al., 2000). Aynı zamanda şizofreni hastalarında ket vurma yetisi, çalışan bellek ve başka insanların perspektifinden bakabilme yetisinde bozukluk olduğu gözlemlenmiştir (Badcock et al, 2002; Brüne, 2005; Forbes et al., 2009; Frith, 2004; Galaverna et al., 2012; Lee and Park, 2005).

Mevcut çalışmanın temel amacı, şizofreni tanılı bireylerin karşı olgusal ifadeleri anlama ve üretme becerilerini incelemektir. Bu doğrultuda, araştırmada şu sorulara ışık tutmak hedeflenmektedir:

1. Şizofreni tanılı bireyler -yapısal ve bilişsel zorluğa rağmen- karşı olgusal

yapıları anlama ve üretme becerisine sahip mi?

2. Şizofreni grubunda elde edilen performans skorları, klinik değişkenler (hastalık süresi, semptom şiddeti), bilişsel işlevler ve demografik özelliklere göre değişkenlik göstermekte midir?

Alanyazındaki bulgulara dayanarak, şizofreni hastalarının bilişsel ve anlamsal karmaşıklık nedeniyle, bildirici koşullulara kıyasla karşı olgusalları anlamada daha düşük performans göstereceği varsayılmıştır. Üretme becerileri için ise şizofreni tanılı bireylerin biçim-sözdizimsel karmaşıklık nedeniyle daha az koşullu cümle üreteceği öngörülmüştür. Ek olarak, şizofreni tanılı kişilerin karşı olgusal anlamı iletmek için daha az karmaşık cümle yapıları üreteceği öngörülmüştür. İkinci araştırma sorusu için, yürütücü işlev bozukluğunun dil alanındaki yeteneklerin azalmasına yol açacağı için, karşı olgusal skorlarının hastaların klinik ve bilişsel özelliklerinden etkileneceği varsayılmıştır.

Deney

Bu çalışmaya, Ankara Etlik Şehir Hastanesi Psikiyatri Kliniği'nden gönüllü olarak katılan, anadili Türkçe olan, şizofreni tanısı almış 40 hasta (Ort. yaş = 37,7; Yaş aralığı = 22–67; 16 kadın, 24 erkek) dahil edilmiştir. Tüm hastalar, semptom şiddetinin katılımcı yanıtları üzerindeki etkisini kontrol edebilmek amacıyla semptomatik remisyon dönemindeydi. Hastaların tanıları DSM-5 Bozuklukları için Yapılandırılmış Klinik Görüşme (SCID-V) ile konulmuştur. Pozitif ve negatif semptomlar, Pozitif ve Negatif Sendrom Ölçeği (PANSS) (Kay ve vd., 1987; Kostakoğlu ve vd., 1999) kullanılarak değerlendirilmiştir. Ayrıca, yaş ve eğitim düzeyi açısından eşleştirilmiş, herhangi bir psikiyatrik ya da nörolojik rahatsızlığı bulunmayan 40 sağlıklı birey (Ort. yaş = 37,15; Yaş aralığı = 19–55; 22 kadın, 18 erkek) çalışmaya dahil edilmiştir. Her iki gruptaki katılımcılar da en az lise mezunudur. Tüm katılımcılar, deneyin amacı hakkında bilgi sahibi değildi. Deneysel çalışmaya katılan bireyler, pilot çalışmalara katılanlardan farklıdır. Bu tez çalışması, Orta Doğu Teknik Üniversitesi İnsan Araştırmaları Etik Kurulu ile Ankara Etlik Şehir Hastanesi Bilimsel Araştırma Değerlendirme ve Etik Kurulu tarafından onaylanmıştır. Aynı zamanda tüm katılımcılardan yazılı onam alınmıştır.

Katılımcıların karşı olgusal cümleleri anlama ve üretme örüntülerini değerlendirmek amacıyla iki deney gerçekleştirilmiştir. Anlama becerisini ölçmek için, 8'i dolgu maddesi (filler) olan toplam 16 sorudan oluşan bir doğru-değer yargısı testi kullanılmıştır. Bu test, Aktepe'nin (2022) göz izleme deneyinden uyarlanarak tasarlanmıştır. Üretim becerisini değerlendirmek amacıyla ise, yine 8'i dolgu maddesi olan 16 sorudan oluşan bir diyalog tamamlama testi geliştirilmiştir. Anlama deneyi, bağlamsal bilgi içeren bir cümle ile başlamaktadır (örn. Mutfakta kahve ve süt var). Bu cümlenin hemen altında bağlam cümlesinde geçen nesnelere ait iki görsel (örn. Kahve ve süt) yer almaktadır. Bağlam cümlesi ve görseller ardından, ya bildirici koşullu (Enes süt içtiyse uyur), ya da karşı olgusal koşullu (Enes süt içseydi uyurdu) içeren bir cümle sunulmuştur. Hedef cümleyi takiben, katılımcılara bu cümleye dayalı olası sonuçları içeren üç seçenek sunulmuştur. Katılımcılardan, bağlam cümlesi, görseller ve hedef cümlesi olarak verilen koşullu cümleye dayanarak verilen üç seçenekten hangisinin veya hangilerinin gerçekleşme olasılığı olduğunu belirtmeleri beklenmiştir. Bu üç seçenek, koşullu doğruluk tablosuna göre oluşturulmuştur. Katılımcıların her bir seçeneği "Olabilir", "Olamaz" veya "Kararsızım" olarak işaretlemesi istenmiştir. Üretim deneyinde ise, katılımcılar öncelikle 3-4 cümleden oluşan kısa bir senaryo okumuştur. (Örn. Ebru bugün derste sunum yapacak. Çıkmadan önce üzerine kahve döküldüğü için evden geç çıktı. Ebru'nun babası, sunuma yetişip yetişemeyeceği konusunda endişeli. Ebru'nun annesi ve babası durum hakkında konuşuyorlar.) Senaryoyu okuduktan sonra, senaryoda da bahsedilen iki karakter arasında geçen iki satırlık bir diyalog sunulmuştur. Diyaloğun son cümlesi ya bildirici (indicative) ya da karşı olgusal (counterfactual) bir koşullu cümle içermektedir. Bu cümlelerin fiillerine herhangi bir ek eklenmemiştir ve katılımcılardan bu cümlelere anlamlı olacak şekilde belirli eklerin eklenmesi beklenmiştir. Katılımcılar, bağlama uygun olarak bildirici koşullu (Taksiye bindiyse yetişir) veya karşı olgusal koşullu (Taksiye binseydi yetişirdi) cümleleri doğru morfem diziminde ürettilerse "1" puan almışlardır. Koşullu bir yapı üretmediklerinde, morfem dizimi yanlış yapıldığında veya bağlama uygun olmayan şekilde bir koşullu cümle ürettiklerinde (örn. bildirici koşullu yerine karşı olgusal cümle üretimi) "0" puan almışlardır.

Sonuç

Bu çalışma, şizofreni tanılı bireylerde karşı olgusal cümlelerin anlaşılması ve üretilmesini incelemeyi hedeflemiştir. Çalışmanın temel bulgularından biri, şizofreni tanılı bireylerin karşı olgusal ifadelerin anlamada kontrol grubua göre daha düşük performans gösterdiği yönündedir. Cümle tipi bazında karşılaştırıldığında ise, şizofreni grubunda karşı olgusal cümlelerin anlamlandırılması bildirici koşullulara göre daha az başarılı sonuç vermiştir. Anlama deneyinde şizofreni grubunun karşı olgusallarda gösterdiği düşük performans, şizofreni tanılı bireylerin alternatif gerçeklikleri zihinsel olarak temsil etmede güçlük yaşadıklarına işaret edebilir. Bu bulgu, şizofrenide karşı olgusal muhakeme bozukluklarının gözlemlendiğini öne süren çalışmalarla tutarlıdır (Hooker vd., 2000; Leitman vd, 2006; Contreras vd., 2016; Albacete vd., 2017). Karşı olgusallar alternatif olayların zihinde canlandırılmasını gerektirir ve bunun için zihin kuramı, karşı olgusal muhakeme, çalışma belleği ve ket vurma yetileri gibi bilişsel becerilerin kullanılması önemli bir rol oynamaktadır. Bu bilişsel yetilerin şizofrenide bozulduğu bildirildiğinden (Hooker vd., 2000; Badcock vd., 2002; Frith, 2004; Brüne, 2005; Lee ve Park, 2005; Forbes vd., 2009; Galaverna vd., 2012; Contreras vd., 2016), şizofreni gruubndaki karşı olgusalları anlamada düşük performans, yürütücü işlevlerdeki bozulmanın ve özellikle karşı olgusal muhakeme ve zihin kuramı eksikliğinin bir sonucu olabilir. Bu çalışma iz sürme testi A ve B testleriyle yürütücü işlevleri ölçmeyi hedeflemiş olsa da, zihin kuramı, karşı olgusal muhakeme, ket vurma gibi bilişsel becerileri ayrıca ölçmemiştir. Özellikle zihin kuramı bozuklukları şizofrenide temel bozukluklardan biri olduğundan, zihin kuramı becerilerindeki bireysel farklılıkların karşı olgusal anlama performansına katkıda bulunmuş olması muhtemeldir. Dolayısıyla, çalışmada karşı olgusalların anlaşılmasında bulunan bozulma, yalnızca karşı olgusal muhakeme bozukluğundan değil, aynı zamanda zihin kuramı bozukluklarından da kaynaklanabilir. Bu durum, ilerde karşı olgusallarla alakalı yapılacak dil işlemleme çalışmalarında göz önünde bulundurulmalıdır.

Şizofreni tanılı bireylerin karşı olgusalları anlama zorluğu yalnızca yürütücü işlev bozukluklarından değil, aynı zamanda edimbilimsel bozukluklardan da kaynaklanıyor olabilir. Karşı olgusallar edimbilimsel açıdan zorlayıcı yapılardır,

çünkü gerçekleşmemiş senaryolardan bahsettikleri için Grice'ın Nitelik İlkesini ihlal ederler (Kulakova ve Nieuwland, 2016b). Karşı olgusallar aynı zamanda Nicelik İlkesini de ihlal eder. Bu ilke, gerektirdiğinden az ya da fazla bilgi verilmemesini koşul kılar (Grice, 1975). Karşı olgusallar, ölçeksel sezdirim (scalar implicature) yapılmasını gerektirir çünkü "-mış olabilirdi" veya "-acaktı" gibi olasılık ifade eden yapılar içerirler ve bu yapılar, gerçekleşmiş olaylardan bahseden cümlelere kıyasla daha az bilgilendirici kabul edilir. Nieuwland vd. (2010), edimbilimsel olarak daha az yetkin bireylerin konuşma ilkelerinin ihlalini anlamakta daha çok güçlük çekebileceğini öne sürmüştür. Bu nedenle, karşı olgusallar gibi ölçeksel sezdirim gerektiren yapılardan örtük anlamları çıkarmada şizofreni tanılı bireyler daha fazla zorlanma yaşayabilirler, ki bu da anlama deneyindeki daha düşük performansı açıkayabilir.

Anlama deneyindeki bulgular şizofreni grubunda açık bir karşı olgusal bozulmaya işaret ederken, üretim deneyi farklı bir örüntü ortaya koymuştur. Şizofreni grubu içinde, karşı olgusal ve bildirici cümle üretimi arasında anlamlı bir fark gözlemlenmemiştir. Ancak kontrol grubuyla karşılaştırıldığında, şizofreni grubunun karşı olgusal üretim başarısı kontrol grubuna göre daha düşüktür. Üretim deneyindeki düşük skorlar, karşı olgusal muhakeme yetersizliğinin bir sonucu olabileceği gibi, karşı olgusal yapıların biçimbilimsel zorluklarından da kaynaklanması mümkündür. Üretim deneyinde katılımcılar bazı cümlelerde yapısal olarak karşı olgusal cümleler kurmasalar bile, kurdukları cümleler karşı olgusal anlam içermiştir. Örneğin, bazı katılımcılar karşı olgusal koşul belirteci olan –sA yerine olumsuzluk ekleriyle bahsi geçen eylemin gerçekleşmediğini ifade edebilmiştir (İşi bitseydi gelirdi cümlesi yerine İşi bitmedi ve gelmedi cümlesinin oluşturulması). Bu durum, katılımcıların karşı olgusallığı senaryodan anlamsal düzeyde çıkarabildiğini, ancak biçimbilimsel düzeyde kodlayamadığına işaret edebilir. Literatür, şizofrenide dil üretiminin formal düşünce bozukluğundan olumsuz olarak etkilendiğini, bu durumun kullandıkları dilde sözdizimsel karmaşıklığın azalmasına ve biçimbilimsel çeşitliliğin sınırlanmasına neden olduğunu göstermiştir (Kuperberg, 2010; Walenski vd., 2010; Ziv vd., 2022). Bu sebeple, şizofreni tanılı bireyler, bilişsel sınırlılıklar ve koşullu cümlelerin biçimbilimsel zorlukları sebebiyle

daha basit yapıda veya daha yaygın olarak kullanılan yapıları üretmeyi bir strateji olarak kullanmış olabilirler.

Bu çalışma, dolaylı olarak sağlıklı grubun karşı olgusalları anlama ve üretme örüntüleriyle ilgili de bulgular sunmuştur. Sağlıklı gruptaki katılımcılar, anlama deneyinde karşı olgusallarda bildirici cümlelere göre daha düşük skor elde etmişlerdir. Bu durum karşı olgusal ifadelerin tipik popülasyonlarda bile yüksek bilişsel yük gerektirdiğini ve bu cümlelerde zorlanma olduğunu göstermektedir. Üretme deneyinde ise, karşı olgusalların üretim performansı bildirici koşullulara göre daha yüksek sonuç vermiştir. Bu bulgu, din anlama ve üretmenin farklı süreçler olduğunu vurgulamaktadır. Bu asimetrik bulgu aynı zamanda iki deneyin bağlamsal zenginliğinin farklılıklarıyla ilgili olabilir. Çalışmada kullanılan üretim deneyi senaryolarla desteklendiğinden, anlama deneyine göre daha fazla bağlamsal ipucu içermektedir. Buna karşılık, anlama deneyinde daha az edimbilimsel ipucu olduğundan, cümlelerin belirsizliği artmış olabilir. Bu durum, sağlıklı gruğta karşı olgusalların üretiminin anlamaya göre daha başarılı olmasını açıklayabilir.

Çalışmanın bir diğer odak noktası, şizofreni grubundaki skorların semptom şiddeti/süresi, yürütücü işlev becerileri veya demografik özelliklerinden ne kadar etkilendiği yönündedir. Bulgular, eğitim düzeyinin hem anlama hem üretme deneylerinde performans artışını belirleyen bir faktör olduğunu göstermektedir. Lisans derecesini tamamen veya kısmen tamamlamış katılımcılar, lise mezunu katılımcılara göre daha her iki deneyde de daha yüksek performans göstermişlerdir. Bu bulgu, eğitsel deneyimlerin nöral verimliliği ve telafi edici mekanizmaları artırarak bireylerin bilişsel olarak zorlayıcı görevlerde daha etkili performans göstermelerine olanak tanıdığını öne süren bilişsel rezerv tanımıyla örtüşmektedir (Stern, 2002; Barulli ve Stern, 2013). Eğitim düzeyinin bu çalışmada güçlü bir belirleyici olmasının bir diğer nedeni ise, yüksek eğitim düzeyine sahip kişilerin ruh sağlığı farkındalığı ve okuryazarlığının daha yüksek olması sebebiyle sağlık hizmetlerine erişimlerinin daha etkili olmasından kaynaklanabilir. Psikoza yönelik erken müdahale programları, tedavisiz geçen psikotik sürenin azalmasına katkı sağlamakta ve böylelike potansiyel bilişsel hasarların önüne geçmektedir (Bird vd., 2010). Ayrıca, yüksek eğitim düzeyine sahip bireylerin bilişsel olarak uyarıcı

çevrelere daha çok erişimlerinin olması, genel olarak bilişsel gelişimi ve test çözme becerilerini artırmış olabileceğinden, iki deneyde de daha yüksek skorlar elde etmelerine yol açmış olabilir.

Hipotezimizin aksine, semptom şiddeti ve hastalık süresi gibi klinik değişkenler ve İz Sürme A ve B testleri gibi bilişsel ölçekler, karşı olgusalların anlama ve üretimine anlamlı bir etkide bulunmamışlardır. Bu durum, örneklemimizdeki hastalık şiddeti düzeyinin bireysel farklılıkları ortaya koyacak kadar değişkenlik göstermemesi ile açıklanabilir. Ayrıca, İz Sürme A ve B testleri yürütücü işlev ölçmek için geçerli testler olmakta birlikte, karşı olgusalları anlama ve üretme için kritik olaran karşı olgusal muhakeme, zihin kuramı, ket vurma, çalışma belleği gibi işlevlerin izole olarak değerlendirildiği bir test bu çalışmada kullanılmamıştır. Bu durum, karşı olgusalları anlama ve üretme süreçlerini etkileyen bilişsel işlevlerin belirlenmesini zorlaştırmıştır.

Kısıtlar ve Gelecek Çalışmalar

Şizofreni tanısı almış bireylerin karşı olgusal ifadeleri anlama ve üretme konusunda bir bozulma gösterdikleri açık olmakla birlikte, bu bozulmanın altında yatan neden, hem yapının hem de hastalığın karmaşık doğası sebebiyle net olarak saptanamamıştır. Bu sebeple, daha net bir bulgu için şizofrenide karşı olgusalların işlemlenmesinde çift anlam işleme (dual meaning), edimbilimsel bozukluklar ve yürütücü işlevlerin ayrıca değerlendirildiği ayrıntılı bir deneysel tasarıma ihtiyaç duyulmaktadır. Ayrıca, formal düşünce bozukluğunun şiddeti dil yetilerini etkileyebileceğinden, şizofreni tanılı kişilerde formal düşünce bozukluğunun kontrol edildiği bir çalışma daha net bir sonuç verebilir.

Şizofreni grubunda gözlemlenen karşı olgusal anlama ve üretme bozukluğu, dil ve biliş temelli görevlerin rehabilitasyon programlarına dahil edilmesi gerekliliğini ortaya koymaktadır. Ek olarak, eğitimin karşı olgusalları anlama ve üretmedeki pozitif etkisi, eğitimin şizofreni tanılı kişilerdeki bilişsel ve dilsel bozuklukları hafifletebileceğini, dolayısıyla erken müdahele programlarının önemini vurgulamaktadır.

Gelecek çalışmalar, şizofreni tanılı bireylerde nörogörüntüleme teknikleri kullanılarak karşı olgusal cümle işlemleme yetileri ile ilgili daha hassas analizler sunmalıdır. Ek olarak, eğitim seviyesi düşük olan şizofreni tanılı kişilere yönelik eğitim temelli müdahele çalışmalarına odaklanmalı ve eğitimin karşı olgusal muhakemeyi ve karşıolgusal cümle anlama ve üretimini iyileştirip iyileştirmediğini araştırmalıdır.

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