Auditory Pareidolia: Effects of Contextual Priming on Perceptions of Purportedly Paranormal and Ambiguous Auditory Stimuli

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Abstract

Reality television programs that explore purportedly paranormal phenomena with pseudoscientific research approaches have emerged in popular culture. These shows commonly feature electronic voice phenomena (EVP), whereby recording devices capture audio signals that are interpreted as paranormal messages. We compared perceptions for voices in EVP with actual speech, acoustic noise, and degraded speech. Some participants were told that the experiment was about speech intelligibility, whereas others were told that the experiment was about paranormal EVP. The paranormal prime increased the proportion of trials for which participants perceived voices in both EVP stimuli and degraded speech. When a voice was detected, low agreement was found regarding the content of EVP messages. In both priming conditions, participants reported general skepticism in the paranormal. Results are discussed in the context of theoretical perspectives on paranormal events, trait-versus-state accounts of paranormal beliefs, and pseudoscientific approaches to research.

Auditory Pareidolia: Effects of Contextual Priming on Perceptions of Purportedly Paranormal and Ambiguous Auditory Stimuli

In recent years, a number of reality television programs (e.g., *Ghost Adventures, Ghost Hunters, Ghost Lab,* and *Paranormal State)* have emerged that explore purportedly paranormal phenomena. Although these programs frequently assume the guise of research and objective investigation, they bear many of the hallmarks of pseudoscience (see Bunge, 1984), including, most notably, flawed research standards. One type of ostensibly supernatural occurrence commonly featured in these shows is electronic voice phenomena (EVP), whereby electronic recording devices are alleged to have captured audio of human-like voices. These auditory signals are interpreted as messages from paranormal or discarnate entities, and the recording of alleged EVP frequently has been proffered as evidence of the existence of supernatural beings among paranormal enthusiasts.

Recordings of purported EVP predate reality television (Banks, 2001) and became of interest with the emergence of widely available recording devices. Raudive, an author of a book on EVP phenomena, asserted, "Tape-recorder, radio and microphone give us facts in an entirely impersonal way and their objectivity cannot be challenged" (1971, Chapter 1). Though modern recording technology undoubtedly offered advantages in the documentation of auditory events, Raudive was not concerned with the role of human auditory perception in actively decoding the content of an auditory stimulus. A wealth of research in psychology, however, has examined the susceptibility of human perception to the effects of top-down processing, whereby expectations and previous knowledge actively shape perception, especially for ambiguous or degraded stimuli.

Warren's (1961) classic "verbal transformation" experiment showed that a word or phrase presented in a repeating loop was perceived as a frequently morphing series of different words. The perceived content of the repeating stimulus was idiosyncratic enough across participants to lead Warren to suggest that the procedure could have value as a projective psychological test. Similarly, Deutsch (2003) created artificial amalgamations of looping phonemes that, though meaningless in their bottom-up content, were perceived as a morphing stream of "phantom words" that assumed different perceptions across listeners.

Similar research has shown that the context and expectations of the listener can dramatically influence perceptions of ambiguous auditory stimuli. Bruce (1958) had participants listen to sentences embedded in acoustic noise. A sentence was preceded by a single, clearly perceivable word that was either semantically related or unrelated to the sentence's content. Priming with a related word facilitated accurate comprehension of the sentence. Priming with an unrelated word shifted perceptions of the sentence's content toward interpretations that were semantically related to the prime word, even if the actual content was objectively incongruent with the prime word. Bruce said, "…the encouragement of expectations by a single spoken word was enough to ensure complete success or complete failure of sentence intelligibility. Where that failure took the form of erroneous interpretations, their source in the misleading keyword was often obvious, and they were frequently reported as *heard*" (pp. 96, emphasis retained). The expectation induced by the situational context resulted in a shift in perception such that people actually believed that they had heard different words as a function of the preceding stimulus.

Recent research has suggested that people who hold paranormal beliefs may be more susceptible to some perceptional illusions. Pareidolia is the tendency to perceive meaningful forms in suggestive configurations of ambiguous stimuli. Common examples of pareidolia

include the perception of faces in nature (such as in the configurations of clouds or knots on trees) or in human-made objects (e.g., grounded electrical outlets in the U.S. appear to have a pair of eyes and a mouth). Riekki, Lindeman, Aleneff, Halme, and Nuortimo (2013) recently demonstrated that believers in paranormal phenomena were more likely to experience perceptual illusions like pareidolia in ambiguous visual stimuli. Participants performed a signal detection task with picture stimuli that either did or did not contain a visual artifact that resembled a face. Paranormal believers had a more liberal response bias than non-believers, even though the groups were equivalent in their actual ability to detect artifact faces. Paranormal believers also perceived the ambiguous stimuli to be more "face-like." Elk (2013) showed a parallel pattern of results for point-light displays. Paranormal believers showed a response bias toward illusory perceptions of human motion in the displays as compared to paranormal skeptics. Collectively, these findings suggest a tendency for paranormal believers to have a response bias toward perceiving agency in ambiguous stimuli. This effect seems to be based in perceptual processes; a recent review (Irwin, 2009) concluded that cognitive deficits do not seem to accompany paranormal beliefs.

Instances of auditory pareidolia were reported in recent work that used audification—a method of auditory display for listening to periodic data—to examine large data sets of astronomical radio observations (Lunn & Hunt, 2013) . In a pilot experiment to test the ability of listeners to detect the presence of anomalous signals in audified noise files, the researchers observed an unexpected number of illusory tonal signals in control files of white noise. Further studies replicated the effect and showed that unprimed, naïve listeners reported illusory mechanical noises, natural noises, tones, and human voices in white noise files. Interestingly, however, when the listeners were primed with examples of signals (e.g., tonal patterns) before

test trials, their illusory perceptions took the form of the example signals—a finding that prompted the researchers to suggest, "It is possible to steer a listener to report a particular type of phantom signal, just by playing an example earlier" (pp. 250).

Because of the well-documented tendency for people to have illusory perceptions across a wide array of stimuli due to both top-down perceptual effects and perceptual biases that seem to correlate with paranormal beliefs, perceptual agreement among human listeners should be a prerequisite for establishing the validity of ostensible voice communications in EVP recordings. Cardoso (2012) catalogued a variety of acoustic abnormalities that resembled utterances and were described as EVP, but the contents of the purported EVP were most commonly confirmed only by agreement among the EVP researchers. In a few instances, Cardoso conducted "listening tests," but the methods and full results of the tests were not reported. Other methodological difficulties are frequently introduced during the EVP recording process. For example, EVP experiments commonly have introduced de-tuned radio hiss (for white noise) and even reversed recordings of human voices (i.e., nonsense phonemes), in an effort "…to present an acoustic energetic stimulation for the formation of EVP utterances within, above, or together with the random speech sounds" (Cardoso, 2012, pp. 496, also see Banks, 2001). Given the perceptual illusions described by, for example, Warren (1961), Deutsch (2003), and Bruce (1958), it is not surprising that the introduction of an ambiguous auditory stimulus facilitates anomalous perceptual experiences. An important step for distinguishing idiosyncratic illusory perceptions from veridical messages in purported EVP would be to objectively establish agreement with respect to the perceived content of the stimuli.

Swale and Wood (2009) reviewed further scenarios leading to false-positive reports of EVP, including but not limited to instances where independent video recordings documented the

actual human observers or participants speaking in proximity to recording devices (also see Ellis, 1975). Upon amplification and further processing, the faint, verifiably human voices were reported to sound remarkably similar to other purported EVP. In multiple instances, recordings of voices described as EVP were later verified to be degraded signals from radio broadcasts that had interfered with recording devices (Baruss, 2001; Ellis, 1975). Ellis concluded that the purported voices in Raudive's recordings could be attributed to utterances from the people running the recording devices, acoustic anomalies, or interference from radio devices. He noted his subjective impression that "their supposed evidentiality correlates inversely with their audibility" (pp. 40). French (2001) anecdotally documented the tendency for EVP to evoke the perception of a human voice when the listener was prompted beforehand with the ostensible message, but for the content of the sounds to have no decipherable message without such prompting.

Houran and Lange (1996) proposed a psychological theory of paranormal events, whereby contextual factors—such as the suggestion of paranormal activity—lead people to misinterpret ambiguous stimuli. In presenting their model, they discussed the importance of the labeling of a context as "paranormal." This suggestion, they argued, can initiate a series of cognitive-perceptual processes that result in people misinterpreting normal perceptual ambiguities as having meaning and structure. The precise theoretical mechanisms likely involve a behavioral liberal shift in response bias (see, e.g., Elk, 2013; Riekki et al., 2013), which has physiological correlates in top-down modulation of neural processing that shapes perception via expectation (Engel, Fries, & Singer, 2001).

We conducted an experiment that looked for perceptual consistency across purported EVP stimuli as compared to other neutral and ambiguous auditory stimuli to examine—other

mitigating factors (recording conditions, etc.) notwithstanding—whether or not humans perceived the content of purported EVP to be the same across listeners. We compared the perception of EVP to actual speech, acoustic noise, and actual speech embedded in acoustic noise. We expected that participants would be unable to reliably detect and identify the purported messages in EVP as compared to the actual human speech control condition. We expected that the prevalence of the perception of human voices would be similar between purported EVP and degraded speech signals (speech in noise)—two different types of ambiguous stimuli. A noise-only control condition was also included. Further, some participants were told that the purpose of the study was to examine the intelligibility of different speech signals in noise, whereas others were told that the experiment was about purported EVP from paranormal investigations. We expected that participants who were told that they were participating in paranormal research would be more susceptible to reporting hearing voices in all stimulus types (see Houran and Lange, 1996). Finally, we took measures of the extent to which participants believed in paranormal phenomena at the end of the experiment to examine possible differences in self-reported paranormal beliefs as a function of the experimental conditions.

Methods

Participants

Participants ($N = 28$, 22 females, M age = 19.79, $SD = 0.96$ years) were recruited from undergraduate psychology courses at Lafayette College and were compensated with course extra credit. One participant was excluded from all analyses for failing to follow the experimental instructions. An a priori power analysis using g*Power software (Faul, Erdfelder, Lang, & Buchner, 2007) indicated that power of .81 would be achieved for the between-subjects effect in the current design with an effect size of .50 and a sample size of $N = 22$. The within-subjects and

interaction effects also would have adequate power (> .80) under these conditions. For smaller effect sizes, the sample size used here would have been slightly underpowered for the between-subjects effect. Our final sample balanced statistical and pragmatic concerns. Participants were recruited from a small pool of psychology students, and the manipulation was the mere suggestion of a paranormal context. As a result, as much data as possible were collected within a 48 hr time window in an effort to minimize the potential for diffusion of the instructional manipulation across levels of the between-subjects variable.

Apparatus

Experimental procedures and instructions were presented on iMac computers via a program written with Adobe Director software. Audio stimuli were presented with Sony MDR-V6 headphones.

Stimuli

EVP stimuli. Samples of purported EVP were extracted as mp3 (44.1 kHz, 128 Kbps stereo) files from the series of videos titled *Ghost Adventures - Guess that EVP* on the Travel Channel website[1] using the Audio Hijack Pro software program. The video segments showed excerpts of paranormal researchers finding EVP in audio recordings. Stimuli were processed to select only the audio associated with a single instance of the EVP and normalized. The mean duration of EVP stimuli was 609 (*SD* = 248) ms.

Speech stimuli. Samples of actual human speech in the same series of videos were extracted as mp3 (44.1 kHz, 128 Kbps stereo) files using the Audio Hijack Pro software program. The samples were selected to be approximately matched in duration to the EVP stimuli, and the mean duration of speech stimuli was 606 (*SD* = 277) ms. Before the experiment, both

[1] http://www.travelchannel.com/video/guess-that-evp

experimenters independently judged speech stimuli with 100% agreement regarding the content of the utterances.

Degraded speech stimuli. The speech stimuli described above were embedded in white noise produced by the Audacity audio editing program. The noise track was normalized along with the speech stimulus track, and the noise was then amplified at a fixed level of +5 dB relative to the speech signal. This signal to noise ratio has been suggested to present considerable challenges for accurate speech perception (Taylor, 2003).

Noise stimuli. Noise stimuli were 600 ms of white noise produced by the Audacity program. The duration approximated the mean durations of the EVP and speech in noise stimuli.

Selection and processing of stimuli. We identified a total of 49 EVP in the series of videos. We then identified an equivalent number of speech stimuli in the videos that were approximately matched to an EVP trial based on the length of the speech utterance. For the speech stimuli, we avoided speech sounds that contained background music or other obvious non-human sounds, and we also avoided selecting speech stimuli that referenced "listening" or "hearing." We included 34 EVP stimuli in the final stimulus set. EVP sounds that were not included as study stimuli were omitted on the basis of our inability to find appropriate speech stimulus matches (with respect to duration). No evaluation of the intelligibility of EVP was undertaken during the stimulus selection process. The final stimulus set included 34 EVP stimuli from the video series, 34 human speech sounds from the same videos that were matched to the EVP stimuli based on approximate duration, 34 degraded speech stimuli that consisted of the speech stimuli with added noise, and 34 repetitions of noise alone. All stimuli well-exceeded reported duration thresholds for categorizing speech versus nonspeech sounds (Bigand, Delbé,

Gérard, & Tillmann, 2011). All audio tracks were given 5 ms onset and offset ramps using the Audacity software program and exported as mp3 (44100 kHz, 128 Kbps) files.

Procedure

Instructional priming manipulation. Following informed consent, the computer program randomly assigned participants to one of the priming conditions, and the instructional prime was the first experimental procedure to which participants were exposed. Participants in the unprimed condition (n = 15) were told "This is an experimental study of the identification of voices in noisy environments." Participants in the paranormal prime condition (n = 12) were told "This is an experimental study of the identification of electronic voice phenomena--purported voices of ghosts in recordings from paranormal research." No additional reference to the instructional prime was made during the course of the procedure, and the remainder of the experiment followed the exact same procedure for all participants.

Task. On a given trial, participants heard one of the stimuli repeated only once. Participants were instructed to listen to a stimulus and then to indicate whether or not they detected a voice in the stimulus. Response options were "yes" or "no," and responses were registered with the computer mouse. Following "no" responses, participants proceeded to the next trial. Following "yes" responses, the program directed participants to a screen with an empty text box above which participants were instructed, "Please type what you think the voice said. If you aren't sure, then type your best guess as to what the voice said. Please type only your guess about what the voice said (i.e., don't type "I don't know," etc.)." The program presented a total of 136 trials of the task—34 trials of each of the stimulus categories—in a different random order for each participant.

Following the completion of all of the experimental trials, participants completed a demographic questionnaire and a computer adaptation of the Paranormal Scale (Tobacyk & Milford, 1983)—a brief questionnaire designed to measure the extent to which participants held beliefs in paranormal phenomena. Scores on the scale can range from 1 to 5, with 5 indicating strong belief in paranormal phenomena and 1 indicating strong skepticism or disbelief.

Results

The primary dependent variable was operationalized as the proportion of "yes" responses within each stimulus type. Inadvertent errors in the data collection program resulted in missing data across all participants for two trials of the EVP stimuli and one trial of the degraded speech stimuli. As a result, the proportion of "yes" responses for EVP, speech, degraded speech, and noise stimuli were calculated out of 32, 34, 33, and 34 total trials respectively. These data were analyzed with a 2 (instructional condition) by 4 (stimulus type) mixed analysis of variance (ANOVA)[2]. Levene's test showed that homogeneity of variance assumptions held across the between-subjects instructional manipulation at all four levels of the stimulus dependent variable, Fs = 0.004 – 2.72, ps = .11 - .95. For the within-subjects manipulation, the assumption of sphericity was violated, Mauchly's W = .16, $p < .05$, so a Greehnouse-Geisser correction, $\in$ = .58, was used in analyses involving the stimulus type.

[2] The speech and noise conditions violated the ANOVA assumption of normality and showed little variance. An alternative analysis approach would be to exclude both of these conditions from the ANOVA. These conditions were controls and their respective ceiling and floor effects and low variability clearly differentiate them from the other stimulus conditions (see Figure 1) without inferential confirmation. We performed this analysis as a 2 X 2 ANOVA (omitting the conditions for which the normality assumption was violated), and the pattern of significant differences for the remaining two conditions (EVP and speech in noise stimuli, for which the normality assumption held) was exactly the same. We report the 2 X 4 ANOVA here with all conditions included for the sake of completeness.

Results showed a significant main effect of instructional condition, $F(1, 25) = 4.26$, $p < .05$, partial $\eta^2 = .15$. Across all stimulus types, participants who were told the experiment was about paranormal EVP (*M* proportion of "yes" responses = .51, *SD* = .10) were significantly more likely to respond that a voice was present in the sound as compared to participants who were told the study was about voices in noisy environments (*M* = .43, *SD* = .10). The main effect of stimulus type was also significant, $F(1.74, 43.50) = 275.61$, $p < .001$, partial $\eta^2 = .92$. Follow-up pairwise comparisons showed that means for all stimulus types were significantly different from each other (all *p*s < .05). Participants reported the highest proportion of "yes" responses for the speech stimulus condition (*M* = .99, *SD* = .01), followed by the degraded speech condition (*M* = .48, *SD* = .24), the EVP condition (*M* = .40, *SD* = .19), and the noise condition (*M* = .01, *SD* = .05). Both main effects were qualified by a significant interaction of instructional condition with stimulus type, $F(1.74, 43.50) = 4.24$, $p < .05$, partial $\eta^2 = .15$. Simple effects examined the instructional manipulation at each level of stimulus type (see Figure 1). For EVP stimuli, participants who were told the study was about paranormal EVP were significantly more likely to report having heard a voice than participants who were told the study was about voices in noisy environments, $p < .05$, and the same pattern of results held for degraded speech stimuli, $p < .05$. For both speech stimuli and noise stimuli, there were no significant differences between the two instructional conditions, *p*s > .05.

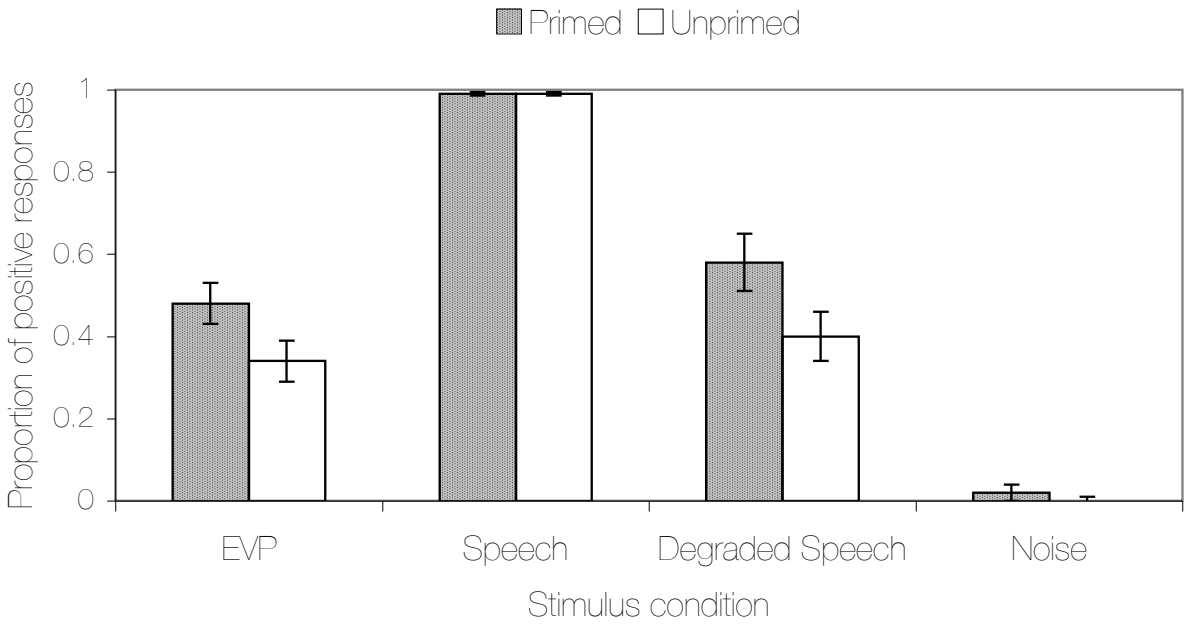

Figure 1. Mean proportion of responses for which participants reported a voice in the stimulus as a function of stimulus type and instructional priming condition. Error bars represent standard error.

Qualitative data for all "yes" responses were examined further for agreement regarding the content of the utterance. No agreement was possible for the noise condition, because there were no trials for which more than one person indicated having heard a voice in the stimulus. For the other three stimulus types, participants' typed responses were examined for agreement with each other on a trial-by-trial basis. The content of responses was scored as being in agreement when participants typed the exact same word or phrase for a particular trial. Homophones (e.g., "there" and "their") were scored as being in agreement with each other, and responses with typographical and spelling mistakes were scored as being in agreement with matching responses that did not have such mistakes. Partial matches and rhyming words were not scored as being in agreement. For each trial with more than one qualitative response available, the percent agreement was calculated as the response for which the highest number of respondents agreed on the content of utterances divided by the number of participants that provided a qualitative response (i.e., the number of participants reporting having heard a voice)

for that particular trial. Table 1 shows representative examples of raw data for each of the three stimulus types. The EVP stimulus purported to say "talk" shown in Table 1 was scored as having 22% agreement. Nine participants heard a voice, but only two agreed on the spoken content. The speech stimulus "just" was scored as having 89% agreement, because 24 out of 27 participants reported having heard the exact same content. The degraded speech stimulus "possibly" was scored as having 27% agreement, because four of the 15 participants who reported hearing a voice agreed on its spoken content. The mean percent agreement was calculated across all EVP (29 trials with available data where at least two participants heard a voice), speech (34 trials), and degraded speech (29 trials) stimulus types and analyzed with a one-way ANOVA that treated the stimulus type as the independent variable with trials (rather than subjects) as the cases. The ANOVA revealed a significant effect of stimulus type, $F(2, 89) = 338.33$, $p < .001$, partial $\eta^2 = .88$. Tukey's post hoc test showed that participants had a higher mean percent of agreement about the content of speech stimuli ($M = 95\%$, $SD = 10$) as compared to the EVP ($M = 13\%$, $SD = 14$) and degraded speech ($M = 19\%$, $SD = 17$) conditions, ps $< .001$. The EVP and degraded speech conditions were not significantly different from each other, $p > .05$.

An independent samples t-test compared scores on the Paranormal Scale (Tobacyk & Milford, 1983) for the two instructional conditions. There was no significant difference between groups, $t(25) = .82$, $p > .05$. Mean scores for both the primed condition ($M = 1.37$, $SD = .23$) and the unprimed condition ($M = 1.17$, $SD = .12$) suggested that both samples were quite skeptical and, on average, did not tend to believe in paranormal phenomena.

Finally, for EVP stimuli, an analysis compared participants' typed responses to the *Ghost Adventures* researchers' interpretations of the stimuli, which were subtitled in the videos of the

television broadcast. The content of responses was scored as being in agreement when participants typed the exact word or phrase as the subtitles for a particular trial. Homophones (e.g., "there" and "their") were scored as matching, and responses with typographical and spelling mistakes were scored as matching. Across 32 trials of EVP stimuli and 27 participants, there were a total of 8 trials (0.9% of trials) for which participants' perceptions of the content of words or brief phrases contained in EVP exactly matched the paranormal researchers' interpretations.

Discussion

Research has shown that a combination of spectral and temporal cues distinguish voices from other acoustic stimuli (e.g., Agus, Suied, Thorpe, & Pressnitzer, 2010), and anomalies in ambient noise and environmental sounds may contain acoustic features that resemble the cues that define voice stimuli as such. Modern recording devices are suited to pick up a wide variety of audible signals, some of which have spectral and temporal properties that may be perceived as voice-like, especially after signal processing (amplification, etc.) and/or in the presence of acoustic noise, detuned radios, and (not surprisingly) meaningless phonemes. The implication of some EVP research seems to be that such occurrences would happen so infrequently that they must be meaningful (see Cardoso, 2012, pp. 501). On the contrary, it is probabilistically inevitable that, over the course of hours of recording and virtually endless possible audio signal processing procedures and background noise additions, some anomalies in recordings will be perceptually similar to human voices.

Our results offer evidence in support of the model of paranormal events described by Houran & Lange (1996), who posited that the mere suggestion of paranormal occurrences leads to shifts in the perception of ambiguous stimuli. Specifically, participants who were told the

experiment was about paranormal EVP seem to have shifted toward more lenient criteria for believing that a voice was present in ambiguous auditory stimuli, even though they did not reliably agree upon the content of the perceived utterances. The influence of this suggestion was specific to ambiguous stimuli (EVP and speech degraded in noise), and it persisted despite the fact that participants in the condition receiving the paranormal suggestion reported strong skepticism about beliefs in the paranormal at the end of the study. Researchers (e.g., Elk, 2013; Riekki et al., 2013) have demonstrated perceptual differences attributable to the tendency toward paranormal beliefs as a trait (i.e., an enduring personal characteristic) rather than a state (i.e., as a contextually-invoked mental set). To our knowledge, this is the first empirical demonstration of perceptual effects attributable to the contextual suggestion of paranormal phenomena in otherwise self-reported skeptical participants. More research is warranted to replicate and expand upon this finding; our experiment used a limited range of brief stimuli.

The role of active perception often has been overlooked in the attribution of meaning to the content of alleged EVP, and to date little evidence has been offered for the reliability of interpretations of EVP across naïve listeners in controlled perceptual experiments. A wealth of research (e.g., Bruce, 1958; Elk, 2013; Riekki et al., 2013) has demonstrated the role of expectations and biases on the perception of many stimuli—especially stimuli that are inherently ambiguous or meaningless in their bottom-up form. A holistic examination of evidence in the case of purported EVP leads to the reasonable conclusion that top-down expectations and biases have resulted in illusory perceptions of voices in ambiguous auditory stimuli.

The EVP stimuli used here were taken from a television show that has the primary intent of entertaining and promoting travel destinations. For purposes of harmless entertainment, viewers of such shows might be willing to suspend disbelief. Such entertainment, however,

blurs the line between science and pseudoscience. Recent research suggested that exposure to pseudoscience in television programming was strongly related to pseudoscientific beliefs in a sample of Taiwanese participants (Tsai et al., 2012). At worst, these approaches permit flawed ideas the same status as empirically supported ideas. Raudive (1971), for example, said, "The essence of the voices can be gleaned from their acoustically perceptible appearance and from insight into the meaning of their utterances, rather than through psychological knowledge…they are an acoustic fact and need no special theories to confirm them" (pp. 8). His perspective implied that the use of technical equipment and the act of recording per se resulted in scientifically sound evidence for EVP, despite the fact that the overarching attitude and approach seemed to lack other key values of science, especially skepticism and an emphasis on eliminating rival explanations for observed phenomena. The perpetuation of misinformation about science in popular culture has harmed public discourse on important topics such as climate change, vaccination programs, and the teaching of science in schools (see, e.g., Morrison, 2011; Rosenau, 2012). In our experiment, the mere suggestion of paranormal research topic resulted in a perceptual shift in perception in otherwise skeptical participants. More research is needed to examine whether or not this shift can result in further effects on attitudes, cognitive processes, and behavior, as was suggested by Houran and Lange (1996).

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