Do human screams permit individual Recognition? - Replication

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ABSTRACT

The replication seeks to provide some insight into whether nonlinguistic vocalizations, such as screams, are able to aid humans in identifying individuals based solely on their screaming patterns. Participants were asked to distinguish vocalizers after listening to two recordings. Response accuracies and discriminability indices were calculated to check for scream receptiveness. We also interpreted d' scores in order to break down response errors and accuracy for each participant. According to our findings, the majority of listeners were able to distinguish individuals based on their screams.

The replication also focused on results derived from vocalizer gender differences. By analyzing the varying mean response latencies created by male and female vocalizers, we were able to interpret how well humans are at discriminating against each gender's screams. The goal of this project is to further our understanding of the evolutionary purpose behind screams and to provide further insight into how screams are related to an individual's identity.

Keywords: nonlinguistic vocalization, response accuracy, vocalizer, screaming patterns

INTRODUCTION

The main purpose behind this research was to determine whether humans are capable of identifying others through their screams. Our hypothesis is that screaming can be used to identify individuals and gender influences this identification process. Information on this topic is useful because it could demonstrate how screams are able to provide humans with certain evolutionary advantages that ensure survival at a young age. Although not much is known about gender influence on scream recognizability, analyzing its role in the identification process is important to learn about possible social and scientific implications.Therefore, we conducted additional analyses to test whether the gender of the vocaliser as well as the listener influences the accuracy of the identification. As screaming carries evolutionary advantages to species and can have a role in many fields including but not limited to forensic science, this research plays an important role to determine how screams play a role in identity recognition.

1. Evolutionary reasons behind scream discrimination

A parent could be at a park with their child. They wait by a bench while their child goes off to the playground. With other kids being loud and screaming, a parent can usually still recognize their child yelling, either from playing or from pain. Although this scenario is anecdotal, studies have shown that parents are prone to react to their child's screams. Research has determined that parents are able to discriminate the vocalizations of their children from those of others. Infants were used in a study to see if parents were able to recognize their own child amongst others based on acoustic cues. It was found that the majority of parents, both fathers and mothers, were able to accurately single out sounds that pertained to their own children (Green &

Gustafson, 1983). Although empirical research on this topic is not abundant, Green and Gustafson's findings provide insight into how this ability might translate to human screams, as an infant's cries can be compared to adult screams since they both indicate urgent need and danger, respectively. It has also been concluded that screams with higher duration and pitch are more emotionally significant than screams with lower duration and pitch, thus showing that screams that portray more negative emotions such as anger and fear tend to receive more attention from listeners (Schwartz, 2019). This study also mentioned that longer screams were perceived to be more intense and the scream pairs which showed greater differences in duration showed more accurate identification of vocalizer identities. Other studies have shown that being able to recognize intense vocalizations is key in the development of parental attachment to their children (Gustafson et al., 2013). Such findings indicate that screams play a role in bonding, thus explaining the reason behind their evolutionary significance and their disposition to being recognizable. The Schwartz study and the Gustafson et al. study might be hinting at why there might have been differences in accuracies in the replication depending on the type of scream since some were more intense than others, which means that more emotional screams produced higher recognizability from an evolutionary perspective.

2. Gender differences in scream recognition

There has been a wide variety of responses regarding the effect that gender has on recognizing human vocalizations. When looking at whether both female and male parents are able to recognize their child's screams, it has been determined that mothers have the tendency to be better at accurately being able to identify their child's screams. However, studies that look

closely into the distinction between the ability of females and males to recognize identities from screams are rare.

3. Distinctions between human sounds

Stable indicators of a person's identity seem to be missing from laughter and whispers, but screams seem to be more recognizable due to their emotional valence (Lavan et al., 2018b). This study shows that there are other forms of vocalizations that are able to help individuals decipher speaker identity, despite them not being as impactful as screams. There was also evidence that showed that spontaneous vocalizations were not encoded efficiently by listeners compared to vocalizations that had an intent (Lavan et al., 2018b). Spontaneous laughter and other vocalizations other than screams are important in that they provide some insight on why screams might be more reliable when trying to identify a person because these can be broken down more clearly into specific tones and the contexts in which they happen. One study was able to show that screams, yelling, whining, and other vocalizations have distinct acoustic features (Green et al., 2011). This indicates that sounds produced by screams are easier to identify since they have specific features that can help categorize people into groups listeners can recognize.

4. The Present Study

The current study replicates and provides new evidence regarding the recognizability of screams using data collected and published by Engelberg, Schwartz, and Gouzoules (2019). In Engelberg et al.'s (2019) original study, participants were presented with and asked to distinguish between pairs of scream recordings that were either from the same vocalizer or two

different vocalizers. The ability to identify vocalizers was operationalized in two ways: response accuracy and response latency.

Response accuracy measures how many times a participant accurately distinguished between the two cases and response time is defined as how long the participant took to decide his case choice. Both these variables are used to show if the gender of vocalizer and screamer is a variable that influences the recognition ability of people by using screams.

METHODS

1. Participants:

A pool of 104 college students (73 females, 41 males) from Emory University were gathered for this study. Students were between the ages of 17-41 years (M = 19.53, SD =2.48). All students were recruited through an online portal system. Individuals who signed up for the experiment received class credit.

2. Stimuli:

Vocal recordings were taken from a variety of entertainment outlets such as movies and television shows, and some social media sources. Some video recordings were edited when it was necessary in order to make the scream more transparent for the listener (i.e. removing the background music from a screaming scene). These audio files were compressed into 16-bit 22.05 kHz WAV files by using Adobe Audition CC. The lengths of certain audio files were converted to a range of 50% to 150% of its original length using Adobe Audition for the duration modified trials. The audio files created consisted of 41 female vocalizers and 17 male vocalizers.

3. Procedure:

Participants were asked to listen to pairs of vocal recordings of screams, and then decipher if the pair of screams originated from the same person or two different people. Thus, each pair of screams presented to participants either showcased the same vocalizer twice or two different vocalizers. Each pair of screams was separated by 2000 milliseconds of silence.

The experiment contained two types of stimuli of a scream and were subsequently tested in different pairings to participants. One type of stimuli tested the same vocalizer for a round while the other tested a different vocalizer for another round. There are several duration modified trials where it's the exact same scream played twice but with the second version artificially lengthened or shortened. The duration modified trials are a version of the same vocalizer trials, but instead of two different screams from the same person. Therefore, the same vocalizer and duration modified trials are treated as one type of trial in the replication analyses.

In total, the experiment contained 60 pairs of screams: 24 different vocalizers, 24 of the same vocalizers, and 12 duration modified vocalizers. Duration and same vocalizer trials contained scream pairs that originated in the same vocalizer. All participants heard the same 60 pairs of screams, but trial order was randomized. However, during data analysis researchers found a duplicate pair of the same vocalizer and a duplicate pair of different vocalizers in the study. Thus, duplicated audio files were omitted and the study utilized 58 different stimuli pairs (23 different vocalizers trials, 23 same vocalizers trials, and 12 duration modified trials). The 41 female vocalizer tapes and the 17 male vocalizer tapes were appropriately distributed into the trials. Female audio tapes involved 16 same vocalizer pairs, 15 different vocalizer pairs, and 10 duration modified pairs. Male audio tapes consisted of 7 same vocalizer pairs, 8 different

vocalizer pairs, and 2 duration modified pairs. Researchers gathered data on response accuracy via a serial response box that allowed participants to select "same" or "different". The duration that it took for participants to select a correct answer was recorded as response latency.

4. Data preparation

Response accuracy and discriminability indexes were calculated for each participant and by gender of either the vocalizers or the screamers as well. The discriminability index (d') is a parameter used to measure the sensitivity a participant has to distinguish between two stimulus groups. It is a preferred measurement of accuracy to the response accuracy as it takes into account both response bias and unbalanced groupings. The discriminability index was found by calculating the difference between the Z-transformed Hit Rate and the Z-transformed False Alarm Rate. A hit occurs when a participant correctly identifies that two vocalizations originated from the same individual (i.e., responding "Same" when the correct answer is "Same"). On the other hand, if the participant incorrectly states that two vocalizations originated from the same individual (i.e., responding "Same" when the correct answer is "Different"), a false alarm would occur. To obtain data on the Hit Rate, the total number of accurate responses for the same vocal pairs and duration modified pair trials was summed and then divided by the total number of trials where the same vocalizer emitted both screams (i.e., 36 total trials). For data on the False Alarm Rate, the total number of inaccurate responses (i.e., responding "Same") for the different vocal pairs was summed and then divided by the total number of trials where different vocalizers emitted each scream (i.e., 24 total trials). Both the Hit Rate and False Alarm Rate were then normalized against a standardized bell-curve distribution. Finally, the Z-transformed False Alarm

Rate was subtracted from the Z-transformed Hit Rate to calculate the d' score. Thus, higher d' scores indicated a higher ability to identify screams from the same vocalizer.

Response accuracy captured by d' score. Furthermore, duplicate trials and responses that were received with a response latency more than 10ms before the second scream recording ended were removed from consideration. The latter exclusion was performed because it was deemed impossible for the participant to know the identity of the vocalizer without waiting for the recording to finish. This exclusion resulted in the removal of 489 out of 6,032 available trials.

RESULTS

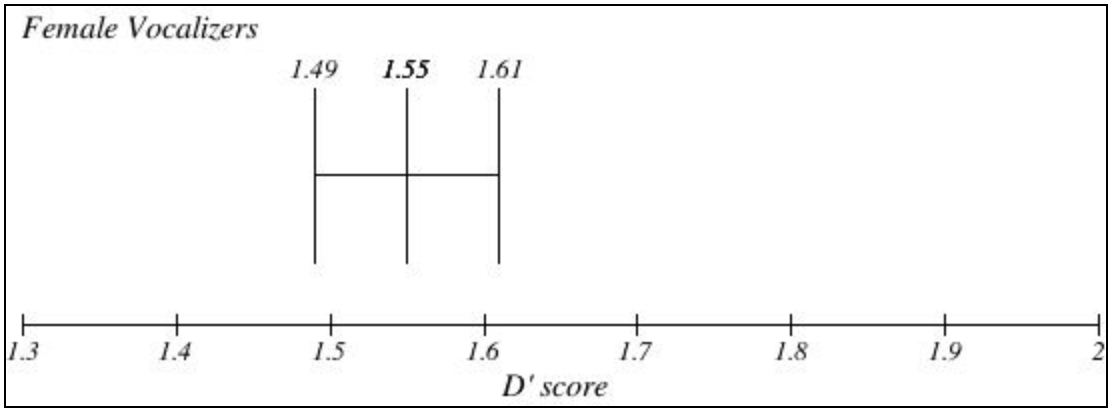

Figure 1: d' scores for female vocalizers

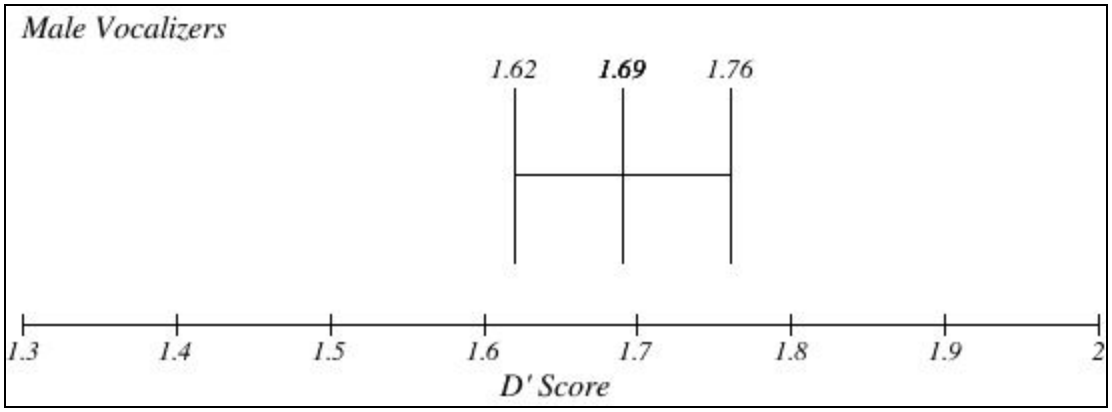

Figure 2: d' scores for male vocalizers

The replication analysis primarily focused on effects of vocalizer gender and listener gender on response latency and response accuracy, which is captured by d' score, a statistical measurement of the effect size used to find the difference between the means of two groups. A d' score value of 0 and values closer to 0 would mean that the participants could not discriminate against the same or different identities based on the scream pairs. A d' score greater than 1 indicates that there was reliable discrimination between the given pairs. The independent variables in the replication study were the gender of the vocalizer and the gender of the listener. The main dependent variable of interest was the d' score, but response latency was also taken into consideration. The sample mean for the experiment as a whole, not just including gender, was 1.63 and the SE was .06. From this it is clear that female vocalizers negatively deviated from the mean with a 1.55 average d' score, yet had the same SE (.06) (Fig. 1). Male vocalizers, on the other hand, positively deviated from this mean score with a 1.69 mean d' score, yet had a larger SE of .07 (Fig. 2).

GenderMod_rt_ANOVASTATS

	numDF	denDF	F.value	p.value
(Intercept)	1	102	475.857192534044	0
ScreamerSex_Factor	1	102	12.8438338754247	0.00052107991824335
Sex	1	102	3.42587191373527	0.0670759412092206
ScreamerSex_Factor:Sex	1	102	0.965435039763302	0.328146208354472

Figure 3: F-values and p-values computed using ANOVA to analyze effect of valizer gender on response latencies

GenderMod_dprime_ANOVASTATS

	numDF	denDF	F.value	p.value
(Intercept)	1	102	958.662216966203	0
ScreamerSex_Factor	1	102	4.25402683914883	0.0416985276291371
Sex	1	102	0.133844640248222	0.715236275772246
ScreamerSex_Factor:Sex	1	102	0.333677122237049	0.564774825179345

Figure 4: F-values and p-values computed using ANOVA to analyze the effect of vocalizer gender on d' scores

To determine whether listener and vocalizer gender are related to d' scores/response latencies, we conducted a mixed ANOVA with listener gender as the between-subjects variable and vocalizer gender as the within-subjects variable (see Figure 1). The main effect of vocalizer gender on response was significant (F-value = 12.8438, p =0.0005 < 0.001, Fig. 3), suggesting that trials with male vocalizers did elicit slow responses more than female vocalizer trials); the main effect of vocalizer gender on d′ scores was also relatively significant (F-value = 4.25, p = 0.042, Fig. 4), suggesting that listeners were better at discriminating male screams than female screams. These main effects were not qualified by a significant interaction between listener and vocalizer gender (listener gender: p = 0.715; interaction: p = 0.0.565, Fig. 4) or response latencies (listener gender: p = 0.067; interaction: p = 0.328, Fig. 3). These results suggest that there is little effect of listener gender on response latency or d' score nor is there significant interaction between listener gender on response latency and d' score.

The p value is a value indicating the likeliness of a given hypothesis, if the p value is low, the null hypothesis is rejected. If the p value is between .1 and .9 the hypothesis has been proven, in this case the hypothesis is that there is no correlation. Given that both of our p values for the d' effects on listener gender and the interaction between listener gender and vocalizer gender are both between .1 and .9 it can be concluded that neither are proven true. Furthermore, there was also no correlation in the mean response latencies for listener gender or for the interaction between listener gender and vocalizer gender, the p scores were .057 and .467. Since a score of .057 is relatively low we question the assumption of whether listener gender does not have an affect on the mean response latency, but the results are not clear.

In terms of the vocalizer, the data shows that the listeners had a higher d' score when identifying male vocalizers versus than female vocalizers, the average d' was 1.69 with a standard error of .07 (Fig. 2). This value is slightly higher when compared to the d' scores when females were the vocalizers, with an average d' of 1.55 and a standard error of .06 (Fig. 1). These results show that trials with male vocalizers had a higher mean response accuracy compared to trials involving female vocalizers.

GenderMod_rt_MEANSFORFIGURE

	ScreamerSex_Factor	Sex	emmean	SE	df	lower.CL	upper.CL
1	Female_Screamer	Female	990.676085108827	57.5679956020232	103	876.503543544858	1104.8486266728
2	Male_Screamer	Female	1099.55037170056	71.7935181991665	102	957.148268756962	1241.95247464415
3	Female_Screamer	Male	1183.57867606945	88.3408739992189	102	1008.3549713547	1358.8023807842
4	Male_Screamer	Male	1371.9057183566	110.170626558523	102	1153.38280294487	1590.42863376833

Figure 5: Impact of vocalizer gender on response latencies

Similarly, we found that vocalizer gender did significantly influence response latencies. For male vocalizers the mean response latency was 1183.58 Milliseconds (ms) with a standard error of 88.34 for female screamer and 1371.91 Milliseconds (ms) with a standard error of 110.17 for male screamer. For females the mean response latency was 990.68 Milliseconds (ms) with a standard error of 57.57 for female screamer and 1099.55 Milliseconds (ms) with a standard error of 71.79 for male screamers (Fig. 5). Trials with male vocalizers have a higher mean response latency than trials containing only female vocalizers.

DISCUSSION

The present replication study provided support for Engelberg et al.'s (2019) findings. More specifically, we found that male screams were more accurately discriminated against than the female screams, as indicated by the slightly higher d' prime score. While the original study conducted by Engelberg and his team sought to explore human screams permitting individual recognition, our results expand on this work by indicating the particular role of gender in this process of discrimination. The original study considered two possible cases: the effect of the listener's (participant) gender and that of vocalizer gender. Our initial expectation was that there wouldn't be much difference between the identification of female and male vocalizers, regardless of the listener's gender. However, with regard to the results described above, we found that male screams were more accurately distinguished by the participants as opposed to female screams.

More studies may be required to accurately deduce that in general, male voices are more easily identifiable than female voices. This does bear significance in different sectors of society,

especially relating to males and females in a workplace or any other industry. While there are multiple historical reasons contributing to sexual inequality, such evidence from current scientific research further provides a scientific perspective to this issue. For instance, past studies have found that having a characteristic male voice elicits better responses in terms of respect and authority. In a study conducted by Randy C. Anderson and Casey A. Klofstad, a sample of men and women were asked about their preference of a leader based on the candidate's voice. Majority of the participants preferred leaders with deeper voices (masuline voices) over those which were more feminine in nature (Anderson, 2012).

It is worth noting that there could be limitations to how well speakers are able to determine these vocalizations using their different resources. One particularly relevant resource of interest is an individual's level of empathy. Empathy is integral to many non-verbal forms of communication, including screaming. In a study conducted by Rene Altrov at the Institute of the Estonian Language, researchers found that there was no significant difference between the recognition abilities of men and women based on their EQ scores measuring their relative empathic abilities (Altrov, 2013). This supports our earlier observation in the replication that listener gender had little impact in the ability to recognize screams. However, vocalizer gender did play a significant role in the replication study. It has been concluded by some researchers (Schwartz, 2019) that screams with higher duration and pitch are more emotionally significant, and whether or not male screams fit this category is still an active area of study.

With the correlation of screams and empathy, researchers are investigating broader variations of why certain screams or sounds may be more distinguishable than others. For instance, a group of researchers at the University of Geneva, Switzerland found that people

distinguished audio recordings of negative emotions faster than any other emotional response (Schaerlaeken & Grandjean, 2018). Such as that audio recordings of anger, disgust, and fear were distinguished faster and more accurately than emotions such as joy, sadness, or neutralness. From an evolutionary standpoint, analysts outline that recognizing negative emotions more is inherently vital to human survival. If individuals can quickly and accurately discern negative vocal emotions such as anger, they can successfully thwart imminent danger. This framework of theory is further supported as researchers noted that the vocal recording of fear was quickest and most accurately tested audio recording than any other in the experiment. Other than that, this study also examined audio recordings of short vocal bursts. The current study manipulates the duration of vocal recordings in which an individual must determine if it is the same vocalizer or not. In doing so, researchers can determine the effect of the duration of a vocal recording in response accuracy.

CONCLUSION

This study on the recognition of human screams is essential as it looks at voice recognition from a different angle. The replication focused on analyzing a variety of responses produced by the participants. Both vocalizer and participant gender were interpreted, and the differences between participant response latencies and response accuracies were calculated using the d' score, a measurement that calculates the variability between the means of the responses.

After going through the data of these trials, the results suggest that people are mostly (approximately 80%) able to distinguish between different screamers. D'scores showed that listener gender had no significant impact, but vocalizer gender did. It turned out that male vocalizers yielded higher d' scores than female vocalizers regardless of the gender of the participants. This meant that male screamers are more easily distinguished and identified compared to female screamers. This study can be used in many fields, including forensic science and surveillance. This field can be inspected further by looking further into gender and empathy and see how these factors affect scream recognition.

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