Frightened by the perpetrator’s voice: Startle responsivity and cognitive processing predict earwitness speaker identification

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ABSTRACT

This study was inspired by the case of a robbery victim who was startled and reminded of the crime upon hearing a stranger’s voice, while not clearly recognizing the speaker. To investigate whether specific voices can modulate startle reactions and thereby predict speaker identification, we presented an audio hijack scenario to 84 participants and afterwards asked them to identify the perpetrator among neutral and negative speech fragments, while measuring flash-evoked eye-blink startle responses. Furthermore, we addressed data-driven cognitive processing during the audio scenario as a potential moderator in voice discrimination. Negative speech and the perpetrator’s voice led to potentiated startle. Enhanced startle was positively associated with voice discrimination, but only in neutral speech fragments. In negative fragments, this association was weakened as a function of self-reported levels of data-driven processing during encoding. Thus, startle responses can generally predict accurate voice recognition, but speech emotionality and cognitive processing moderate this relationship.

1. Introduction

A few years ago, an armed robbery took place in a small Dutch supermarket. Several perpetrators forced the manager to open the safe of the market, while the other staff members were held hostage, handcuffed, and threatened with firearms. The staff members did not see the perpetrators but could hear them speak in a language they thought to be Arabic. At the time, the police were unable to arrest any suspects. Curiously, about one year later, a new lead emerged. One of the staff members heard a stranger talk and suddenly had a strong bodily reaction, including goose bumps all over her body, accompanied by intrusive memories of the robbery. Even though she did not clearly recognize the voice or understand what the person said, she notified the police. Following up on this new lead, the police consulted our forensic speech analysis department (the Maastricht Forensic Institute, the Netherlands), inquiring whether the woman’s physical reaction to the stranger’s voice could be a sign of actual voice recognition. To date, no experimental data are available to provide a satisfactory answer to this question. The present study set out to address this question empirically.

Earwitness identification performance is generally considered to be relatively poor compared to eyewitness identification, and highly susceptible to interference (Bull & Clifford, 1999; Öhman, Eriksson, & Granhag, 2013). However, in cases like the supermarket robbery, it is possible that memory for voices is considerably improved due to the memory-enhancing effects of stress and stress hormones (Wolf, 2009). In addition, a bodily startle reaction to hearing someone’s voice – as reported by the employee in the aftermath of the supermarket robbery – could be regarded as a bodily sign of implicit memory, preceding voice recognition and identification (i.e., analogue to a somatic marker in decision making; Bechara, Damasio, Tranel, & Damasio, 1999).

However, matters are complicated by the fact that exaggerated startle responses also represent a core symptom of post-traumatic stress disorder (PTSD; American Psychiatric Association, 2013), a condition characterized by recurrent intrusive trauma memories and physiological hyper-responsivity. That is, PTSD patients often display exaggerated physiological responses when confronted with trauma-related stimuli, indicating heightened sensitivity to negative valence and defensive reactions (Orr & Roth, 2000; Orr, McNally, Rosen, & Shalev, 2004). Critically, in many cases, this modulation can be evoked by a large array of environmental triggers, even if the sensory similarity to the traumatic experience is only vague (Brewin, Gregory, Lipton, & Burgess, 2010; Ehlers, 2010; Ehlers & Clark, 2000). Thus, heightened
physiological reactions do not always occur in response to stimuli that were actually present during a traumatic event, and are not necessarily accompanied by accurate memory recollection (e.g., McNally et al., 2004; Zoellner, Foa, Brigidi, & Przeworski, 2000).

This observation may be explained by cognitive processes during traumatic experiences that moderate the relationship between physiological reactivity and voice recognition. Information processing theories of PTSD (Brewin et al., 2010; Ehlers & Clark, 2000) propose that a maladaptive processing style coined data-driven processing (Roediger, 1990) plays an essential role in the (hyper-)accessibility of trauma memories. Data-driven processing refers to preferential encoding of superficial perceptual features (e.g., colours, shapes, sounds), which may interfere with encoding of the meaning and context of the situation (labelled conceptually-driven processing), thereby impairing later intentional recollection of the memories (Ehlers & Clark, 2000). Indeed, data-driven processing has been linked to intrusive trauma memories (Halligan, Michael, Clark, & Ehlers, 2003; Kindt, van den Hout, Arntz, & Drost, 2008), and may facilitate perceptual priming of trauma-related stimuli (cf. Ehlers, Michael, Chen, Payne, & Shan, 2006; Sündermann, Haasch, & Ehlers, 2013).

Remarkably, data-driven processing during an aversive situation may impact physiological responses and voice identification in two ways. First, focusing on superficial perceptual features enhances attention to detail, which might result in a stronger formation of verbatim traces (i.e., memory for surface details, such as voices; Brainerd, Reyna, & Ceci, 2008). Accordingly, both (selective) startle responsivity and voice discrimination performance would be expected to increase as a function of data-driven processing, amplifying the association between physiological responses and discrimination performance. Second and conversely, data-driven processing can be argued to impair stimulus discrimination. In particular, it has been suggested that recognition memory depends on the degree to which perceptual features are bound into a coherent trace during encoding (Schacter, Norman, & Koutstaal, 1998). Since data-driven processing is associated with feeling overwhelmed by perceptual impressions and an increase in intrusive memories (e.g., Kindt et al., 2008), it is likely to disrupt effective feature binding in memory (also see Huntjens, Wessel, Postma, van Wees-Cieraad, & de Jong, 2015). Accordingly, this processing style might generally impair stimulus discrimination, both in terms of physiological reactivity and voice discrimination.

With these considerations in mind, the present study aimed to elucidate the relationship between physiological responses to unexpected startle probes accompanying specific voices from an aversive event and voice identification performance, as well as the moderating role of data-driven processing during the aversive event. For this purpose, we subjected participants to an aversive audio scenario involving a violent perpetrator. This allowed us to subsequently test eye-blink startle responses and discrimination performance during an auditory voice lineup, using neutral and negative speech fragments (Bradley & Lang, 2000; Meyer et al., 2014). In order to test the moderating influence of processing style, half of the participants were instructed to focus on perceptual details (i.e., data-driven processing; Kindt et al., 2008) prior to listening to the aversive scenario, whereas the others were instructed to focus on the storyline and meaning (i.e., conceptually-driven processing).

Our main expectations were that voice probes from the perpetrator would lead to potentiation of the startle reflexes, relative to probes from unknown foil speakers. In addition, and replicating prior findings with non-voice auditory stimuli (Bradley & Lang, 2000), speech probes with negative valence were expected to amplify startle responses compared to neutral ones. Next, we expected that participants with stronger voice-induced potentiation of physiological responses would also be better able to discriminate the voices when prompted to identify the perpetrator’s voice (both for neutral and negative probes). Finally, we explored the role of data-driven processing style during the aversive audio scenario, with two contrasting hypotheses in mind. In particular, data-driven processing might increase or decrease the association between startle modulation and discrimination, assuming that it (1) increases verbatim encoding due to more attention to detail, or (2) impairs recognition memory due to ineffective feature binding (see above).

In order to examine whether possible associations between startle and voice identification would be paralleled by similar effects in other types of episodic memory, we additionally included a free recall test of the aversive scenario. Based on the assumption that data-driven processing (as opposed to conceptually-driven processing) is associated with a less elaborated depth of processing and encoding of meaning (Craik & Lockhart, 1972), we expected data-driven processing to negatively impact the accuracy for memory for meaning and categories (i.e., gist memory; Brainerd & Reyna, 2002) in favour of memory for specific stimulus information (i.e., verbatim memory). Finally, and analogue to the analyses for voice identification, we explored whether processing styles moderated the association between startle and memory accuracy.

2. Method

2.1. Participants

Eighty-four participants (54 female) enrolled in this study and were assigned to one of two processing conditions: data-driven processing (n = 42) or conceptual processing (n = 42). All participants were undergraduate psychology students of Maastricht University and native speakers of Dutch, with an age ranging from 18 to 31 years (M = 21.3, SD = 2.8). They were recruited at the university campus via poster advertisements, announcements after lectures, and via an online research participation system. Upon response, they were screened for inclusion and exclusion criteria by means of a self-report checklist. Exclusion criteria were: hearing problems, psychological or psychiatric complaints or treatment in the past two years, neurological diseases such as epilepsy, psychoactive medication use such as anti-depressants, alcohol consumption of more than 15 units a week, cannabis or other drugs use more than once a week, severe traumatic experiences, or having been victim of serious emotional or physical abuse. Participants received research participation credits or a 15 € voucher in return for completing the study. This study was approved by the standing ethical committee of the Faculty of Psychology and Neuroscience, Maastricht University.

2.2. Aversive audio scenario

2.2.1. Plot and procedure

To expose participants to a reasonably ecologically valid aversive experience involving voices in the absence of visual stimulation, we used an audio-recorded staged bus hijacking lasting approximately 8 min. To introduce participants to the scenario, they were initially shown a live news article on a constructed website resembling a widely read Dutch news portal (www.nu.nl), surrounded by authentic links and advertisements. The article informed about an ongoing bus hijacking, many aspects of which would still be unknown. Next, participants listened to the recordings portraying the following plot.

A young woman (hereafter: the victim) enters a bus and takes a seat. A male stranger (hereafter: the perpetrator) sits down next to her and starts conversing in an obtrusive manner. He elaborates that he is going to visit his brother in prison, trivialising that his brother had robbed an elderly couple. The victim is initially reluctant to reply, and eventually tells him that she does not want to talk to him. The perpetrator starts insulting her, and the situation escalates when the bus driver intervenes, triggering the perpetrator to shout angrily. The bus driver calls the police, but the man grabs the telephone and demands the police to release his brother. After ending the call, he shouts at the passengers, pulls a gun, threatens the passengers, and takes the woman hostage. The bus driver almost loses control of the bus. The perpetrator calls the
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