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Painful Moan or Erotic Groan: Top-down Influence on the Emotional Response to Sounds

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Abstract

The present study tested the effects of top-down processing, in particular the influence of contextual knowledge, on the emotional interpretation of sounds. This was done through a study on the affective priming of auditory stimuli. Eighteen sounds from the International Affective Digitized Sounds (six positive, six negative, and six neutral) were played in three different framing-label conditions. The positive condition displayed an emotionally positive label preceding each sound, the negative condition displayed an emotionally unpleasant label, and the neutral condition displayed letter labels. The current study chose to examine the effects of top-down processing by examining both implicit and explicit measures of emotional response. Electrodermal activity and facial muscle activity were recorded in order to measure the physiological responses to each label-sound pair as a means of investigating implicit responses. Participants also provided their ratings of each sound's valence and arousal in order to measure explicit emotional responses. It was hypothesized that participants would exhibit physiological responses typically evoked by pleasant stimuli (e.g., increased zygomaticus activity) in the positive label condition, and responses typically evoked by unpleasant stimuli (e.g., increased corrugator activity) in the negative label condition, both regardless of sound valence. This study found both sound type and label type to have a significant effect on participants' ratings on valence, but not on their ratings of arousal. There was, however, a significant interaction of sound type and label type on both valence and arousal. In regards to physiological measurements, sound type had a significant effect on zygomaticus activity, but not on electrodermal activity or corrugator activity. Label type did not produce a significant effect for facial muscle activity or electrodermal activity.

1. Introduction

The James-Lange theory of emotion proposes that emotions are the physiological changes that occur in response to stimuli (Pastorino et al., 2010), thus measuring emotion is a matter of measuring responses such as fluctuation in heart rate or skin conductance and facial muscle movements. The theory of unconscious inference suggests that the perception of a stimulus relies, in part, on information the observer gathers from the environment. A single stimulus may be perceived in multiple ways based on the observer's prior knowledge and the information they gather from the environment (Goldstein, 2011). When the processing of a stimulus begins with information gathered directly from the stimulus it is known as bottom-up processing and when it begins with prior knowledge it is known as top-down processing. When sensory input is ambiguous, top-down processing allows intent and content to have an influence on perception, contributing information and filling in any informational gaps in the stimulus (Sussman et al., 2002). It has been shown in prior studies (e.g., Lang et al, 1993; Sussman et al, 2002) that top-down influence has the ability to alter experience, perception, behavioral responses, and the organization of stimulus representation in the brain. Expanding on earlier research, this study examined the impact of top-down processing on emotional responses by priming auditory stimuli with affective labels. Eighteen sounds from the International Affective

Database of Sounds 2nd edition (IADS; Bradley et al., 2007) were each primed with labels of differing degrees of attractiveness, categorized as positive, negative, or neutral in valence. The effects of the affective priming on the emotional interpretation of these auditory stimuli were assessed by examining two types of emotional responses; implicit responses, which are unconscious and uncontrollable, and explicit responses, which are conscious and subjective (Gyurak, 2011).

The present study chose to use facial electromyography (EMG) and electrodermal activity (EDA) as a means of measuring implicit emotional responses. Research suggests that certain emotional states tend to correlate with particular emotional facial expressions (Dimberg, 1990; Jancke et al., 1996; Bradley et al., 2000), thus facial EMG is used in the measurement of emotional valence. Facial EMG is able to detect very minor muscle movements that occur as a result of even the slightest facial expression (Dimberg, 1990). Facial expressions of negative emotion, such as those that would occur after perceiving an unpleasant stimulus, tend to exhibit a strong contraction of the corrugator muscle, which pulls the eyebrows together in a furrow. The zygomaticus major muscle, which controls one's ability to raise the corners of their lips and smile, displays an increase in activity when a pleasant stimulus is perceived and a positive emotional response is evoked (Jancke et al., 1996).

Previous research has demonstrated that EDA functions as a reflection of emotional response, more specifically arousal, and that significant skin conductance response (SCR) occur as a reflection of varying levels of arousal which occur in response to auditory stimuli, such as music (Andreassi, 2011). For this reason, the current study used EDA to measure arousal levels, and then compared these data with participants' ratings of arousal.

The current study hypothesized that top-down processing should allow for the description of an affective auditory stimulus to influence the emotional response it prompts. When an auditory stimulus is described using pleasant labels, it should elicit physiological responses similar to those produced when perceiving pleasant stimuli. When the same auditory stimulus is labeled with an unpleasant description, it should prompt a physiological response typical of unpleasant stimuli. The main objective of the present study is to evaluate the role of top-down processing in the perception of affective stimuli in order to better understand the extent to which context can influence perception, and with it, emotional response.

2. Methodology

2.1 Participants

Thirty-six undergraduate college students from the University of North Carolina at Asheville were recruited to participate in this experiment. Students may receive partial course credit for their participation.

2.2 Stimuli

The current study used eighteen sounds from the International Affective Database of Sounds 2nd edition (Bradley et al., 2002), which were deemed by the researchers as ambiguous enough to allow for multiple interpretations. The study was a 3x3 mixed design in which label condition was the within-participants factor and consisted of three conditions; positive displayed only positive primes (e.g., *woman enjoying sex*, *Wonka's chocolate fountain*); neutral displayed only neutral primes (e.g., *sound E*); and negative displayed only negative primes (e.g., *vomiting*, *stomach pain*). The between-participants factor was sound valence and consisted of three sound types; positive, negative, and neutral. All sounds were played once in each of the three label conditions. A complete descriptions of sounds from IADs can be seen in Figure 1.

IADS 2 Sound ID	Sound Description	mean valence	mean arousal
721	beer	6.71	5
221	Male Laugh	6.65	5.05
205	EroticFem3	6.47	6.46
377	rain1	5.84	3.93
210	EroticMale1	5.72	6.64
204	EroticFem4	5.68	6.82
728	paper1	4.72	4.35
245	hiccup	4.18	5.05
243	Couple Sneeze	3.86	5.19
910	electricity	3.86	6.18
699	bomb	3.59	6.19
134	rattlesnake	3.55	6.98
730	Glass Break	3.22	6.23
289	gunshot	3.06	6.57
501	Plane Crash	2.74	6.93
244	Man Wheeze	2.44	6.31
255	Vomit	2.08	6.59
276	FemScream2	1.93	7.77

Figure 1. List of sounds from the IADS with description and original mean valence and arousal ratings.

2.3 Recording Methods

Facial EMG and EDA data were acquired using a Biopac MP36 data acquisition unit and Biopac Student Lab System software (BSL 3.7.3). For EDA recording, two EL507 electrodes were attached to the subject's middle and index finger on the subject's non-dominant hand and connected to the data acquisition unit using the SS57L lead. Isotonic electrode gel, Biopac gel 101, was applied to electrodes in order to increase conductance.

Facial EMG activity will be recorded over the corrugator muscle and zygomaticus major muscle using Ag-AgCl electrodes and a standard electrolyte gel (Biopac Gel 100) which aids in conductance. Electrodes were connected to the data acquisition unit using SS1LA electrode leads. Two electrodes were placed above the left eyebrows, and two were placed just above the jaw bone on the left side. The first eighteen participants were run using the EDA leads as grounds, but the following participants had an additional electrode attached to their forehead which acted as the ground. This procedural change was an effort to reduce impedance but does not discount the previous data.

2.4 Procedure

Data was collected in a sound-attenuated booth (WhisperRoom). After completing the informed consent, participants were attached to the physiological sensors. Participants were provided with details on how to use the SAM to rate sounds given a wireless handheld keyboard for entering responses. Each of the eighteen trials began with a label (determined by condition) for the following sound, which was displayed for approximately 2000ms. Then a fixation cross was displayed during the presentation of the auditory stimulus in order to direct participants' focus toward the stimulus. The fixation cross and auditory stimulus were presented for 4000ms. After the stimulus was presented, the SAM scale for valence was displayed until a response was keyed in, at which point the scale for arousal was displayed until a response was received. Ratings ranged on a scale of 1-9, with 1 representing a low rating (e.g., *calm*, *unhappy*) and 9 representing a high response (e.g., *aroused*, *happy*). There was a brief delay of 3000ms in between trials of the experiment. After all eighteen trials played, participants were disconnected from equipment, debriefed on the experiment, and thanked for their participation.

2.5 Analysis

Raw EDA was initially filtered in Biopac, using FIR low-pass filter of 1 Hz with the number of coefficients set at 4000 and an IRR high-pass filter set at .01 Hz, and then it was exported to Matlab for further processing. SCR was evaluated by taking the average peak amplitude within an 8-second epoch from 1s pre-stimulus onset (baseline) to 8s post-stimulus and the log of max values (log (SCR +1)) for responses greater than 0.05 micro Siemens were then used in analysis. Facial EMG data was exported from Biopac to Matlab for further processing and was evaluated using the integrated values and the average peak amplitude within a 1-second pre-stimulus to 6-second post-stimulus epoch. In testing for the main effects of sound type, values were averaged across all six exemplars for each sound type.

3. Results

3.1 Affective Ratings

3.1.1 valence ratings

A 3 (positive label, negative label, neutral label) x 3(positive sounds, negative sounds, neutral sounds) mixed-design ANOVA was performed on the data gathered from participants' ratings on valence. The main effect of sound type on valence ratings (Figure 2a) was significant (F (2, 33) = .25, p<.01), and the main effect of label condition on valence ratings (Figure 2b) was also significant (F (2, 33) = 3.869, p=.031). In addition, there was a significant interaction of sound type and label condition for valence ratings (F (2, 33) = 9.854, p<.01) (Figure 3).

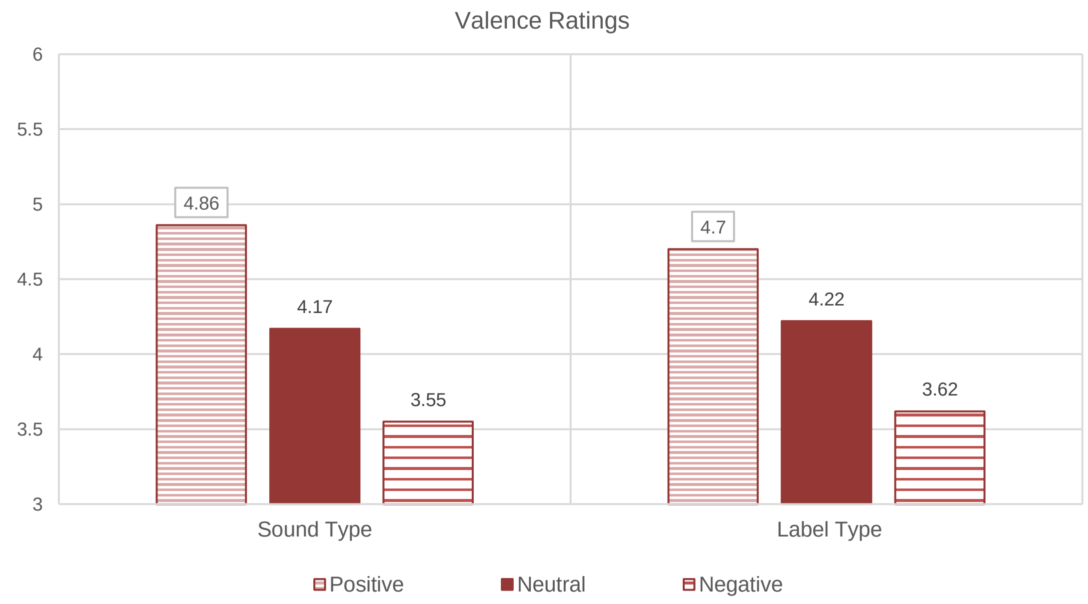

Figure 2. (a) The left side of the graph represents mean ratings of valence, collapsed across sound types and exemplar and (b) the right side represents valence ratings by label condition.

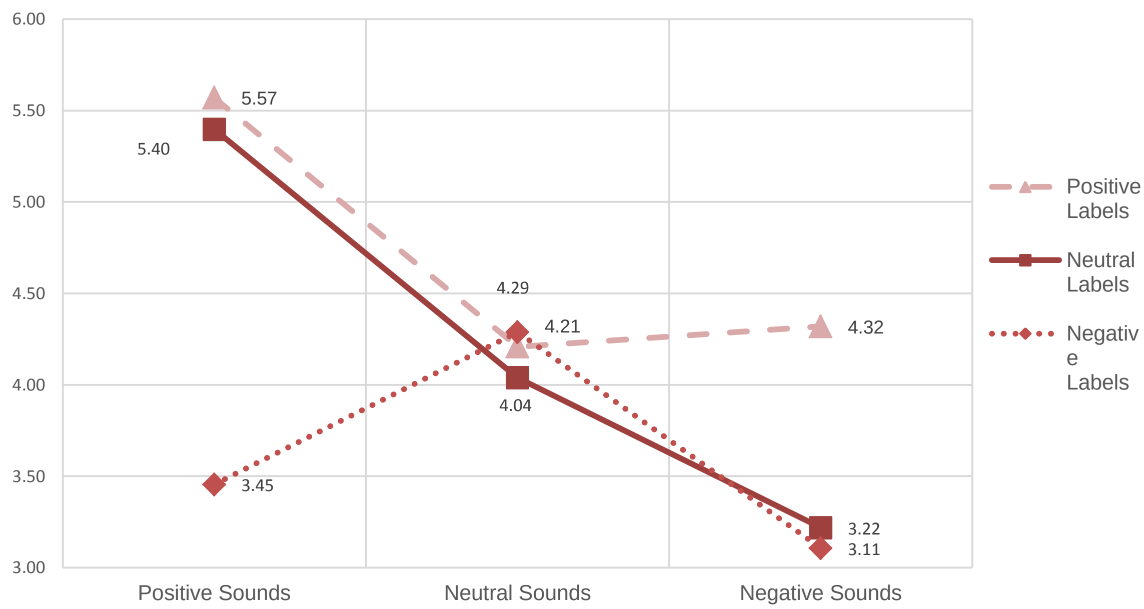

Figure 3. Interaction of sound type and label condition on valence ratings.

Figure 3 Participants' ratings of valence by sound type, collapsed across sound exemplar, and label condition. Negative sounds with negative labels were rated by participants' as being the most unpleasant, and positive sounds with positive labels were rated as most pleasant.

3.1.2 arousal ratings

A second 3 (positive label, negative label, neutral label) x 3(positive sounds, negative sounds, neutral sounds) mixed-design ANOVA was performed on the data gathered from participants' ratings on arousal. The main effect of sound type on ratings of arousal (Figure 4a) was not significant (F (2, 33) = .67, p=N.S.). The main effect of label condition on ratings of arousal (Figure 4b) was also not significant (F (2, 33) = .003, p= N.S). There was, however, a significant interaction between sound type and label condition on participants' ratings of arousal (F (2, 33) = 2.713, p=.037) (Figure 5).

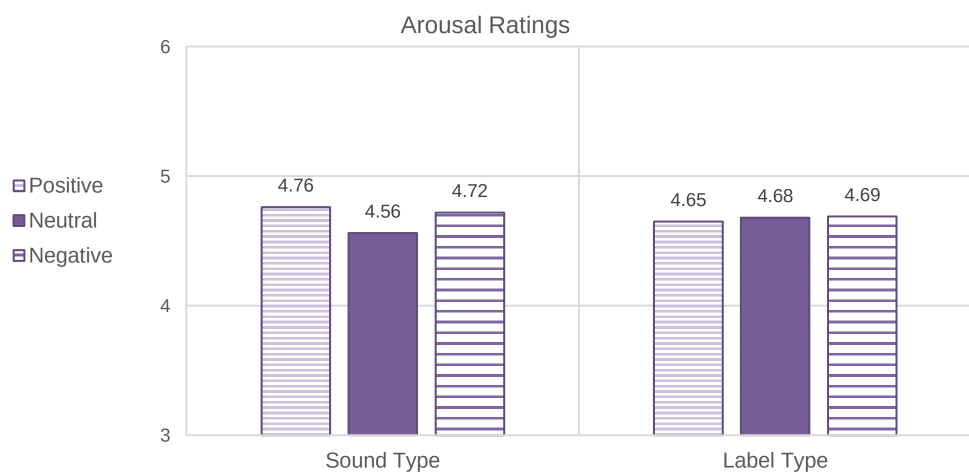

Figure 4(a) the left side of the graph represents mean ratings of arousal, collapsed across all sound types and exemplar; 4(b) the right side of the graph represents mean ratings of arousal, collapsed across label condition.

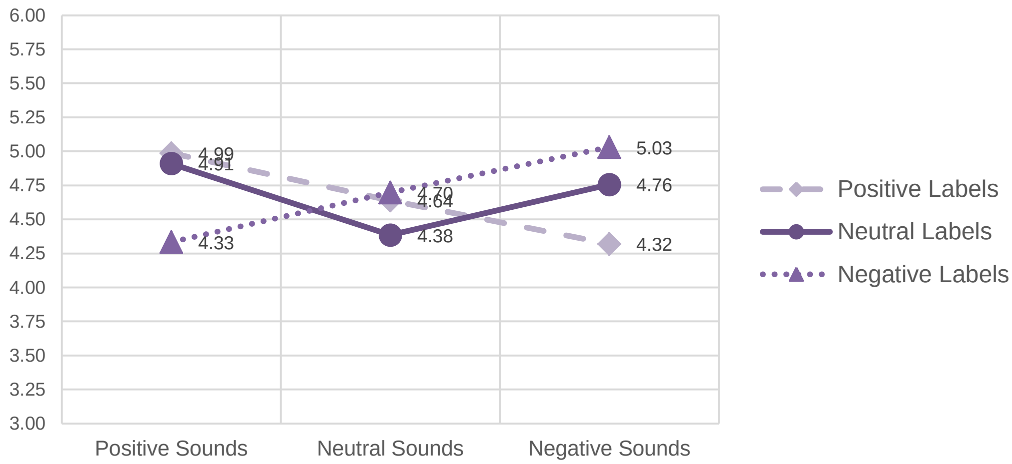

Figure 4. Interaction of sound type and label condition on arousal ratings.

Figure 4 Participants' ratings of arousal by sound type, collapsed across sound exemplar, and label condition. Negative sounds coupled with negative labels were rated as the most arousing, followed by positive sounds with positive labels. Negative sounds with positive labels were the least arousing, followed closely by positive sounds with negative labels.

3.2 Electrodermal Activity

A 3(positive label, negative label, neutral label) x 3(positive sounds, negative sounds, neutral sounds) mixed-design ANOVA was performed on the log of max SCR values (log (SCR +1)) for responses greater than .05 micro Siemen. The main effect of sound type on SCR was not significant (F (2, 26) = .580, p=N.S.). The main effect of label condition on SCR was also not significant (F (2, 26) = .083, p= N.S).

3.3 Facial Electromyography

Two 3 (positive label, negative label, neutral label) x 3(positive sounds, negative sounds, neutral sounds) mixed-design ANOVA were performed on facial EMG data; one ANOVA for corrugator EMG and another for zygomaticus EMG.

There was a marginal effect of sound type on corrugator EMG (F (2, 24) =2.854, p=0.067), but the main effect of label on corrugator EMG was not significant (F (2, 24) =2.341, p=N.S) (Figure 5a). The main effect of sound type on zygomaticus activity was significant (F (2, 24) = 4.170, $p<.05$), though the main effect of label on zygomaticus activity was not significant, (F (2, 24) =4.572, p=N.S) (Figure 5b).

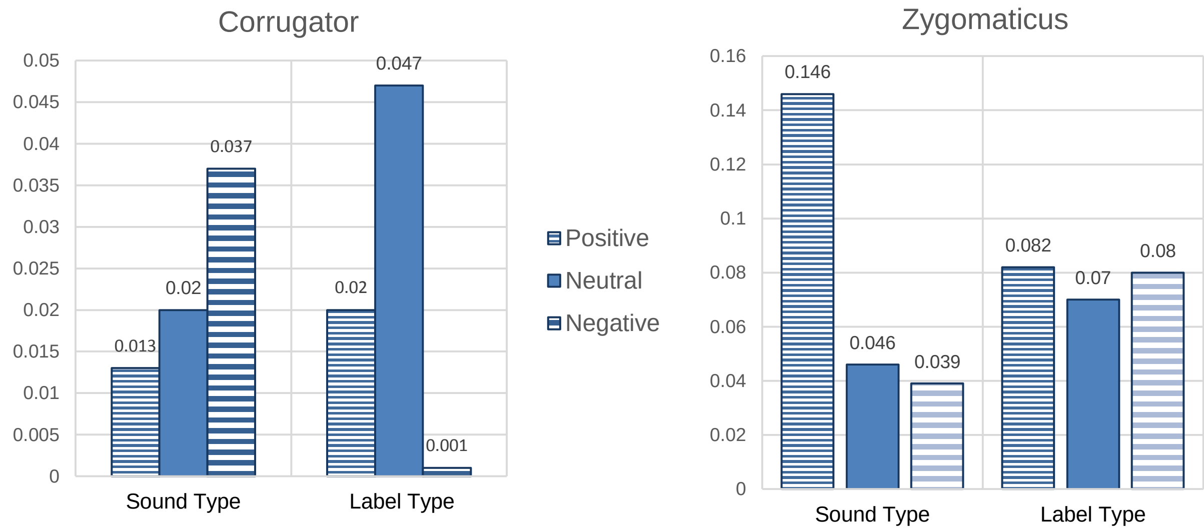

Figure 5. (a) On the left, the main effect of sound type and label type on corrugator facial EMG values. On the right (b), the main effect of sound type and label type on zygomaticus facial muscle EMG values.

4. Discussion

The goal of this study was to examine the effects of top-down processing on emotional responses to sounds. This was done through an affective priming experiment that manipulated emotional responses to auditory stimuli by presenting a text label before each sound. The current study examined both implicit and explicit emotional responses in order to explore any differences in participants' believe their emotional responses are and what their physiological data say about their emotional responses. To measure explicit, or conscious, emotional responses, participants' ratings of arousal and valence were collected using the SAM (Bradley et al., 1994); to measure implicit, or subconscious, emotional responses, the this study measured facial EMG and EDA. It was hypothesized that the labels, designed to frame the sound as positive, negative, or neutral, would alter the response, explicit or implicit, to reflect the valence of the label more so than the pre-established valence of the sound. Corrugator muscle activity was hypothesized to be greatest in the negative label condition and lowest in the positive label condition. Zygomaticus major muscle activity was hypothesized to be greatest in the positive label condition and lowest in the negative label condition. Arousal was generally higher for stimuli that are either negative valence or positive valence, and neutral stimuli provoke low levels of arousal.

4.1 Affective Ratings

Label condition had a significant effect on participants' ratings of valence; when sounds were played in the positive label condition, they were rated most pleasant and when played in the negative condition, sounds were rated most unpleasant. This trend confirms that the valence of a framing message can affect the perception of an affective auditory stimulus. Independently, both the label condition and the sound type had a significant effect on participants' conscious emotional reactions to the stimuli. Sounds were rated higher in valence when preceded with a positive label, and lower in valence when preceded with a negative label.

Regardless of label, positive sounds were rated highest in valence and negative sounds were rated lowest. There was also a significant interaction of sound type and label condition on participants' ratings of arousal and valence. This could imply that primes, such as labels, work in tandem with stimuli, in this case sounds, in the evocation of emotional response. Arousal ratings, though differing from their pre-established ratings, were not significantly affected by label condition or sound type. When looking at arousal ratings by label condition, arousal levels were relatively unchanged between the three conditions and the difference in arousal ratings between sound types was relatively small as well.

4.2 Electrodermal Activity

The current study failed to find any significant effects of sound type or label condition on skin conductance responses. SCR was not significantly affected by sound type; however, positive and negative sounds were rated as more arousing than neutral, which as mentioned before, has been the trend in previous studies (Bradley et al., 2000). A similar trend would have ideally been observed in the label conditions; however, the negative label condition yielded the greatest responses, followed by neutral, then positive. The inability of this study to produce significant effects of sound type or label condition on physiological measures of arousal as well as conscious ratings of arousal suggests that arousal may be more difficult to manipulate.

4.3 Facial EMG

Regardless of the valence of the framing message, peoples' physiological emotion responses will be reflective of the valence of the stimuli. There was not a significant effect of label on facial muscle activity or skin conductance responses. This suggests that the study was successful in manipulating participants' explicit responses in regards to valence but unsuccessful in manipulating their implicit responses. Though physiological responses were not affected by label condition, there was a significant effect of sound type on the zygomaticus EMG. Following the previously established trend (Bradley et al., 2000), positive sounds elicited the greatest zygomaticus muscle activity and negative sounds provoked the least. This suggests that the zygomaticus muscle will activate in response to sound valence, regardless of the valence of framing messages.

In a previous study which used facial EMG to evaluate affective responses to sounds (Bradley et al., 2000), corrugator activity was greater overall than zygomaticus activity. In the current study, however, the zygomaticus muscle displayed greater activity than the corrugator muscle. It is possible this difference is a result of the labels being ill-fitting for the sounds they were assigned to, or participants found these labels entertaining and thus smiled or laughed. This experiment did not find any significant effects of sound type or label on the activity of the corrugator muscle, though looking at corrugator EMG in terms of sound type, negative sounds elicited the most activity and positive sounds provoked the least, which is a trend that has come to be expected for the corrugator muscle.

5. Conclusion

The results of the current study suggest that explicit emotional reactions can be reflective of bottom-up processing, or the valence of the stimuli, as well as top-down processing, or the valence of the label. The labels may have been unsuccessful in manipulating emotional responses due to errors in the process of designing and assigning labels. Labels were chosen based on the researchers' beliefs that they would be reflective of different valences, though the labels were not tested on whether they fulfilled these criteria before being applied to sounds.

One concern of the present study is whether negative and positive labels used for the same sound were congruently evocative, in that "*Willy Wonka's chocolate fountain*" may not be as evocative as "*vomit*." Further research into the affective response to text and vocabulary would be necessary in order to ensure that labels are representative of their intended valence. It's possible that the sounds chosen for this experiment were not ambiguous enough to allow for multiple interpretations for each sound. A number of participants mentioned that the sounds might have had a greater impact on arousal had they been played through headphones rather than speakers. This may have impacted participants' ratings of arousal as well as their SCR. Experimental design for future studies should include a more precise measurement of sound volume and could benefit from using headphones.

6. References

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