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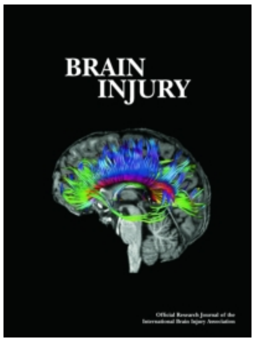

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LETTER TO THE EDITOR

The Linguistic Acoustic ThreaT Effect (LATTE): Screening tool for the impact of semantic threat in speech processing after a brain injury

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Recent papers from the lab [1,2] have presented a set of validated lexical and spoken sentences to test for the ability of persons with brain injury to process emotions in spoken communication. It is suggested that an unbalanced processing of emotions after brain injury might engender difficulties in communication. This study focuses on the impact of one spoken emotion, threat, on linguistic/cognitive processing, presenting the Linguistic Acoustic Threat Effect (LATTE). This test can be used to screen for a specific response to semantic threat as a possible source for communication difficulties in persons with acquired brain injury (ABI). The associated set of stimuli is available to researchers and clinicians (Supplementary Appendix).

Background

Reduced ability to interpret emotions in spoken communication following ABI has a negative impact on their quality-of-life. Previous papers have suggested assessing emotion-identification difficulties in speech (EID) as a path for rehabilitation. This study focuses on the specific impact of spoken threat words (negatively emotionally charged words [3]) on communication, as they may be processed differently in persons with ABI, due to changes in neural networks dedicated to emotion processing.

Printed threat words have been found previously to impede cognitive processing, using the Emotional Stroop Effect with healthy participants [3] and to a larger extent with ABI participants [4]. Spoken threat semantics can impact daily communication as well. For example, hearing the threat word 'death' could slow down performance, because the threat content will generate a vigilance response that will interfere with ongoing cognitive processing [3]. Only a handful of studies tested the impact of spoken threat semantics and these paradigms might not be appropriate for use with ABI: (a) threat words used were less frequent than the neutral ones, biasing responses, especially in ABI populations; (b) threat words were presented together in a single block, rather than assessing the impact of a single word.

The Linguistic Acoustic ThreaT Effect (LATTE) task is very different. Listeners are asked to monitor for the presence of certain phonemes in spoken threat and neutral words. For example, when asked to monitor for the phoneme /duh/, the spoken threat word 'death' designates a phoneme-present response. Phoneme detection is based on both the sensory input and the processing of the lexical-semantic code (top-down). The latter is reinforced because listeners are uncertain about the location of the phoneme in the word [5]. An interference from semantic threat will trigger longer and less accurate responses reflecting the impact on cognitive/linguistic processing. The next section presents the stimuli and data from healthy adults to be used as a baseline for the performance of persons with ABI in future studies.

Testing LATTE with baseline population

Participants

Sixty-seven University of Toronto students (18–25 years old) participated. All were native English speakers, as assessed by a self-report and a vocabulary test (Mill-Hill), had pure-tone air-conduction thresholds within clinically normal limits in the 0.25–3 kHz range in both ears (≤ 20 dB HL) and had no indication of head trauma or CNS diseases.

Stimuli

Two sets of words, 12 threat and 12 neutral, were selected based on their ratings on valence and arousal with a group of 88 native English speakers [1]. General, rather than ABI-specific, threat words were used to generate a baseline with healthy participants. The Supplementary Appendix indicates

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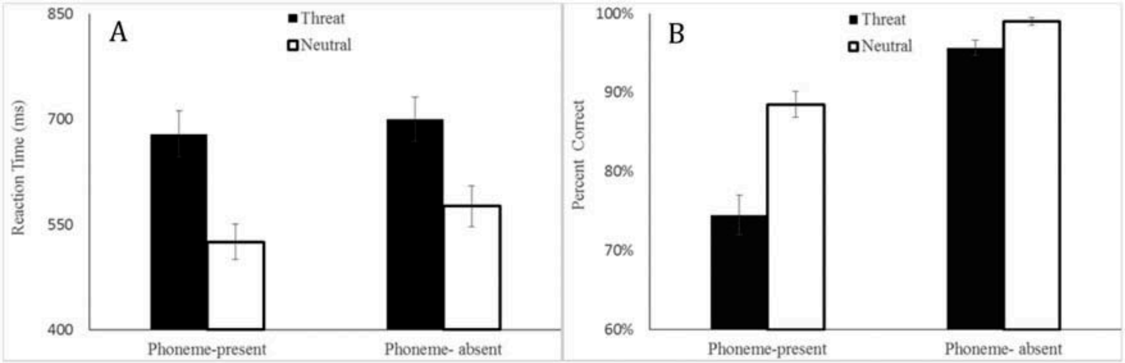

Figure 1. Average latencies (*a*, including only correct responses) and accuracy (*b*) for the LATTE paradigm.

that words were equated across categories on lexical characteristics. The 24 words were digitally recorded (at a sampling rate of 24 414 Hz) by a female native English speaker, spoken with a neutral tone of voice. The choice of recorded stimuli was based on clarity of speech, as assessed by native-English speakers. The final set of spoken words was equated on average duration and root mean square intensity.

A target phoneme was chosen for each spoken word, such that half of the threat and half of the neutral words were designated as phoneme-present trials and the other half as phoneme-absent. Target phonemes and their position in the word (beginning, middle and end) were counterbalanced across semantic categories and responses. A trained speech-language pathologist verified that the chosen phonemes in the spoken stimuli were clear and unambiguous.

Procedure

The task comprised one block of 24 trials, intermixing 12 threat and 12 neutral words. Participants were asked to listen carefully to the spoken words and monitor for the presence of a target phoneme that varied from trial to trial by pressing the appropriate key. Each trial began with the experimenter reading aloud the designated target phoneme, after which the recorded word was played to them. Participants were encouraged to respond as soon as they detected the phoneme and were reminded that the designated phoneme may appear any time during the spoken word or may not appear at all. The trials were self-paced. Experimental blocks were preceded by three practice trials with feedback.

Results

Figure 1 presents average latencies (Figure 1(*a*)) and accuracy (Figure 1(*b*)) across conditions. It is clear to see that spoken threat words delayed responses (latency: 689 vs 550 ms; $F(1,65) = 117$, $p < 0.001$, $\eta_p^2 = 0.64$) and generated more mistakes (accuracy: 85.1% vs 93.7%; $F(1,65) = 27.8$, $p < 0.05$, $\eta_p^2 = 0.30$) than neutral ones. Note, these effects are evident both in phoneme-present and phoneme-absent conditions.

Discussion

This study presents a new paradigm, LATTE, where participants are asked to monitor for the presence of phonemes in spoken threat and neutral words. The data suggest that healthy listeners were not able to avoid processing the threatening semantic content of spoken words, when monitoring for phoneme presence. Note that threat-related effects occurred, even on target-absent trials (where no target phoneme was present in the spoken word), emphasizing that the effect of threat was general across all stimuli and robust.

Results suggest that semantic threat may have an impact on speech communication. Namely, listening to continuous speech requires a rapid update of incoming information. Correct processing of the spoken message may be hindered by the impact of the threatening semantics of a single spoken word, even with healthy adults, as it was found to delay performance by ~ 150 milliseconds and reduce the accuracy for identifying the phonemic makeup of a word by ~ 10%. It is argued that LATTE can be used to screen for potential difficulties in everyday spoken communication, when threat words are spoken in a sentence alongside neutral ones.

These data should serve as a baseline for the assessment of the performance of individuals with ABI using the same task. The stimuli for the test are available in a Supplementary Appendix. It is suggested that an increased threat-related effect for individual(s) with ABI may present additional explanations to the difficulties they experience in spoken communication and, especially, spoken emotions. The current literature has stressed the importance of locating the potential sources of these problems in ABI, deeming this an ‘urgent priority’ given the negative impact that it has on the quality-of-life of individuals with ABI [6]. If future planned studies demonstrate a difference in the extent of this effect in ABI patients, the addition of the LATTE to the arsenal of tools available for clinicians and researchers can serve to provide client-targeted assessment and rehabilitation.

Given the success in which this study was able to trigger a reliable short-term threat-related effect, one can foresee employing LATTE for populations beyond ABI. For example, the threat-related effect may have unique implications for older adults, given age-related sensory and cognitive changes, specifically in adverse listening conditions [7]. Future research is needed to test these predictions.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

Supplementary Material

A folder containing 24 digital audio files (WAV) is available on the publisher's website. The Appendix also holds Table I, that details the characteristics of the 24 words.

References

1. Ben-David BM, Thayapararajah A, Van Lieshout PHHM. A resource of validated digital audio recordings to assess identification of emotion in spoken language after a brain injury. Brain Injury 2013;27:248–250.
2. Ben-David BM, Van Lieshout PH, Leszcz T. A resource of validated affective and neutral sentences to assess identification of emotion in spoken language after a brain injury. Brain Injury 2011;25:206–220.
3. Algom D, Chajut E, Lev S. A rational look at the emotional Stroop phenomenon: a generic slowdown, not a Stroop effect. Journal of Experimental Psychology: General 2004;133:323–338.
4. Coates RC. Use of the emotional stroop to assess psychological trauma following traumatic brain injury. Brain Injury 2008;22:353–360.
5. Frauenfelder UH, Segui J. Phoneme monitoring and lexical processing: Evidence for associative context effects. Memory & Cognition 1989;17:134–140.
6. Henry JD, Phillips LH, Crawford JR, Theodorou G, Summers F. Cognitive and psychosocial correlates of Alexithymia following traumatic brain injury. Neuropsychologia 2006;42:133–141.
7. Ben-David BM, Chambers CG, Daneman M, Pichora-Fuller KM, Reingold EM, Schneider BA. Effects of aging and noise on real-time spoken word recognition: evidence from eye movements. Journal of Speech, Language, and Hearing Research 2011;54:243–262.