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Gesture and Speech Disfluency in Narrative Context: Disfluency Rates in Spontaneous, Restricted, and Encouraged Gesture Conditions

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Abstract

Gestures facilitate speech production by helping speakers reduce cognitive load. Studies on gesture-speech interaction mostly examined the effect of representational gestures on spatial contexts. However, abstract deictics (e.g., pointing at objects that are not visually present) might also have a role in facilitating cognitive processes. The present study investigated the effect of gestures on disfluency rates by presenting a narrative task in three conditions: spontaneous, restricted, and encouraged gesture use. We found that disfluency rates across three conditions did not significantly differ. The use of abstract deictics in the spontaneous gesture use condition was a significant predictor of disfluency rates in the gesture restricted condition. Results indicate that gestures' facilitative roles might be manifested differently depending on the context. Abstract deictics might also benefit speakers, especially in a narrative context. Studying abstract deictics can provide new insights on gesture and speech production interaction.

Keywords: gesture, speech disfluency, gesture restriction, narrative context

Introduction

Language is multimodal. People produce gestures along with their speech to convey information (McNeill, 1992), which improves communication between speaker and listener. However, studies show that gestures do not only benefit listeners; speakers themselves also benefit from producing gestures (Göksun et al., 2013, Kita & Davies, 2009; Melinger & Kita, 2007). In other words, gestures might have self-oriented functions for speakers (Kita et al., 2017; for a review, see Özer & Göksun, 2020). As Kita and colleagues (2017) argued, gestures decrease cognitive load and allow speakers to better conceptualize information through activation, manipulation, packaging, and exploration of information units. Gestures' self-oriented functions might facilitate cognitive processes, including speech production, as gesture and speech are closely associated mechanisms (Kita & Özyürek, 2003). Then, one can argue that gestures might facilitate speech production, particularly when planning load is high and when people reveal temporary errors in speech production, called disfluency.

Disfluency can be described as temporary errors, revisions, and pauses observed in speech (Maclay & Osgood, 1959). The speech production process requires cognitive resources to be executed properly (Khawaja et al., 2008). Studies have shown that disfluencies might be frequently observed in situations where speakers are dealing with cognitively demanding tasks (e.g., Bortfeld et al., 2001; Morsella & Krauss, 2004; Shriberg, 1996). Correspondingly, when participants' gesture use is restricted, they are more likely to be disfluent (Morsella & Krauss, 2004; Özer et al., 2019; Rauscher et al., 1996). Thus, disfluency rates in one's speech might be linked with task demands, which can be experimentally manipulated to understand the facilitative roles of gestures (Arslan & Göksun, 2022; Bortfeld et al., 2001; Goldin-Meadow et al., 2001). These findings highlight the importance of gestures on reducing cognitive load, which, in turn, influence disfluency rates in speech (Finlayson et al., 2003; Krauss et al., 2000). Thus, studying disfluency in relation to gestures is crucial to grasp the nature of disfluent speech. In this study, we ask whether (1) restricting or encouraging hand use influences disfluency rates in one's speech in telling narratives, and (2) one's tendency to gesture in spontaneous speech is associated with the likelihood of being disfluent when hand use is restricted.

Co-speech gestures are hand movements that accompany speech production (McNeill, 1992). People produce gestures along with their speech to convey information (Hostetter & Alibali, 2011). According to the classical classification of gestures by McNeill (1992), representational gestures (e.g., iconic and metaphoric) have meaning units that mostly accompany verbal output. For instance, a person can produce a gesture by referring to a concrete object (e.g., making a circular shape with hands while describing an apple), which makes that gesture an iconic gesture. Similarly, if a person refers to an abstract concept rather than a concrete one (e.g., drawing a circle while talking about the notion of an idea), then it is called a metaphoric gesture. Deictic gestures can be described as simply pointing at something. Beat gestures do not carry such semantic units; instead, they follow speech input with a rhythmical flow in accordance with the speech. Even though gestures have an important role in improving communication by affecting the listener (e.g., Beattie & Shovelton, 2000), gestures, particularly representational ones, have a facilitative function for the speaker as well (e.g., for a review, see Özer & Göksun, 2020).

The Gesture-for-Conceptualization hypothesis (Kita et al., 2017) argues that gestures can facilitate speech production by reducing cognitive load and helping speakers conceptualize information. People produce speech by controlling and

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packaging information units into verbal units. According to the Gesture-for-Conceptualization hypothesis, gestures have a similar function in terms of affecting individuals' thinking process by helping the conceptualization process in four ways: activation, manipulation, packaging, and exploration of the information (Kita et al., 2017). First, gesture enables the use of spatio-motoric representation rather than abstract representations. Second, gestures are produced as manipulation of such spatio-motoric information like actions. Third, people use gestures for packaging information in certain units, such as chunking that facilitates information storage and usage. As a last function, gestures serve as an exploration tool for rich spatio-motoric information (Chu & Kita, 2011; Kita et al., 2017). Since we do not manipulate real objects while using gestures, we rely on abstract representations that schematize information units and alter those units in various forms depending on the desired function.

Iconic gestures are at the core of the current theoretical frameworks that focus on gestures' self-oriented functions, particularly the gesture-for-conceptualization hypothesis (Kita et al., 2017). However, other gestures, particularly deictic gestures, might be informative as well in understanding gestures' link with cognitive processes. For instance, older adults, whose language production skills decrease with age (Burke et al., 1991), are more likely to use deictic gestures than younger adults (Arslan & Göksun, 2021). Such studies are conducted with narrative tasks in which participants use deictics in an abstract manner as what they point at is not physically present. For that reason, such deictics are named abstract deictics, observed frequently in bilinguals' speech (Nicoladis, 2007). Using narrative tasks, therefore, might be insightful to observe the use of abstract deictics.

Studies with bilinguals show that they also benefit from abstract deictics to reduce their cognitive load on narrative tasks (Azar et al., 2020; Gullberg, 2013). For instance, Azar et al. (2020) examined the difference between monolinguals' and bilinguals' gesture rates in narratives. Results indicated that bilinguals used more abstract deictics compared to monolinguals. Considering that bilinguals have more cognitive load than their monolingual peers due to monitoring and using two languages (Bialystok & Craik, 2010), using abstract deictics as a tool for helping the conceptualization process might be a strategy for reducing the cognitive load (Azar et al., 2020; Nicoladis, 2007). In light of the studies targeting older people and bilinguals, focusing on abstract deictics besides representational gestures might lead to a better understanding of the link between gesture and speech production.

Disfluency

Individuals produce speech to communicate and convey information to other people. However, speech production can have temporary errors in speech that are called disfluencies (Maclay & Osgood, 1959). As Maclay and Osgood (1959) suggests, there are four types of disfluencies. There are repairs in which the speakers revise what was previously said (e.g., I went to school – *market*). Repetitions occur when a speaker repeats some part of a sentence (I like apple *apple*). As the third type, filled pauses are sounds that are produced between words (e.g., *um*). Last, silent pauses are temporary breaks in a sentence that do not contain any sound, unlike filled pauses. Although Maclay and Osgood's (1959) classification does not include fillers (e.g., filler words such as *you know*, *I mean*), previous studies have highlighted the importance of fillers for both processing and communicative functions (Bortfeld et al., 2001; Corley & Stewart, 2008). Disfluencies might result from cognitive and communicative processes (Fraundorf & Watson, 2014). It is crucial to understand disfluencies with their relation to cognitive resources.

Speech production requires cognitive resources to correctly form meaningful and grammatical words, phrases, or sentences (Acheson & Macdonald, 2009; Lindström et al., 2008). Thus, high demand on cognitive resources would be reflected in speech as disfluencies (Oviatt, 1995; Shriberg, 1996). Previous research mostly manipulated cognitive load through task difficulty (e.g., Bock, 1995; Bortfeld et al., 2001; Morsella & Krauss, 2004). Considering gestures' facilitative roles in speech planning and production, one might suggest that gestures can have an extenuative role in speech disfluencies. In other words, gestures, with their function of benefiting the speaker in managing cognitive demands by helping the conceptualization process (e.g., Kita et al., 2017), can affect disfluency rates in speech. Previous research has shown that when gesture use is restricted, participants' disfluency rates have significantly increased (Morsella & Krauss, 2005; Rauscher et al., 1996). Therefore, restricting individuals' hand use and then observing their disfluency rates in speech might be required to obtain direct evidence. Conducting experiments with narrative tasks might also allow researchers to investigate the role of abstract deictics on speech production (Azar et al., 2020; Nicoladis, 2007).

The Present Study

In this study, we investigate the role of gestures in speech production, particularly in disfluency. We examined individuals' disfluency rates and patterns when they spontaneously gestured, their hand use was restricted, and they were encouraged to gesture. To investigate gesture-speech interaction, we used a cartoon retelling task to obtain gesture and speech samples.

Considering the existing literature on gesture-disfluency interaction (Arslan & Göksun, 2022; Morsella & Krauss, 2004; Rauscher et al., 1996), we expect participants to be more disfluent in the restricted condition than the spontaneous and encouraged conditions. Moreover, we predict that participants' representational gesture use in the spontaneous gesture condition would predict the disfluency rates in the gesture restricted condition. Last, as abstract deictics are suggested to decrease cognitive load (Azar et al., 2020; Nicoladis, 2007), we hypothesize that abstract deictic use in the spontaneous gesture condition might be associated with the disfluency rates observed in the gesture restricted condition.

Methods

Participants

We recruited 34 young adults (17 females). The age range was 18-28 (M_{age} = 23, *SD* = 2.72). The sample size (28 plus an additional 10% risk of attrition) was determined through G*power analysis (Faul et al., 2009) by setting alpha level as 0.05, effect size as (ηp^2) 0.25, and the power as 0.80. All participants were native Turkish speakers and were using their right hands predominantly. The participants had no neurological, hearing, or vision problems. The study was approved by the Institutional Review Board committee of Koç University. Five participants were recruited through the Koç University Subject Pool and rewarded with 1 course credits for their participation. The remaining twenty-nine participants have participated voluntarily. We collected informed consents before the experiment.

Materials

We used three slightly varied versions of Tom and Jerry cartoon movie clips to elicit speech and gesture production. All cartoons had a similar content in which there was a chase happening between the cartoon characters. The duration of each videoclip was around one minute. We have used Zoom software to conduct the study (Zoom Video Communications Inc., 2016).

Procedure

The study was conducted in an online environment through a Zoom meeting. Informed consents were taken from the participants before the experiment. Then, demographic information was collected. As a language production task, three different versions of Tom and Jerry cartoon movie clips were shown through screen sharing to participants in three gesture conditions: spontaneous, restricted, and encouraged. The order of video clips was counterbalanced across the conditions. Participants were instructed to watch the video carefully before each video started without any prior instructions. After watching the video, the experimenter closed the screen sharing, and participants were asked to explain what they have watched in the movie clip without seeing the content. In each gesture condition, we asked participants to describe what they watched. All participants had the same gesture condition order as spontaneous, restricted, and encouraged, respectively. In the spontaneous condition, participants watched cartoons and spontaneously told what they watched without any instructions from the experimenter regarding hand use. In the gesture restricted condition, participants were instructed to hold their hands stable on their lap or table while retelling the cartoon. The experimenter would kindly have warned them not to move their hands if any movement had happened during the retelling process. In the encouraged condition, participants were explicitly instructed to use their hands while retelling the cartoon (i.e., the experimenter said, "Can you please tell what you watched in the video by using your hands?"). A single session took approximately 20 minutes. All sessions were video recorded for transcription and coding.

Coding

Speech and Disfluency To transcribe speech and code speech disfluency, we used ELAN software (Lausberg & Sloetjes, 2009). Silent pauses, filled pauses, repairs, repetitions, and fillers were identified and coded. A research assistant coded speech disfluencies of all participants while another assistant coded 30% of the participants' disfluencies. The two coders revealed a high interrater agreement in identifying (r = .87, p < .001) and categorizing disfluencies (κ = .89, p < .001). Both coders were blind to the experimental hypotheses. All disfluency rates were calculated per 100 words.

Gesture ELAN software was used to code gestures (Lausberg & Sloetjes, 2009). The first author and a research assistant coded all participants' gestures to ensure coding reliability. We coded iconic, metaphoric, deictic, and beat (McNeill, 1992). A research assistant coded speech disfluencies of all participants while another trained assistant coded 30% of the participants' disfluencies. The two coders revealed a high interrater agreement in identifying (r = .83, p < .001) and categorizing gestures (κ = .82, p < .001). Both coders were blind to the experimental hypotheses. All gesture frequencies were calculated per 100 words.

Results

We conducted a paired samples *t*-test, taking gesture frequency as the dependent variable, to understand whether we were able to manipulate gesture rate of participants in the encouraged conditions compared to spontaneous conditions. We found that individuals gestured significantly more in the encouraged gesture condition (M = .32, SD = .09) than the spontaneous gesture condition (M = .19, SD = .14), $t(33)$ = -5.26, p < .001.

We then carried out a repeated measures analysis of variance (ANOVA) to see whether total disfluency rates differed across three gesture conditions (i.e., spontaneous, restricted, and encouraged). We found that the main effect of condition was not significant, $F(2,66) = 1.65$, $p = .200$, $\eta p^2 = .048$. In other words, total disfluency rates across three conditions were comparable (Table 1). The frequency of using specific disfluency types was also comparable across the three conditions, Fs(2,66) > 1.63, ps > .204, ηp^2s < .047.

We also conducted a linear regression analysis to predict disfluency rates in the gesture restricted condition. The predictor variable was representational gesture use in the spontaneous gesture condition. The regression equation was not significant, $F(1,33) = 2.24$, $p = .144$, with an R^2 of .065. That is, representational gesture frequency in the spontaneous gesture condition did not significantly predict the disfluency rate in the gesture restricted condition (β = .256, p = .144).

Table 1: Mean (*M*) and Standard Deviation (*SD*) values of the total disfluency rate across gesture conditions.

Condition	*M*	*SD*
Spontaneous gesture	.32	.10
Restricted gesture	.32	.10
Encouraged gesture	.29	.07

Note. For each condition, $N = 34$.

We carried out a linear regression analysis to understand whether beat gesture frequency predicted disfluency rates in the gesture restricted condition. The regression equation was not significant, either, $F(1,33) = 1.25$, $p = .272$, with an R^2 of .038. Beat gesture frequency in the spontaneous gesture condition did not significantly predict the disfluency rate in the gesture restricted condition ($\beta = -.194$, $p = .272$).

Last, when we carried out the same regression analysis with the deictic gesture use in the spontaneous gesture condition as the predictor variable, we found that the regression equation was significant, $F(1,33) = 4.93$, $p = .034$ with and R^2 of .133. In other words, deictic gesture use in the spontaneous gesture condition significantly predicted disfluency rates in the gesture restricted condition ($\beta = .365$, $p = .034$).

Discussion

In this study, we examined whether gesture production was associated with disfluency rates in speech. Participants told narratives from a cartoon in spontaneous, restricted, and encouraged gesture conditions. We asked whether restricting or encouraging gestures would lead to differences in speech disfluency rates. Results indicated that we successfully manipulated the gesture rate in the encouraged gesture condition, as individuals produced more gestures in the gesture encouraged than in the spontaneous gesture condition. However, disfluency rates across three conditions were comparable, suggesting that there were no significant differences in participants' speech disfluencies when they used gestures or not. We also investigated whether representational gesture use in the spontaneous gesture condition could predict disfluency rates in the restricted condition. Similarly, we found that disfluency rates in the absence of gestures were not associated with people's spontaneous gesture use. However, the use of abstract deictics in the spontaneous gesture condition was a significant predictor of the disfluency rates in the gesture restricted condition.

Our results do not provide evidence of representational gestures' facilitative roles in speech production, particularly in speech fluency. When people were restricted from using gestures, their disfluency rates in speech did not significantly increase. Although this finding contradicts the literature, considering earlier research by Rauscher et al. (1996) and Krauss et al. (2000), there is a fundamental difference in our study design. Rauscher et al.'s (1996) study mainly focused on gesture-disfluency interaction in a spatial context and tried to understand gestures' impact on disfluency rates by using spatial tasks. Even though our cartoon task has some spatial units, such as motion events (e.g., a chase happening between cartoon characters), it is not a purely spatial task. The narrative context presented to participants can be considered less spatial compared to tasks used in previous studies, which suggested an effect of gesture restriction on disfluency (e.g., Krauss et al., 2000; Rauscher et al., 1996). If there was a task with high spatial content (e.g., address description), representational gestures' impact on disfluency rates might be more prominent. However, narrative context may affect gesture and disfluency interaction differently than spatial tasks.

Recent findings also highlight a similar implication regarding the role of task type when it comes to understand gesture-speech interaction (Cravotta et al., 2021; Finlayson et al., 2003; Kısa et al., 2021). In line with our findings, when researchers use narrative tasks to examine how gesture restriction would affect speech disfluency, restricting gestures did not result in a significant increase in disfluency rates (e.g., Cravotta et al., 2021). Representational gestures might have a specific impact on spatial vocabulary that can be elicited effectively through spatial tasks (Özer et al., 2017; Rauscher et al., 1996). In our study, people might have lighter need for using gestures since the material they were asked to explain did not elicit spatial words as much as other spatial tasks (but see Kısa et al., 2021). Thus, restricting gestures in narrative telling might lead to a comparatively less cognitive load that can result in decreased rates of speech disfluency. Therefore, it is possible that the interplay between representational gesture use and speech disfluency might be affected by different tasks and contexts.

In contrast, unlike representational gestures, we found that the use of deictic gestures significantly predicted disfluency rates in the gesture restricted condition. It is important to note that in our study, while people were telling what they watched in the movie clips, the target material (i.e., cartoon scenes) was not present. They first watched the cartoons and then retold the stories presented in those cartoons. Therefore, the deictic gestures produced in the spontaneous gesture condition could be described as abstract deictics since they were not pointed at physically present materials. Previous research shows that abstract deictics are used in narrative contexts by groups that need to manage high cognitive load, such as bilinguals (Azar et al., 2020; Nicoladis, 2007) and older adults (Arslan & Göksun, 2021). Similarly, people in our study might use abstract deictics rather than representational gestures to deal with a cognitive load since they were tested in a narrative context. As reported in the previous studies (Finlayson et al., 2003; Rauscher et al., 1996), examining gesture and disfluency interaction through gesture restriction in a fully spatial context can result in the use of representational gestures being more prominent. However, telling a narrative might enhance the facilitative roles of abstract deictics' on managing cognitive load since people cannot benefit from representational gestures due to less amount of spatial input (e.g., Azar et al., 2020; Nicoladis, 2007). In other words, individuals who are likely to get help from abstract deictics to decrease cognitive load might be more negatively affected in terms of fluency when their hand use is restricted.

In conclusion, these findings indicate that there seems to be no effects of gesture restriction and encouraging gesture use on speech disfluency rates. On the contrary, abstract deictics used in spontaneous gesture condition might be a predictor of disfluency rates in the gesture restricted condition. These results suggest that the impact of different gesture types on speech disfluency might change depending on the task and context. People might benefit from abstract deictics rather than iconic gestures in terms of facilitating speech production in a narrative context, unlike talking about spatial concepts. Further research is needed to understand the role of abstract deictics in cognitive processes, particularly in speech production.

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