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When the mask falls: The role of facial motor resonance in memory for emotional language

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ABSTRACT

The recognition and interpretation of emotional information (e.g., about happiness) has been shown to elicit, amongst other bodily reactions, spontaneous facial expressions occurring in accordance to the relevant emotion (e.g. a smile). Theories of embodied cognition act on the assumption that such embodied simulations are not only an accessorial, but a crucial factor in the processing of emotional information. While several studies have confirmed the importance of facial motor resonance during the initial recognition of emotional information, its role at later stages of processing, such as during memory for emotional content, remains unexplored. The present study bridges this gap by exploring the impact of facial motor resonance on the retrieval of emotional stimuli. In a novel approach, the specific effects of embodied simulations were investigated at different stages of emotional memory processing (during encoding and/or retrieval). Eighty participants underwent a memory task involving emotional and neutral words consisting of an encoding and retrieval phase. Depending on the experimental condition, facial muscles were blocked by a hardening facial mask either during encoding, during retrieval, during both encoding and retrieval, or were left free to resonate (control). The results demonstrate that not only initial recognition but also memory of emotional items benefits from embodied simulations occurring during their encoding and retrieval.

1. Introduction

Enjoying one's favorite sweets can put a smile on one's face; however, a mere picture of those sweets or even the word "sweets" can produce similar effects. Recently, this phenomenon has been explained by embodied simulations, in which the emotion originally experienced from an emotional stimulus is automatically re-enacted (Niedenthal, 2007; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005; Niedenthal, Winkielman, Mondillon, & Vermeulen, 2009; Semin & Cacioppo, 2008). Embodied simulations correspond to the activation of emotion-related and modality-specific sensations or physical actions caused by conceptual knowledge about emotions (Halberstadt, Winkielman, Niedenthal, & Dalle, 2009). For example, simulated emotional responses are linked to bodily reactions, such as facial expressions. This has been demonstrated using the electromyography technique (EMG; Cacioppo & Petty, 1981), as well as the facial action coding system (FACS; Ekman & Friesen, 1978; e.g., Hawk, Fischer, & Van Kleef, 2012). EMG recordings have repeatedly shown the spontaneous activation of an observer's facial muscles compatible with the emotional content of a stimulus. For example, matched facial muscle activation occurs in response to facial expressions (e.g., Dimberg, Thunberg, & Elmehed, 2000; Dimberg, Thunberg, & Grunedal, 2002) or non-facial stimuli such as emotional words (Foroni & Semin, 2009; Niedenthal et al., 2009), prosody (e.g., Hietanen, Surakka, & Linnankoski, 1998; Quené, Semin, & Foroni, 2012), and also more generally with positive and negative affect-inducing pictures, sounds, and words (Larsen, Norris, & Cacioppo, 2003). While the former is often referred to as facial mimicry (see Hess & Fischer, 2014 for a review), the latter is often denoted as facial motor resonance, a condition in which the perceiver attributes emotional meaning to a stimulus at hand. It has been argued that this proprioceptive feedback facilitates the comprehension and processing of emotional information (e.g., Foroni & Semin, 2009; Niedenthal et al., 2009; Zwaan & Taylor, 2006).

Evidence in line with this interpretation comes from studies in which facial muscles' activity is blocked by external manipulations. For example, by instructing participants to hold a pen laterally between their teeth, facial responses can be prevented, impairing the recognition of emotional words and facial expressions (Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001; Niedenthal et al., 2009; Oberman, Winkielman, & Ramachandran, 2007). In a study by Havas, Glenberg, Gutowski, Lucarelli, and Davidson (2010), participants were found to be slower in reading emotionally negative sentences after they had received Botulinum Toxin-A (BOTOX) injections into the corrugator supercilii (muscles used in frowning). The authors argued that facial motor resonance is thus not only an accessorial phenomenon, but is causally and selectively involved in emotion processing. Growing

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evidence supports the claim that the role of embodied simulations may go well beyond initial processing: they also seem to guide our behavior and judgments (e.g., Foroni & Semin, 2009, 2011, 2012; Winkielman, Berridge, & Wilbarger, 2005).

The phenomenon of facial motor resonance is especially interesting. It has been correlated to activations in the limbic regions and in the amygdala, which are known to be involved in experiencing and processing emotions (Carr, Iacoboni, Dubeau, Mazziotta, & Lenzi, 2003; Lee, Josephs, Dolan, & Critchley, 2006; Wild, Erb, Eyb, Bartels, & Grodd, 2003; see Dalgleish, 2004 for a review). In fact, lesion and neuroimaging studies suggest that the amygdala is specifically associated with memory for emotional but not neutral information (e.g., Adolphs, Cahill, Schul, & Babinsky, 1997; Brierley, Medford, Shaw, & David, 2004; Cahill, Babinsky, Markowitsch, & McGaugh, 1995; Markowitsch et al., 1994). In agreement with theories of embodiment, when facial muscles are blocked, the activity in the amygdala is attenuated (Hennenlotter et al., 2009). Hence, previous findings suggest an important role for facial motor resonance in the processing of emotional content.

Another important aspect of emotion processing that has so far been neglected by the embodiment literature is the enhancement of our memory for emotional content in comparison to neutral stimuli (see Buchanan & Adolphs, 2002; Hamann, 2001; LaBar & Cabeza, 2006, for reviews). The Enhanced Emotional Memory (EEM) effect has been demonstrated for a wide range of emotional stimuli, such as narratives (Laney, Campbell, Heuer, & Reisberg, 2004), words (Kensinger & Corkin, 2003) and pictures (Chainay, Michael, Vert-Pré, Landré, & Plasson, 2012). A question then arises as to whether the EEM effect is due to and supported by bodily reactions, such as facial motor resonance. According to some studies, memory for emotional stimuli is facilitated if a stimulus's affective tone is congruent with the participant's mood during retrieval (Cloitre & Liebowitz, 1991; Fitzgerald et al., 2011; Liu, Wang, Zhao, Ning, & Chan, 2012). Indeed, it is widely accepted that memory can be improved when affect at encoding or retrieval matches the valence of emotional stimuli, which is generally referred to as mood congruent memory (Blaney, 1986). A related but distinct phenomenon is that memory can be improved by the reinstatement of the learning environment at retrieval (see Smith & Vela, 2001 for a review). This context- or state-dependent memory effect can be established by any meaningful contextual cue, such as ambient odor (Herz, 1997), music (Mead & Ball, 2007), or internal mood states (see Eich, 1995 for a review). For example, mismatching participants' internal mood states during encoding and retrieval leads to impaired memory for words (Lang, Craske, Brown, & Ghaneian, 2001), as well as for symbols and photographs (Robinson & Rollings, 2011). But do embodied simulations play any role in this mood-congruency and context- and state-dependency memory effect? Or are these effects simply produced by better integration of information due to external cues and context? Concrete attempts to study the effects of body movements on emotion retrieval were conducted by Casasanto and Dijkstra (2010) and Förster and Strack (1996). Both studies led to conceptually similar results. Motor movements schematically associated with "positivity", such as moving marbles upward or shaking one's head vertically, and movements schematically associated with "negativity", such as moving marbles downward or shaking one's head horizontally, influenced retrieval of autobiographical memory and recognition of positive and negative words, respectively. Förster and Strack (1996) concluded that performing incompatible motoric and conceptual tasks (e.g. shaking the head horizontally while encoding positive words) requires more cognitive capacity than performing compatible motoric conceptual tasks (e.g. shaking the head vertically while encoding positive words). This additional demand in attentional resources eventually resulted in decreased performance during incompatible conditions. Although these studies provide evidence for a motor-to-meaning congruency effect on memory, they did not aim at investigating the role of embodiment in memory retrieval. Since Casasanto and Dijkstra (2010) did not control for mood, it is moreover possible that the active body movements (moving marbles upwards or downwards) induced a positive or negative emotional state similar to the emotional state under which the information had been originally encoded, hereby causing improved memory by means of a state-dependency effect. A more concrete approach to study the role of embodiment in object recognition was recently employed by Decloe and Obhi (2013), who applied Single pulse Magnetic Stimulation (TMS) over the motor cortex during observation of a model thumb typing on a cell phone. Their findings suggest that embodied simulation indeed are linked to the recognition of objects of action, but they results are restricted to embodied actions and non-emotional objects. Thus, the general role of facial motor resonance and embodied processes in emotional memory remains speculative.

Given this information, the present study seeks to investigate the putative role of embodiment during encoding and retrieval of emotional language. We expect that the role of facial motor resonance goes beyond the initial processing and recognition of emotional stimuli (Havas et al., 2010; Niedenthal et al., 2001; Niedenthal et al., 2009), and also affects memory for emotional information. To test this prediction, participants performed a memory task involving the encoding and retrieval of emotional and neutral words. Depending on the experimental condition, facial muscles were blocked by a hardening facial mask either during encoding, during retrieval, during both encoding and retrieval, or never (control). In contrast to the blocking methods used in previous studies (e.g., Foroni & Semin, 2009, 2011, 2012; Havas et al., 2010; Niedenthal et al., 2001, 2009; Oberman et al., 2007), we implement a new method involving the application of a hardening cosmetic mask that aims to block all relevant muscles at once, allowing us to investigate the effects of blocked facial muscles on the encoding and retrieval of a wider range of emotional words. By testing the effect of blocking facial muscles on memory for both positive and negative emotional content, we were also able to avoid the possible mood-congruency confounding (see Casasanto & Dijkstra, 2010; Havas et al., 2010). For the encoding phase, we used a categorization task (following Niedenthal et al., 2009) that involved the categorization of words as being either related or unrelated to emotion. We predicted that if our blocking manipulation successfully interfered with facial motor resonance, performance on the categorization task should be impaired for words from all emotion types as shown by Niedenthal and colleagues implementing a different blocking manipulation.

Our primary hypothesis was related to the performance on the memory task. We expected that in comparison to when facial muscle action is free (control), memory for emotional but not for neutral words would be impaired if facial muscles are blocked during encoding, during retrieval, or during both. Specifically, we were interested in whether blocking facial motor resonance during encoding or retrieval only produces similar effects, or whether the effects are specifiable. If facial motor resonance supports the initial identification and processing of emotional information and its later recognition and retrieval, then blocking facial muscles during encoding or during retrieval should likewise interfere with the memory of emotional words. In these two conditions the encoding and retrieval phases also provided no contextual cues: during the blocking conditions, a hardening dry mask interfered with facial muscle activity, while in the free conditions a soft creamy control mask ensured free muscle activity. In the memory literature, it's found that similarity between encoding and retrieval context may help memory performance. Thus, the predictions regarding the inhibition of facial resonance during both encoding and retrieval were less definitive: on the one hand, it is possible that blocking during both encoding and retrieval leads to even stronger interference with memory of emotional content, on the other hand, it is possible that a contextual effect might compensate for any additional interference that such a double blocking may cause.

2. Method

2.1. Participants

Eighty young healthy Italian native speakers (49 females; mean age: 23.7 ± 3.8) participated in the experiment. Participants were randomly