The Role of Hand Gestures in Emotion Communication:

Do Type and Size of Gestures Matter?

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Abstract

We communicate emotions in a multimodal way, yet non-verbal emotion communication is a relatively understudied area of research. In three experiments, we investigated the role of gesture characteristics (e.g., type, size in space) on individuals' processing of emotional content. In Experiment 1, participants were asked to rate the emotional intensity of emotional narratives from the videoclips either with iconic or beat gestures. Participants in the iconic gesture condition rated the emotional intensity higher than participants in the beat gesture condition. In Experiment 2, the size of gestures and its interaction with gesture type were investigated in a within-subjects design. Participants again rated the emotional intensity of emotional narratives from the videoclips. Although individuals overall rated narrow gestures more emotionally intense than wider gestures, no effects of gesture type, or gesture size and type interaction were found. Experiment 3 was conducted to check whether findings of Experiment 2 were due to viewing gestures in all videoclips. We compared the gesture and no gesture (i.e., speech only) conditions and showed that there was not a difference between them on emotional ratings. However, we could not replicate the findings related to gesture size of Experiment 2. Overall, these findings indicate the importance of examining gesture's role in emotional contexts and that different gesture characteristics such as size of gestures can be considered in nonverbal communication.

Keywords: emotion communication, processing of emotional content

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We communicate emotions both verbally and non-verbally. Previous research has shown that people are fairly good at decoding relevant emotional cues while communicating with others, particularly for facial expressions (for reviews, see Ekman, 1992; Keltner et al., 2003; Russell et al., 2003), and vocal expressions (for reviews, see Juslin & Laukka, 2003; Juslin & Schrerer, 2005; Scherer et al., 2003). Non-verbal emotion communication, however, is a relatively understudied topic in the emotion literature. Earlier studies have focused on static cues that enable emotion perception (e.g., Tracy & Robins, 2004). More recently, the importance of dynamic qualities of body movement has gained attention (Atkinson et al., 2004; Glowinski et al., 2011). However, a more comprehensive understanding of the role of body movements, posture, and particularly hand gestures in emotion understanding is still needed (but see de Gelder, 2006; Schindler et al., 2008).

Hand gestures are key for face-to-face communication. They accompany natural daily speech. During a conversation, speakers spontaneously produce hand movements that support certain aspects of speech content (Hostetter, 2011). Previous research has shown the importance of gestures in emotion perception (e.g., Gunes & Piccardi, 2007; Dael et al., 2013). Yet, we do not know how exactly hand gestures help listeners' understanding of emotions. Previous research lacked specifically which different features of gestures have an influence on emotion communication. The current study examines 1) the way hand gestures influence emotion understanding, and 2) the features of hand gestures that would influence people's judgments of affect.

1.1 Emotion Understanding

Making accurate judgments about others' emotional states is fundamental for social interactions in daily life. Emotion comprehension studies indicate that in general people are adept at identifying basic emotions (e.g., Atkinson et al., 2004; Russell et al., 2003). In particular, facial (for reviews,

see Keltner et al., 2003; Russell et al., 2003) and vocal expressions (for reviews, see Juslin & Scherer, 2005; Scherer et al., 2003) provide observers emotionally relevant cues.

Our knowledge on affective understanding mainly stems from studies that have used prototypical static images (e.g., Buchanan & Lovallo, 2001; Tracy & Robins, 2004) and a limited number of basic universal emotion categories (e.g., Lawrence et al., 2002; Orgeta & Phillips; 2007). Prototypical facial expressions provide observers easily and clearly understandable emotional cues (Ekman, 1993). Emotion communication, however, is a more complex process than only perceiving a small number of emotion categories and static prototypical faces.

More recent studies have used dynamic expressions or videos to study emotions (Bänziger et al., 2012; O'Reilly et al., 2016; Krumhuber et al., 2017). This allows researchers to see and discover some aspects that are not visible in the standard basic sets of emotion portrayals. Lhommet and Marsella (2015) provide an overview of research on how emotions can be expressed through posture and gesture. They highlight the fact that, in most studies, professional actors are asked to read or perform a script that contains an emotional event or a situation. However, similar to prototypical facial images, this might cause stimuli to be exaggerated or stereotyped, making the speech unnatural.

Although emotions are expressed in a multimodal way, the ways our bodies convey emotional information, is rather an understudied topic. De Gelder (2009) reports that more than 95% of studies on emotions have used facial expressions and ignored other modalities. Posture, body parts, and their movements also reveal information about people's emotional states. For example, previous research suggests that bodily displays help humans make sense of several emotions such as happiness, anger, shame, fear, and disgust (e.g., de Gelder & van den Stock, 2011; Tracy et al., 2009). People are good at recognizing emotions from bodily displays, even when facial information is not provided (Bänziger et al., 2012; de Gelder & van den Stock, 2011; Tracy et al., 2009). Moreover, research in kinesics suggests that the movements of the body (e.g., walking speed) help

people infer the emotional states of others. For instance, while fearful and sad movements are likely to be small in size, angry movements are likely to be larger and faster (Hicheur et al., 2013; Montepare et al., 1987; Roether et al., 2009). These findings emphasize that, in addition to the voice and face, the body is equally important for emotional communication.

As a specific and possibly one of the most prominent bodily movements, gestures also convey information to the observers. Hand gestures are among the most important forms of multimodal ways we use to express meaning (McNeill, 1992; 2005). Do hand gestures also relate to how we make judgments of emotions?

1.2 Gestures

Speakers of all languages frequently gesture while speaking (Goldin-Meadow & Alibali, 2013). Gestures are a pervasive and natural aspect of language (Goldin-Meadow, 2003). Gestures play an important role in communication and thinking by affecting both language production and comprehension processes (see Özyürek, 2018 for a review). They benefit both speakers and listeners (e.g., Alibali et al., 2001; Beattie & Shovelton, 1999; Goldin-Meadow & Alibali, 2013; Holler & Stevens, 2007; Hostetter, 2011). Gestures are mainly classified based on two major types: representational and nonrepresentational. Representational gestures include iconic, metaphoric, and deictic gestures (McNeill, 1992). When gestures display concrete entities such as shapes, actions, or events, they are classified as iconic gestures. Similar to iconic gestures, when the referent is abstract, they are classified as metaphoric gestures. Another gesture type is deictic gestures, in which speakers point to the direction of a referent. Last, beat gestures are nonrepresentational gestures that do not convey any semantic meaning. These are rhythmic and rapid hand movements (McNeill, 1992).

Gestures help us communicate (Beattie & Shovelton, 1999; Cassell et al., 1999), yet they have some other functions. Previous research, particularly in learning and problem-solving contexts with children, has shown that gesturing can alter speakers' mental representations by highlighting certain

information or introducing new ones (Alibali & Kita, 2010, Alibali et al., 2011, Beilock & Goldin & Meadow, 2010). Thus, in addition to reflecting a simulated action (The Gesture-As-Simulated-Action Framework, Hostetter & Alibali, 2008), gestures are suggested to affect speakers' mental representations. As in the language production process, we may argue that observing gestures accompanying a spoken message could affect one's mental representation regarding that information. Namely, observing gestures could facilitate the way we encode and represent information.

Gesture and speech are usually related in meaning to the content of the accompanying speech, particularly for representational gestures. Observers receive semantic information from these co-speech gestures and co-speech gestures can contribute to the understanding of ambiguous speech content (Kelly et al., 1999). Similarly, observers' responses were more accurate when gestures provided additional information to the speech (Beattie & Shovelton, 1999). Gestures also have a significant influence on the way we interpret a verbal expression by complementing the meaning and providing additional information (de Ruiter et al., 2012; Gerwing & Allison, 2009; Melinger & Levelt, 2004). Research shows that gestures aid comprehension by disambiguating (i.e., making the meaning clearer) a spoken message both for children (Demir-Lira et al., 2018; Sekine et al., 2020) and adults (Holle et al., 2008; Holle & Gunter, 2007). Different meta-analyses and reviews have also presented studies in which observing co-speech gestures benefits comprehension of the spoken material (e.g., Dargue et al., 2019; Hostetter, 2011).

Gesture and speech are systematically related to each other, although they convey information in different representational formats due to being expressed in two different modalities (Clark, 1996; Enfield, 2009). They form an integrated system for both language production and comprehension (Kelly et al., 2010; Kita, 2000; Kendon, 2004; McNeill, 2005). Many different models of gesture production were proposed to explain its relationship with the processing of language production (for a review of models, see Özyürek, 2018). During comprehension, listeners also integrate information

from different sources of information to have a unified representation (Alibali et al., 1997; Kelly et al., 1999; Cassell et al., 1999). Kelly and colleagues (2010) proposed the Integrated Systems Hypothesis, which posits that speech and gesture influence each other bidirectionally during comprehending a message. Two types of information presented in gestural and verbal modalities create meaning in an interactive way, forming a context for the interpretation of the other one. Individuals are slower to respond to the incongruent messages presented in two modalities and lower in their performances, suggesting a failed attempt of integration (Holle & Gunter, 2007). The integration of information from two modalities is argued to be automatic and obligatory, indicated by several behavioral and neural findings (Kandana Arachchige et al., 2021; Beattie & Shovelton, 1999; Cassell et al., 1999; Kelly et al., 2010a; Kelly et al., 2004; Özyürek et al., 2007; Skipper et al., 2007, 2009; Wu & Coulson, 2005, 2007). Nevertheless, other studies pinpoint the importance of individual differences in gesture comprehension and speech-gesture integration, suggesting a differential integration process based on individuals' use of visual-spatial and verbal resources (Wu & Coulson, 2014a, 2014b; Özer & Göksun, 2020a, 2020b).

There is also variation in when and how listeners benefit from different types of co-speech gestures. A recent meta-analysis examined several moderators (e.g., the kind of gesture or the information that gestures provided) of the effect of gestures on speech comprehension (Dargue et al., 2019). Findings suggest that the beneficial role of gestures change depending on their semantic relatedness to the accompanying speech. Gestures become more beneficial to comprehension when the gestural and verbal messages are related to each other (Straube et al., 2009). Since iconic or metaphoric gestures are semantically related to speech, they can be more facilitative to comprehension compared to beat gestures (e.g., Beattie & Shovelton, 1999; McNeill, 1992; Hadar & Butterworth, 1997; Beattie & Shovelton, 2002; Holler & Beattie, 2003). Although research on metaphorical gestures is limited, beneficial role of observing metaphorical gestures on comprehension of speech was also evidenced. For example, metaphorical gestures promoted adults'

comprehension of a second language (Repetto et al., 2017) and abstract sentences (Straube et al., 2009). Last, beat gestures may also facilitate comprehension in certain ways as they are temporally related to speech prominence (Esteve-Gibert & Prieto, 2013, see also Krahmer & Swerts, 2007). For instance, Igualada et al. (2017) found that children benefitted from observing beat gestures with short discourses and lists in a recall task. Similarly, beat gestures enhanced memory processes for children by highlighting certain information in a narrative (Austin & Sweller, 2014; Llanes-Coromina et al., 2018, also see Vila-Gimenez & Prieto, 2021 for a review of roles of non-referential gestures in children).

Gestures are especially well-studied in spatial contexts, including giving directions (e.g., Allen, 2003; Arslan & Göksun, 2021), describing spatial patterns (e.g., Melinger & Kita, 2007), or motion in space (e.g., Akhavan et al., 2017; Kita & Özyürek, 2003). They have significant benefits both for speakers and listeners during communicating spatial information. Speakers gesture more when talking about spatial topics than when talking about non-spatial topics (Alibali et al., 2001; Lavergne & Kimura, 1987). Gestures also complement speech when describing spatial relations (e.g., Beattie & Shovelton, 2006; Holler & Stevens, 2007). Speakers usually communicate visual-spatial information (e.g., object size, object location, or manner of the movement) using their gestures rather than speech (Beattie & Shovelton, 2006; Emmorey & Casey, 2001; Holler & Stevens, 2007; Kita & Özyürek, 2003). Similarly, speakers convey some spatial information (e.g., the rotation direction) only in their gestures during their descriptions of mental rotations of objects (Emmorey & Casey, 2001). Listeners benefit from gestural information, particularly when speech contains visual, spatial, and motoric information (Alibali, 2005; Beattie & Shovelton, 1999; Holle & Gunter, 2007; So et al., 2015). For example, compared to no gesturing, gesturing during describing of spatial words enhanced listeners' comprehension (Driskell & Radtke, 2003). Holler and colleagues (2009) showed that participants benefitted from observing iconic gestures that include information about

the size and relative position of objects. However, space is not the only topic we communicate multimodally. Can we extend these findings to different contexts?

1.3 Gestures and Emotion Understanding

Emotion recognition from bodily displays has gained attention over the last years, particularly in the fields of human-machine interaction (HMI) and affective computing. New systems or products, such as robots, are designed to detect human emotions from verbal statements, mimical expressions, or body language (Rozanska et al., 2018). For instance, Gunes and Piccardi (2007) presented an approach to automated visual analysis of emotions using face and upper-body gestures. They showed that recognition accuracy of classifiers was higher when face and upper-body gestures were used. Similarly, Kessous and colleagues (2010) presented their work on automatic emotion recognition and analysis based on data from the face, speech, and bodily gestures. They have tested the classifier based on three different combinations of modalities: face-gesture, face-speech, and gesture-speech. Results indicated better recognition rates when the combination of three different modalities is used. Importantly, the performance of the classifier reached the highest in the speech-gesture pair. These findings support the importance of multimodal affective communication and gestures' role in it. But what makes gestures special?

We express emotions mostly in a simultaneous way through voice, face, posture, and gesture (Lhommet & Marsella, 2015). An early study showed that humans use combined information from face and body during their judgments of human communicative behavior (Ambady & Rosenthal, 1992). The importance of body parts and their movements in both emotion expression and perception was also demonstrated in some other fields such as dance (Dittrich et al., 1996; Sawada et al., 2003) and psychiatry (Hall et al., 1995; Wallbott, 1985). Brain imaging research has shown that body-selected regions in the cortex exhibit greater activation patterns when observing emotional body expressions compared to neutral ones (Peelen et al., 2007). These findings clearly demonstrate the role of bodies in emotion communication.

Only a limited amount of research investigated gestures' roles in emotion communication. Some studies examined gestural arm movements. Pollick and colleagues (2001) found a relationship between perceived emotional activation (arousal) and temporal parameters (e.g., velocity and acceleration) of arm movements. Similarly, Dael et al. (2013) investigated how bodily expressed emotions influence the perception of certain gesture dynamics such as arousal, valence, and potency. Other studies investigated gesture's possible relation between valence and handedness, and how individuals express positive and negative emotional stories in their hands (Casasanto & Jasmin, 2010; Çatak et al., 2017).

Gestures can add a sarcastic or sympathetic meaning to the interpretation of the phrase (Kendon, 2004). A recent study (Guilbert et al., 2021) examined the mnemonic effects of observing gestures during a narrative comprehension task with preschool children and adults. The stories contained either positive, negative, or neutral states. Gestures enhanced recall performance of children. This study is important in terms of showing gesture's possible role in emotionally-related narrative comprehension. However, the research design does not allow us to see the effects of specific characteristics of gestures (e.g., gesture size or type).

Research in kinematics provides some insight into possible features of gestures that might affect our judgments. There is growing evidence suggesting that interlocutors modulate their gesture kinematics (e.g., size, velocity) depending on whether the speech context is communicative. For instance, previous research shows that participants adapt their gestures considering listeners' knowledge by producing larger (Bavelas et al., 2008), more complex (Gerwing & Bavelas, 2004), and higher (Hilliard & Cook, 2016) and gestures during communicating novel information. From listener's perspective, gesture size appears to have an influence on how intense gestures are perceived (Kita, 2009). That is, as the gesture gets larger, it becomes more noticeable to the observer. Similarly, recent research suggests that listeners attend to gestures that are larger in space because they are perceived as more communicatively intended compared to smaller gestures (Trujillo et al.,

2018, 2020). Thus, listeners are more eager to process wider gestures because they tend to believe that those gestures are intended to express some meaning to themselves. Gesture size appears to be important for how people process gestures. This raises the question of how different gesture sizes would influence people's judgments of emotional intensity. For instance, can we see an increase in perceived emotional intensity in wider gestures? The current study design will allow us to answer this question.

Last, most of the gesture comprehension studies have focused on word-level (e.g., So et al., 2012) or sentence-level (e.g., Wang & Chu, 2013) designs. Less research concerns narrative understanding. The importance of narrative comprehension as a cognitive tool for human development was previously demonstrated (Lyle, 2000; Hough, 1990; Schmithorst et al., 2006). Research with young children demonstrated that participants' recall performance was better than the control group when they viewed gestures along emotionally neutral narratives (Macoun & Sweller, 2016; Dargue & Sweller, 2018a, 2018b, 2020). Other studies have suggested that both gesture and speech are simultaneously decoded when perceiving a narrative (e.g., Cassell et al., 1999). Similarly, participants' recall performance on a story was better when the speech was accompanied with congruent gestures compared to when speech was presented alone (Cutica & Bucciarelli, 2008; Galati & Samuel, 2011). These findings support the idea of gesture's crucial role in processing of narratives. However, these studies kept the emotionality of stories neutral to control the potential confound of valence.

1.4 The Present Study

Gestures help us express and infer emotional content, yet; more studies are needed to demonstrate how exactly hand gestures help listeners' processing of emotions. Which specific characteristics of gestures (e.g., type, size in space) are more related to making emotional judgments? First, representational gestures seem to carry a more communicative role than other types of gestures (Dargue et al., 2019), however, previous research has mainly focused on gestures'

role in spatial contexts (Alibali, 2005). The current study investigates gesture's role in a non-spatial, emotional context, and compares the roles of iconic and beat gestures on inferring emotional meaning. It is important to note that the present study differs from earlier studies by examining subjective emotional judgments of participants instead of measuring their comprehension. Second, findings from gesture kinematics studies show that as the gesture's size becomes larger, viewers tend to perceive them as more communicative (Trujillo et al., 2018, 2020). Is this also valid when the content is emotion-related?

In three experiments, we ask two main questions: (a) How do hand gestures help listeners recruit emotional information? (b) What are the characteristics of gestures that may influence people's judgments of an emotional content?

Experiment 1

In Experiment 1, we examined the role of gesture type in detecting emotional meaning. Participants listened to excerpts from books that contain emotional narratives. Only gesture type (iconic vs. beat) was manipulated in Experiment 1, gesture sizes were kept constant. Participants were assigned to either one of the gesture type conditions. After watching each video clip, participants were asked to make judgments about the emotionality of the content. They decided how positive, how negative, and how intense each story was on a 1- to 5-Likert scale.

Our specific predictions were as follows. Prior studies showed higher beneficial effects of representational gestures than nonrepresentational ones on recall of information (Dargue et al., 2019). However, we did not measure participants' performance using accuracy rates or reaction times. Instead, our primary measure was emotional intensity. Thus, differences between the two gesture types in perceived emotional intensity were partially exploratory. However, we expected participants in the iconic gesture condition to rate emotional intensity higher than participants in the beat gesture condition because iconic gestures would strengthen the emotional meaning. This estimate was expected regardless of participants' judgments of the valence of the stimuli.

2.1 Methods

2.1.1 Participants

Fifty-seven undergraduates participated in the study. Data of 8 participants were removed because they did not complete the experiment. Additionally, as we wanted to preclude potential biases that could arise due to the participants' emotion processing, we excluded participants (n = 5) who stated that they had diagnosed with an affective disorder (e.g., depression, bipolar disorder) and were on medication related to their diagnosis. The final sample consisted of 44 participants (37 females, M_{age} = 21.73, SD = 3.20). All participants were native speakers of Turkish. Participants were recruited through the subject pool of Koç University. They provided online consent for participation in accordance with the guidelines approved by the Institutional Review Board of Koç University (2020.339.IRB3.126). Participants received course credit for their participation. They were randomly assigned to one of two gesture type conditions.

2.1.2 Stimuli & Tasks

Norming Study

The narratives that were used in the experimental task were excerpts from various books. We first edited the narratives so that the stories were in the same length and included the same number of sentences. Some narratives were also revised to be written in the first-person perspective. To ensure that the narratives have some emotional content, we conducted a norming experiment. In this norming study, 21 participants were presented with a total of 30 narratives, and were asked three questions on each narrative:

1. "What do you think is the valence of this story?"
2. "What was the dominant emotion(s) in this story?"
3. "How intense was this emotion(s) you chose in the previous question?"

For the first question, participants made a choice among two options: positive or negative. For the second question, participants were provided with a set of 10 emotions (happiness, anxiety, anger,

sadness, courage/pride, disgust, fear, surprise, joy, hate) presented in a random order and asked to select up to three options. Last, in the third question, they rated the intensity of emotions selected in the previous question on a 1-7 Likert scale.

Elimination of the narratives took place in 3 steps. Our first criterion was that at least 85% of the participants must have agreed on the valence of the story. Based on this, 3 narratives were excluded. Then, among the 27 narratives that were left, we were going to eliminate the ones that fell below the mean score of 4.5, however, none of them were below that score. Finally, we eliminated the narratives which at least half of the participants did not agree on the dominant emotion. The final list consisted of 24 excerpts ($M_{intensity}$ = 5.94). We randomly chose 14 excerpts ($M_{intensity}$ = 5.95) among them and recorded the narration to use in Experiment 1 (see below for details).

Experimental task

The experimental task consisted of 14 short narrative videos (3 positive, 11 negative – based on the previous norming study) of a narrator telling narratives that have emotional content. Each video included the same native Turkish female narrator telling a short story about an emotional event or situation. She wore black clothing, and the attire of the narrator was kept gender-neutral. The face of the narrator was kept visible to the viewers to ensure that the stimuli were more natural. Some studies (e.g., Dael et al., 2013) blur or cut out the face area to reduce the effect of facial expression; however, this explicitly directs participants' attention to the gestural information. Dael and colleagues (2013) also state this factor as one of the limitations of their study. As Kandana Arachchige et al. (2021) report in their review, asking participants to simply observe the stimuli makes the study ecologically more valid. Thus, instead of blurring or cutting out the face, the narrator was asked to keep her facial expression neutral during narration. All the narration procedure took place in front of a white wall with no other distractions.

The narrator in the present study did not have acting expertise and tried to maintain her facial expression as neutral as possible. The narrator gestured at the same two utterances (i.e., two gestures

per narrative) in iconic and beat conditions of each narrative. Both hands were used for all gestures in all videos. Participants in both gesture type conditions heard the same story text while seeing either of the two gesture types.

The length of narratives and videos was kept similar. Each video lasts approximately 15 seconds (M = 14.6 sec, range 13 – 17 sec). Since producing gestures affects prosodic prominence of speech (e.g., Krahmer & Swerts, 2007), the audio of each video for each narrative was swapped (i.e., the audio of one video was placed on the rest) as has been done in other studies (e.g., Holle & Gunter, 2007). Participants in both conditions heard the same voice for the same narrative, without the possible confounding effect of speech prosody. Timing of the gestures and speech were the same across all conditions.

2.1.3 Procedure

The entire testing procedure was conducted online, via "Qualtrics," a platform to create and distribute surveys. First, participants were provided with informed consent. After providing consent and the demographic questions, participants completed 1 practice trial that was not included in the analyses. After the practice trial, participants completed the experimental task. They were randomly allocated to either beat or iconic gesture type conditions and the narratives were also presented in a random order for each participant. Participants were instructed to watch the videos carefully, as they were asked to answer some short questions about the videos later. After each video, they were asked to answer three questions:

1. "What do you think was the valence of this story?"
2. "Which emotion was dominant in the video that you have just watched?"
3. "Please rate the intensity of the emotion that you have chosen in the previous question."

The entire session lasted approximately 15 minutes.

2.2 Results and Discussion

We fitted a linear mixed-effects model in R Statistical Software (v4.1.1; R Core Team, 2021) using the lmer() function from the lme4 library (Bates et al., 2015) to investigate whether there was

an effect of condition (i.e., gesture type). In the model, condition was the fixed factor, and emotional intensity judgments of our participants were the outcome variable. The random effects included random intercepts of trials and subjects. We used the lmerTest package (Kuznetsova et al., 2017) in R to obtain p values for the fixed effects.

We started with a random subject- and trial-intercepts only model. Condition was later added as a fixed effect to the null model and compared against the null model. The inclusion of the condition improved the model, $\chi 2(1) = 14.01$, $p < .001$. Iconic gesture condition was associated with higher intensity ratings compared to beat gesture condition by 1.08 ± 0.27, $t(43.91) = 4.06$, $p < .001$. That is, participants in the iconic gesture condition provided higher emotional intensity ratings (M = 3.40, SD = 1.29) than participants in the beat gesture condition (M = 2.32, SD = 1.28). Although we did not manipulate the valence, we then included it as a fixed factor to the model to check whether it affected the responses[1]. We did not find a significant effect of valence, (β = -.27, SE = .21, t = -1.29, p = .22). The gesture condition x emotional valence interaction was also non-significant, (β = .08, SE = .19, t = -.45, p = .66).

In Experiment 1, we investigated the role of gesture type on people's judgments of emotional intensity. In line with our expectations, participants in the iconic gesture condition rated the emotional intensity of the same narratives higher than participants in the beat gesture condition. This could be because iconic gestures would enhance the meaning of the content. Our findings are, although not direct, consistent with the previous studies showing comprehension benefits associated with viewing iconic gestures (e.g., Dargue et al., 2019; Hostetter, 2011). Iconic gestures facilitate comprehension by strengthening the meaning. Although we gathered participants' subjective affective decisions, we argue that findings of Experiment 1 are in line with this argument. Results suggested that iconic gestures might have an influence on our judgments of emotional intensity by enhancing interpretation of spoken content.

1 Note that we included valence of stories based on the norming study we previously conducted.

A notable limitation of Experiment 1, however, concerns the lack of a within-subjects design. Implementation of a between-subjects design did not allow us to confidently conclude that the type of gesture rather than some other factors such as inter-group differences was responsible for the observed effect. Therefore, in a second experiment, we investigated this effect in a within-subjects design. Additionally, Experiment 1 was considered as a second norming study for us to ensure that we have controlled experimental stimuli set in the following studies since the previous norming study did not require our participants to see gestures along with narratives.

Another limitation could be using more negative stories than positive ones. This decision was based on the norming study results in which negative stories were rated as highly emotional than positive ones. We then ran a post-hoc analysis to test whether imbalance in the number of positive and negative stimuli have influenced the results. We found the same effect of gesture type even after running the analyses using negative stimuli only, ($\beta = 1.10$, $SE = .28$, $t = 3.95$, $p < .001$).

In addition to the gesture type, gesture size is another possible characteristic of gestures that might influence our processing of a spoken material. Speakers adjust their gesture sizes (Bavelas et al., 2008; Galati & Brennan, 2014) and height (Hilliard & Cook, 2016) according to the listeners' familiarity or knowledge of the topic. Observers also tend to be attentive to gesture size such that larger gestures are perceived as more communicatively intended than smaller gestures (Trujillo et al., 2018, 2020). Additionally, listeners notice wider gestures more easily compared to narrower gestures (Trujillo et al., 2018, 2020). Can size of a gesture also influence people's judgments of emotional intensity? For instance, as gestures become wider, do we see an increase in perceived emotional intensity?

Experiment 2

In Experiment 2, we assessed whether different gesture sizes (i.e., narrow vs. wide) are related to individuals' emotional intensity judgments. More importantly, we investigated the possible interaction between gesture type and gesture sizes on perceived emotional intensity. In a within-

subjects design, we asked participants to decide how intense each story was on a 1- to 5-Likert scale. We used 8 narrative videos from Experiment 1, manipulating the type and size of gestures. Similar to the results of Experiment 1, we expected higher emotional intensity scores for the iconic gesture trials. Based on the previous research in kinematics demonstrating that size of a gesture influences how observers process that gesture (Trujillo et al., 2018, 2020), we expected to see a difference in perceived emotional intensity between different gesture sizes. We predicted that participants would provide higher intensity ratings for wider gestures regardless of the type of gesture. The current design also allowed us to examine a possible interactive effect of the type and size of gestures. We predicted that iconic-wide gestures would be rated as more emotional than other combinations as they included both semantic content and carried out in a larger space. Last, we checked whether participants' responses in the experimental task relate to their emotion reading abilities or mood states.

3.1 Methods

3.1.1 Participants

Power analysis using G*Power 3.1 (Faul et al., 2007) using an a priori power estimate with a power of .95 and an effect size of .25 revealed a minimum required sample size of $n = 36$. A total of 76 people, participated in this experiment. One person was excluded from analyses because their age was over 50. Similar to Experiment 1, we excluded participants ($n = 12$) who stated that they had diagnosed with an affective disorder and were on medication related to their diagnosis. Two more people were excluded from further analyses because they had participated in Experiment 1. The final sample consisted of 61 participants (53 females, 2 people preferred not to answer, $M_{age} = 22.6$, $SD = 3.87$). Participants were recruited through social media announcements and the subject pool of Koç University. All participants were native speakers of Turkish. They provided online consent for participation in accordance with the guidelines approved by the Institutional Review

Board of Koç University (2020.339.IRB3.126). Participants who were recruited through the subject pool received course credit for their participation.

3.1.2 Stimuli & tasks

Experimental task

The experimental task consisted of 8 trials (i.e., 8 narrative videos). Although we previously conducted a norming study to ensure that narratives carry emotional content and that they are similar in emotionality, that norming study required participants to answer questions upon reading the written texts. In Experiment 1, however, participants listened to the narratives and viewed gestures simultaneously. Thus, we considered Experiment 1 as a second norming study to have a controlled stimuli set for further experiments. We ranked the 14 narratives in Experiment 1 based on the participants' intensity ratings (M = 2.67) and eliminated the lowest- (M = 2.18) and the highest-scored (M = 3.16) ones to overcome a possible inter-narrative variability. We also excluded the positively-valenced narratives because the number of positive and negative ones was uneven and most of the narratives were negative. Therefore, we did not include any questions asking the valence of the narratives, either. The final set of videos consisted of 8 different negatively-valenced narratives. In half of the trials, participants watched iconic gestures accompanying the narrative, and in the other half of the trials, they watched beat gestures accompanying a different set of narratives. Half of the gestures were narrow, and the other half were wide within both iconic and beat gesture conditions. The videos were otherwise identical to those used in Experiment 1. As in Experiment 1, the narrator gestured two times in all the videos. Both hands were used for all gestures in all videos. For example,

Iconic gesture condition:

Yağmurda şarkı söylüyorum ve bu gerçekten mükemmel bir his. Bir sağanak oluyor (Figure 1a, Figure 1c) ve kendimi ona bırakıyorum. Yağmurun yağmasına izin verip deli gibi gülümsüyorum. Dans ediyorum çünkü eğer kendimi yağmurda mutlu edebiliyorsam, hayatta iyi bir yere (Figure 1b,

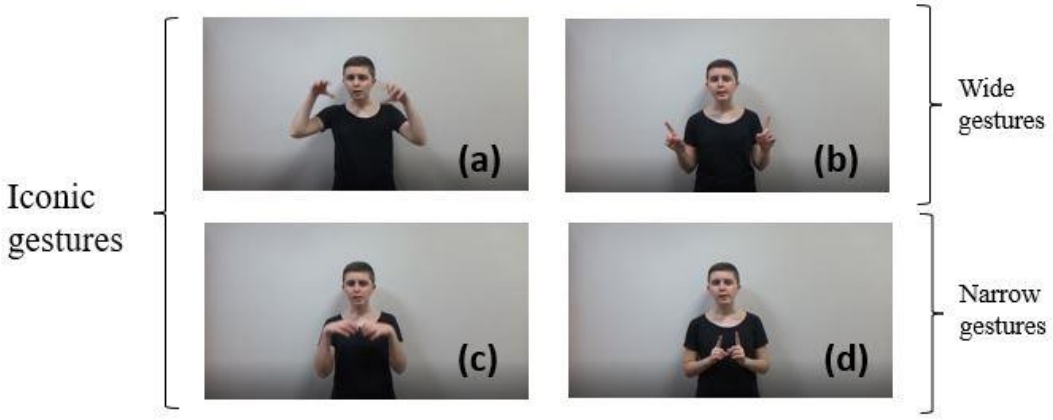
Figure 1d) gelmişim demektir. *(English: I'm singing in the rain, and it's such a glorious feeling. An unexpected downpour (Figure 1a, Figure 1c) and I am just giving myself into it. When the rain falls, I just let it fall and I grin like a madman. I dance with it because if I can make myself happy in the rain, then I am doing pretty alright in life (Figure 1b, Figure 1d)*[2]*.")*

Beat gesture condition:

Yağmurda şarkı söylüyorum ve bu gerçekten mükemmel bir his. Bir sağanak oluyor (Figure 2a, Figure 2c) ve kendimi ona bırakıyorum. Yağmurun yağmasına izin verip deli gibi gülümsüyorum. Dans ediyorum çünkü eğer kendimi yağmurda mutlu edebiliyorsam, hayatta iyi bir yere (Figure 2b, Figure 2d) gelmişim demektir. *(English: I'm singing in the rain, and it's such a glorious feeling. An unexpected downpour (Figure 2a, Figure 2c) and I am just giving myself into it. When the rain falls, I just let it fall and I grin like a madman. I dance with it because if I can make myself happy in the rain, then I am doing pretty alright in life (Figure 2b, Figure 2d).")*

Figure 1

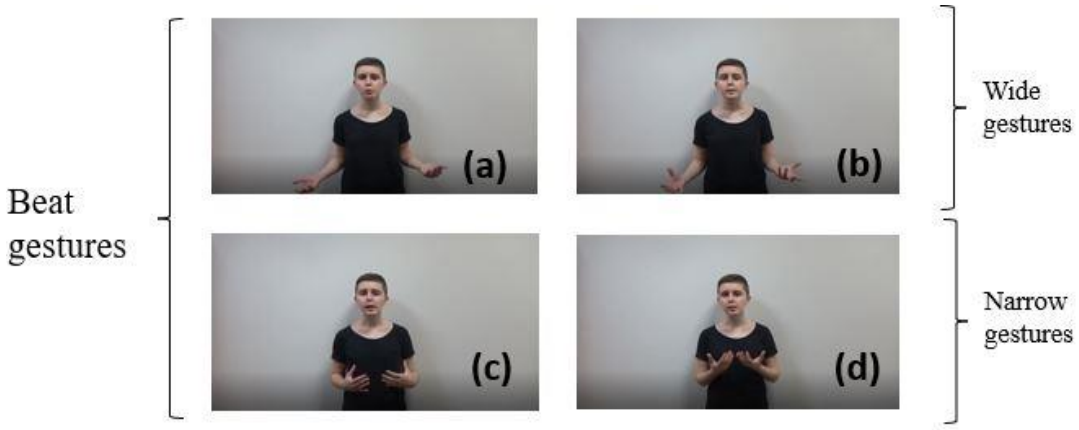
Examples of narrow and wide iconic gestures of the same narrative



2 Note that the last sentence "I am doing pretty alright in life" is translated into Turkish as "I am in a good place in life." The narrator's gesture represented "**a** good place."

Figure 2

Examples of narrow and wide beat gestures of the same narrative



The length of videos was similar to each other. Each video lasted approximately 15 seconds (*M* = 14.13 sec, range 13 – 16 sec).

Emotion reading task.

The 'Reading the Mind in the Eyes' test (RMET; Baron-Cohen et al., 2001; Turkish validation; Yıldırım et al., 2011) has been widely used to measure individuals' ability to recognize the thoughts and feelings of others. In the RMET, participants are presented with several photos of human eyes displaying different feelings. Participants are asked to decide on the emotion that best describes the person in the image is displaying. In the present study, we gathered RMET scores of participants to investigate the possible relation between participants' emotion reading abilities and the intensity ratings they provided.

Mood rating.

The Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) is one of the most frequently used self-reported measures of affect (Merz et al., 2013). After the experimental task and the RMET, all participants completed the PANAS (Turkish validation; Gençöz, 2000) as we wanted to check for a possible relation between participants' mood ratings and the emotional intensity

scores they provided in the experimental task. Participants answered a set of questions based on how they had been feeling in the last two weeks.

3.1.3 Procedure

As in Experiment 1, the entire testing procedure was conducted online, via Qualtrics. The procedure was nearly identical to that in Experiment 1. Participants were asked to rate how intense each video was on a 1- to 5-Likert scale in the experimental task. The narratives were presented in a random order for each participant. Unlike Experiment 1, participants did not receive any valence-related questions. After the experimental task, participants filled out the emotion reading and mood rating questionnaires, always in this order. The entire session lasted approximately 15 minutes.

3.2 Results and Discussion

Similar to Experiment 1, we conducted analyses in R Statistical Software (v4.2.1; R Core Team, 2021) using the lmer() function from the lme4 library (Bates et al., 2015). We also used anova function from car package to obtain p-values. Gesture type, gesture size, and their interaction were fixed factors, and the intensity judgments were the outcome variable in the model. We also incorporated the random intercepts of trials (i.e., narratives) and participants to the model. Results revealed no main effect of gesture type (β = -.01, *SE* = .08, *t* = .11, *p* = .91). Participants provided similar emotional intensity scores for both gesture type conditions. We found a significant main effect of gesture size on emotional intensity judgments (β = .20, *SE* = .08, *t* = 2.54, *p* = .01). However, the observed effect was not in line with our expectations. Participants provided higher emotional intensity scores for the narrow gesture trials (*M* = 2.90) compared to the wide gesture trials (*M* = 2.70). There was no significant interaction between gesture type and gesture size, (β = -.05, *SE* = .15, *t* = -.33, *p* = .74). Descriptive statistics for each gesture variable, mood ratings, and RMET scores can be found in Table 1.

Table 1

Descriptive statistics for participants' judgments of emotional intensity for gesture variable, mood scores, and RMET score

	Mean	Median	SD	Range
Iconic gesture	2.80	2.75	.90	1-4.75
Beat gesture	2.79	2.75	.92	1-4.75
Narrow gesture	2.89	2.75	.92	1-4.75
Wide gesture	2.70	2.75	.88	1-4.50
Positive affect	30.90	32.00	8.97	15-50
Negative affect	25.30	25.00	7.58	13-50
RMET score	24.20	24.00	2.73	18-31

Note. SD = Standard deviation, RMET = Reading the Mind in the Eyes Test.

Last, Pearson's correlation indexes were computed between participants' emotional intensity ratings, mood scores, and RMET scores to explore the nature of the interrelationships. Positive affect scores of participants were calculated by adding their scores on positive items of PANAS. Similarly, negative affect scores were calculated by adding participants' scores on negative items of PANAS. The RMET score was calculated as the total number of correct responses. All Pearson's correlation tests were tested against a Bonferroni-adjusted level of .002 (0.05/21). Results indicated that participants' emotional intensity judgments were not related to their positive or negative mood ratings or emotion reading abilities, *p*s > .002. Table 2 depicts the correlations among all variables.

Table 2

Correlations among participants' judgments of emotional intensity for gesture variable, mood scores, and RMET score

	1	2	3	4	5	6	7
1. Iconic gesture	1						
2. Beat gesture	.78 *	1					
3. Narrow gesture	.90 *	.91 *	1				
4. Wide gesture	.90 *	.90 *	.83 *	1			
5. Positive affect	.05	.09	-.01	.17	1		
6. Negative affect	.18	.16	.22	.12	-.46 *	1	
7. RMET score	.19	.18	.23	.15	.10	-.25	1

Note. RMET = Reading the Mind in the Eyes Test. *$p_{\text{bonferroni corrected}} < .002$.

Experiment 2 investigated whether gesture size and its interaction with gesture type were related to individuals' perceived emotional intensity of narratives. First, similar to the results of Experiment 1, we expected to see an effect of gesture type with higher emotional intensity ratings for iconic gestures. However, results did not support this hypothesis. We found a main effect of gesture size; however, contrary to our expectations, participants provided lower emotional intensity ratings for wide gestures than narrow gestures. Third, we investigated whether there was a gesture type x gesture size interaction and did not find an interaction between these variables. Last, participants' emotion reading, and mood ratings were not related to their intensity scores on any type of trial.

The findings of Experiment 2 were mostly not in line with our expectations. Lack of a significant main effect for gesture type was unexpected because Experiment 1 had suggested that

viewing iconic gestures would result in higher perceived emotional intensities compared to viewing beat gestures. Nonsignificant main effect of gesture type also seems contradictory to earlier studies showing a link between observing iconic gestures and enhanced comprehension (e.g., Dargue et al., 2019; Hostetter, 2011). This unexpected result might be a consequence of removing the lowest- and highest-ranked narratives based on the results of Experiment 1 and using the narratives with average means instead. To check this, we reanalyzed the findings of Experiment 1 with 8 narratives we used in Experiment 2. We again found a significant main effect of condition (i.e., gesture type), $\chi 2(1) = 12.19$, $p < .001$. Iconic gesture condition ($M = 3.47$) was associated with higher emotional intensity scores than beat gestures ($M = 2.41$). Although Experiment 1 had a between-subjects design for gesture type, these findings suggest that the effect of gesture type is present when we only manipulated gesture type. When we included gesture sizes, the effect of gesture type was no longer present. This suggests that different gesture characteristics might be simultaneously influencing individuals' emotional inferences.

For gesture sizes, we anticipated that wider gestures accompanying the speech would result in emotionally more intense perceptions of narratives compared to narrow gestures. Although results suggested a main effect of gesture size, findings were the opposite of our expectations. Interestingly, participants rated narrow gesture trials as emotionally more intense than wide gesture trials. These results might be due to the nature of stimuli we used in the current study. Since the narrator limited herself during the narration of narrow gestures so that her hands stay within her torso area, these gestures might have seemed less natural to our participants, causing narrow gestures to be more salient or attention-grabbing.

Findings of the present study add to the body of literature on nonverbal communication and show the complicated nature of gesture characteristics. In Experiments 1 and 2, we tried to control the valence effects and inter-narrative variability; however, lack of speech-only trials with no gestures can be considered a possible limitation of the current study. Thus, it is important to have a

control experiment in which videos with no-gestures (i.e., speech only) are presented with videos including gestures.

Experiment 3

We conducted Experiment 3 as a control experiment to investigate whether the effects (or lack thereof) in Experiment 2 were due to observing gestures in each trial. In addition to the gesture type and gesture size manipulation, we added narratives with no gestures (i.e., speech only) so that we could compare individuals' responses when they observed and did not observe gestures while listening to the narratives. In a within-subjects design, participants were again asked to rate emotional intensity of narratives on a 1- to 5-Likert scale. In addition to the same 8 narrative videos used in Experiment 2, we included 4 more different narrative videos with no gestures at all.

4.1 Methods

4.1.1 Participants

A total of 67 people participated in Experiment 3. The sample size was determined based on the sample size of Experiment 2. Three people were excluded because they did not complete the study. We also removed data of 7 participants who participated in Experiment 1 or Experiment 2. As in the previous Experiments, we excluded 4 more participants who stated that they had been diagnosed with an affective disorder and were on medication related to their diagnosis. Last, we had to remove data from 1 participant because they did not meet the criteria for the experiment (they were a non-native speaker of Turkish). The final sample consisted of 52 participants (37 females, M_{age} = 20.8, SD = 1.22). Participants were recruited through social media announcements and the subject pool of Koç University. All participants were native speakers of Turkish. They provided online consent for participation in accordance with the guidelines approved by the Institutional Review Board of Koç University (2020.339.IRB3.126). Participants who were recruited through the subject pool received course credit for their participation.

4.1.2 Stimuli & tasks

Experimental task.

The experimental task consisted of 12 narratives (i.e., the same 8 narrative videos used in Experiment 2, and additional 4 narrative videos with no gesture[3]). In the no gesture trials, participants heard the narrative without seeing any gestures. As in previous Experiments, the videos were similar in length (M = 13.92 sec, range 11 – 18 sec). Similar to Experiment 2, participants were asked to rate emotional intensity of each narrative on a 1- to 5-Likert scale.

Emotion reading task.

Similar to Experiment 2, participants filled out RMET.

Mood rating.

Similar to Experiment 2, we gathered mood ratings of participants (i.e., PANAS) after the experimental task and RMET.

4.1.3 Procedure

The entire testing procedure was conducted online, via Qualtrics. The procedure was identical to that in Experiment 2. Participants were asked to rate how intense each video was on a 1- to 5-Likert scale in the experimental task. The narratives were presented in a random order for each participant. After the experimental task, participants filled out emotion reading and mood rating questionnaires, always in this order. The entire session lasted approximately 15 minutes.

4.2 Results and Discussion

Similar to the previous Experiments, analyses were conducted in R Statistical Software (v4.2.1; R Core Team, 2021), and the functions and packages were identical to those used in Experiment 2. Random subject- and trial-intercepts were included as random effects in all models. First, to investigate whether seeing gestures in each trial affected participants' emotional intensity ratings of

3 Note that 1 narrative in no gesture trials was positively-valenced because we did not have any other negatively-valenced video without gestures in our stimuli set.

narratives, the intensity ratings data were submitted to a mixed model with gesture condition (with two levels – means of all gesture trials and means of no gesture trials) as a fixed factor. Again, intensity judgments were the outcome variable, and intercepts of trials and participants were included as random effects in the model. There was not a significant main effect of the gesture condition, (β = .06, *SE* = .10, *t* = .60, *p* = .56). Since the unequal number of trials with and without gestures might have affected the results, we further compared the means of iconic, beat, and no gesture trials. To test this, we submitted these mean scores to a mixed model, which included gesture type as a fixed factor and trials and participants as random intercepts. There was no effect of gesture type, (χ2(2) = .49, *p* = .78).

Additionally, using only gesture trials, we conducted the same linear mixed effects model with gesture type, gesture size, and their interaction as the fixed factors, to test whether we replicated the results of Experiment 2. We did not find a significant effect of gesture type, (β = .04, *SE* = .08, *t* = .51, *p* = .63). As in Experiment 2, observing iconic (*M* = 2.91) or beat gestures (*M* = 3.00) did not differentiate the perceived emotional intensities of narratives. However, unlike Experiment 2, there was not a significant main effect of gesture size, (β = .08, *SE* = .08, *t* = .99, *p* = .35). We did not find a significant gesture type x gesture size interaction, either (β = .02, *SE* = .08, *t* = .27, *p* = .78). Descriptive statistics for each gesture variable, mood ratings, and RMET scores can be found in Table 3.

A further post hoc analysis was performed to compare Experiment 2 and gesture trials of Experiment 3 (i.e., excluding the no gesture trials). We ran a 2 x 2 mixed design ANOVA with gesture type and gesture size as within-subjects factors and experiment (Experiment 2 vs. Experiment 3) as a between-subject factor. Results did not reveal any significant differences regarding gesture variables between Experiment 2 and Experiment 3, (*F*(1, 111) = .99, *p* = .32).That is, emotional intensity scores did not differentiate between the two experiments.

Table 3

Descriptive statistics for participants' judgments of emotional intensity for gesture variable, mood scores, and RMET score.

	Mean	Median	SD	Range
Iconic gesture	2.91	3.00	.84	1-4.5
Beat gesture	3.00	3.00	.92	1-4.75
Narrow gesture	3.03	3.00	.92	1-5
Wide gesture	2.88	3.00	.83	1-4.5
No gesture	2.84	3.00	.94	1-5
Positive affect	29.00	29.00	7.18	15-44
Negative affect	24.9	25.00	8.47	11-47
RMET score	22.6	24	5.07	7-29

Note. SD = Standard deviation, RMET = Reading the Mind in the Eyes Test.

We further analyzed the correlations among participants' responses in the experimental task and their mood ratings and emotion reading abilities. All Pearson's correlation tests were tested against a Bonferroni-adjusted level of .002 (0.05/28). Results did not reveal any significant relationship between these variables, *p*s > .002. Table 4 depicts the correlations among all variables.

Table 4

Correlations among participants' judgments of emotional intensity for gesture variable, mood scores, and RMET score.

	1	2	3	4	5	6	7	8
1. Iconic gesture	1							
2. Beat gesture	.80*	1						
3. Narrow gesture	.90*	.92*	1					
4. Wide gesture	.90*	.90*	.82*	1				
5. No gesture	.73*	.85*	.82*	.77*	1			
6. Positive affect	.02	0	.09	-.07	.05	1		
7. Negative affect	-.11	-.15	-.19	-.06	-.10	-.34	1	
8. RMET score	.05	0	-.02	.07	.12	-.12	-.14	1

Note. RMET = Reading the Mind in the Eyes Test. *$p_{\text{bonferroni corrected}} < .002$.

Experiment 3 was conducted to test whether the effects (or lack thereof) in Experiment 2 were due to viewing gestures in each trial. Results revealed no difference between gesture trials and no gesture trials. Importantly, we replicated some findings of Experiment 2. First, there was no significant effect of gesture type. However, in contrast to the findings of Experiment 2, gesture size did not influence participants' emotional intensity ratings. Results did not reveal a significant gesture type x gesture size interaction, either. Last, participants' emotional states or emotion reading abilities were not related to their responses in the experimental task.

Altogether, findings of Experiment 3 indicate that overall, whether or not our participants viewed gestures did not have an effect on their judgments of emotional intensity. Previous research suggested that gestures – both performing (Beilock & Goldin-Meadow, 2010) and observing (Cook & Tanenhaus, 2009) them- can change people's mental representation of a concept. Although our task only investigated participants' subjective emotional judgments, we expected to see a difference

in gesture and no gesture trials as observing gestures would influence how participants represent a story. In a similar vein, we may argue that iconic gestures, compared to beat gestures, would have resulted in higher perceived emotional intensity of narratives as they represent information. Results of Experiment 3 did not support either of these arguments. More importantly, even thought we did not find differences between Experiments 2 and 3 in terms of people's rating of emotional intensity based on gesture type and size, the effect of gesture size on ratings disappeared in Experiment 3. This could be related to watching narratives with both gestures and without gestures.

General Discussion

In three experiments, we investigated gesture characteristics that might have a role in processing of emotional content. Overall, our findings showed that type of gestures influenced people's emotional intensity judgments of narratives only when all other gesture characteristics were held constant. However, when we included different gesture sizes, the effect of gesture type disappeared, and we only observed an effect of gesture size. In particular, narrow gestures were related to higher emotional intensity judgments than the wider gestures. However, this effect of gesture size disappeared when participants watched narratives both with and without gestures. Last, participants' positive or negative mood ratings and emotion reading abilities were not related to this process.

Previous research suggests that different types of gestures influence cognitive processes in different ways, highlighting beneficial effects of iconic gestures. For instance, viewing iconic gestures was related to increased recall (Aussems & Kita, 2019; Macoun & Sweller, 2016; So et al., 2012; Kartalkanat & Göksun, 2020), and mathematical (Cook et al., 2013; Singer & Goldin-Meadow, 2005) performances in both children and adults. Iconic gestures in our study only highlighted the speech content, without providing additional information (i.e., they were redundant with verbal message). Iconic gestures can also cause simulation of visual and motor representations of different concepts. As a result, these gestures provide richer mental representations of semantic information and enhance several cognitive processes. Likewise, we anticipated that different types

of gestures would differentially influence people's processing of emotional content. We expected that observing iconic gestures would result in higher perceived emotional intensity of narratives than observing beat gestures because they would strengthen the meaning of the narratives. In addition, studies examining the role of gesturing in learning contexts have suggested that gestures can change a speaker's thought (e.g., Beilock & Goldin-Meadow, 2010). In line with that, Cook and Tanenhaus (2009) have found that participants who watched gestures mimicking the way a Tower of Hanoi task is being solved performed better than participants who only followed trajectories of movements, suggesting that observing gestures affected participants' mental representations of a problem. These studies suggest that doing and viewing gestures can affect our mental representations.

Although our task differed from the aforementioned studies in the sense that it did not measure participants' performance or comprehension, we expected to see a differential role of seeing iconic gestures, as meaning-bearers, by influencing participants' representations of emotional narratives. The effect of gesture type was present when it was the only manipulated gesture variable of the study. This might be due to our strategy of eliminating narratives in terms of emotional intensity after Experiment 1. By doing so, we aimed to avoid the possibility of variability among narratives and have a controlled stimuli set instead. This might have led to the disappearance of significant results in gesture type in Experiments 2 and 3. However, when we reanalyzed the findings of Experiment 1 with the narratives we used in Experiment 2, we again found the same gesture type effect. When different gesture sizes were in play, the effect of gesture type was not present anymore. This suggests that instead of stimuli-related reasons, absence of gesture type effect might be due to simultaneous interplay between multiple gesture characteristics.

Previous studies on gestures mainly focused on one aspect of gestures, ignoring others. The present study differs from earlier studies in the way that it included gesture size manipulation in addition to gesture type. Thus, the present study is among the first to examine the role of different

gesture characteristics together and to report an effect of gesture size on processing of emotional meaning. Although prior studies examined the role of different gesture sizes on communicativeness of content (e.g., Trujillo et al., 2018; 2020), they solely focused on one type of (i.e., representational) gestures. Our findings indicate that when different sizes of gestures were involved, the effect of gesture type disappeared. The results were present without any effect of co-speech prosody. These results suggest that several gesture characteristics might simultaneously influence processing of a verbal message – at least when the context is emotion-related. What do these findings tell us about the nature of gestures?

In their seminal work, Kelly and colleagues (2010) argued that listeners integrate gestural and spoken information in an automatic way. Although their argument was supported by several other behavioral, electrophysiological, or neuroimaging studies (e.g., Kandana Arachchige et al., 2021; Beattie & Shovelton, 1999; Cassell et al., 1999; Özyürek et al., 2007; Skipper et al., 2007, 2009; Wu & Coulson, 2005, 2007), a growing body of research suggests the possible involvement of different internal and external factors on this process (Drijvers & Özyürek, 2017; Holle et al., 2010; Holler et al., 2014; Kelly et al., 2007; Obermeier et al., 2012, 2015; Straube et al., 2010). For instance, Drijvers and Özyürek (2018) found that listeners are more attentive to gestural information during comprehension of degraded speech. Individual variances in various cognitive processes can also influence the extent to which observers attend to gestural or verbal information (see Özer & Göksun, 2020 for a review). The current study corroborates this research by showing that in addition to internal (e.g., individual differences) or contextual factors (e.g., degraded speech condition), certain characteristics of gestures and their interaction with each other might also be related to the extent to which listeners are sensitive to them. Our results suggest that, instead of whether or not certain types of gestures exist during processing of a narrative, how much space those gestures take up could also be important. However, caution is needed for this finding as we could not replicate it in our Experiment 3 when we showed participants narratives with and without gestures. When

participants only saw narratives with gestures, specific gesture characteristics would become prominent for them. Emotional ratings across two experiments based on different gesture trials were similar. The lack of gesture size effect in Experiment 3 suggests that participants can be sensitive to gestures when they always saw gestures and compared them to each other. Further research is needed to understand how characteristics of gestures may interact with other experimental manipulations.

Research in gesture kinematics demonstrated that listeners tend to be more attentive to larger gestures because gestures become more noticeable to the viewers as they take up more place in gestural space compared to smaller gestures (Trujillo et al., 2018, 2020). Likewise, we anticipated that seeing wider gestures in our study would lead to higher perceived emotional intensity scores compared to narrow gestures because participants would be more attentive to wide gestures. Our findings did not support this hypothesis. On the contrary, participants rated narratives with narrow gestures as emotionally more intense than narratives with wider gestures. It could be possible that narrow gestures were perceived as less natural by our participants. The narrator in the present study restricted herself from moving her hands beyond her torso area in narrow gesture trials. Compared to a natural daily speech, this restriction of hand movements might have caused our stimuli to be perceived as unnatural by the participants, which in turn might have caused the narrow gestures to be more attention-grabbing. Another factor that could be related to our findings is that our narrow gestures were at the center of the screen whereas wide gestures appeared at the peripheral space too. It may be possible that not only the width of gestures but also the exact space (i.e., center, periphery, right vs. left side of the screen) can be related to individuals' perceived saliency of gestures. Furthermore, eye-tracking studies suggested that several factors such as speaker-fixation (i.e., whether the speaker looked at their own gestures, Gullberg & Holmqvist, 2006, Gullberg & Kita, 2009) or presence or absence of post-stroke holds (i.e., whether a gesture freezes, Gullberg & Kita, 2009) influence the ways listeners direct their attention to an addressee. Therefore, future research

using eye-tracking methodology can examine how different gesture sizes and their location in gestural space are related to people's emotional inferences. Additionally, the narrator in the present study gestured two times in each narrative video. Different gesture frequencies can be used in future studies. Rather than a categorical manipulation (narrow and wide), gesture space can also be systematically manipulated in a continuous way using conditions with and without gestures.

Studies of nonverbal communication frequently demonstrated that certain patterns of bodily cues such as posture, gesture or arm movements are linked to specific feelings. For instance, findings of Lakoff and Johnson (1999) suggested that individuals use vertical axis to express positive and negative feelings. That is, they use upward motions during expressions of positive feelings (e.g., "My spirits rose") and downward motions during expressions of negative feelings (e.g., "I am feeling down"). Earlier studies have also demonstrated the link between joy-like emotions and upward arm movements (Boone & Cunningham, 1998, 2001; Coulson, 2004; de Meijer, 1989; Wallbott, 1998). In terms of posture, previous studies demonstrated a relationship between feelings of pride and an upright position (e.g., Stepper & Stack, 1993), and between disappointment and sadness and a slumped position with a decrease in posture (Riskind, 1984). In a recent study using a subset of the narratives, Özder and colleagues (in press) indicated that speakers used more gestures retelling negative emotional narratives than positive ones, specifically during emotional speech Thus, the valence of narratives could be associated with people's use of gestures. Based on the results of Experiment 1, we decided to remove positively-valenced narratives and used only negative ones. It is important to note here that we found the same gesture type effect even when we ran post-hoc analyses to test whether imbalance in the number of positive and negative stimuli have influenced the results. Since negative emotions are related to smaller or slumped motions in general, the use of negative stimuli in the present study might have led participants to perceive narrow gesture trials as emotionally more intense when they always saw gestures in different trials.

It is also important to note that the narratives in the present study were emotion-laden literary texts from various fictional books. This might have had an effect on our results, considering studies showing differential processing of literary texts than non-literary ones on several cognitive processes (e.g., Kidd & Castano, 2013; Dixon et al., 1993; Djikic et al., 2013). Additionally, there was an imbalance between the number of men and women participating in the present study (i.e., more than 80% consisted of women in each experiment). Although there are mixed and non-consistent findings in the literature, some studies indicate that gender might play a role in emotion processing, suggesting women's advantage over men in decoding and processing emotions (e.g., Thompson, & Voyer, 2014; Sullivan et al., 2017; Olderbak et al., 2018). We have tried to reduce possible external influences, yet we cannot conclude with confidence whether the greater number of female participants has had an impact on the results. Our post-hoc analyses; however, did not yield any differences between male and female participants in any of the gesture variables.

Our results provide new hints regarding the role of different features of gestures in language processing. Altogether, findings suggest the possibility that gesture sizes when participants saw gestures in all trials, instead of mere existence of gestures, might be crucial when people make inferences about emotional meaning. Future studies should consider investigating how the use of gestural space is related to individuals' processing of speech in different domains.

In addition to its theoretical contribution, the present study also entails some practical implications. The present study would be useful in a variety of settings where gestures are used to aid learning, such as classrooms. Teachers are generally suggested to employ gestures during teaching as gestures were found to facilitate learning (Valenzeno et al., 2003; Alibali & Nathan, 2007). Studies examining gestures' role in educational settings; however, mostly focused on different types of gestures. Findings of the current study suggest that instead of different types of gestures, focusing on how wide or narrow those gestures are, could be more critical in learning

settings. However, based on the lack of replicating gesture size effect in Experiment 3, more research is needed in both experimental and natural settings related to gesture size.

One of the strengths of the current study is that it takes the findings of previous gesture studies one step further and explores the role of gestures in a non-spatial, emotional context. Yet, this study has some limitations. We tried to overcome the possible confounders and have controlled experimental settings by applying a within-subjects design and employing an elimination strategy after the Experiment 1. We used narratives with similar emotional intensities; however, this strategy might have caused the disappearance of a possible effect. Future studies could manipulate emotional intensities of narratives and investigate how they might be in relation with different gesture characteristics. Our study could also be insufficient in terms of the number of trials that were presented, which might have influenced the non-replication in Experiment 3. Future research can increase the number of trials. It is also important to note that, in addition to hand gestures, there are several other mediums that are important in nonverbal communication. The present study focused solely on hand gestures and two characteristics of them; however, other features such as velocity (Paterson et al., 2001) and trajectory (Kosanovich, 2015) of hand and arm movements might also be important for nonverbal emotion communication. Thus, research on how different bodily parts and their characteristics are related to people's inference of emotional meaning can be extended.

Conclusion

In three experiments, we investigated features of hand gestures that might be related to individuals' judgements of emotional content - by inquiring whether participants' perceived emotional intensity of emotional narratives were affected by observing gestures differing in type and/or size. Although the results are only partially in line with our expectations, the current study is one of the first studies exploring different gesture characteristics in an emotional context. Our results are not conclusive; however, findings highlight the importance of considering different gesture properties in different contexts in gesture research. Size of gestures, particularly, appears to be

crucial when people always see gestures. Therefore, future studies should consider different gesture characteristics when investigating gesture's role in spatial or non-spatial contexts.

Statements and Declarations

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Ethics Approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Koç University (Date: November 02, 2020, No: 2020.339.IRB3.126). Informed consent was obtained from all individual participants included in the study. The authors affirm that informed consent was obtained for publication of the images in Figures 1 and 2.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on request. The authors also have full control of all primary data and that they agree to allow the journal to review their data if requested.

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