

An unpleasant sound could be a pleasant change to the methods used to study aversive
Pavlovian conditioning in children and adults

David L. Neumann & Allison M. Waters
School of Psychology, Griffith University

Address for correspondence: David Neumann, School of Psychology, Griffith University
(Gold Coast Campus), Mail: GRIFFITH UNIVERSITY QLD, Queensland, 4222,
Australia, E-mail D.Neumann@griffith.edu.au, Facsimile +61(0)7 5552 8291, Telephone
+61(0)7 5552 8052

COMMENTARY

Biological psychology research is conducted against a social backdrop that influences the research questions asked and the methods used to answer these questions. Research on aversive Pavlovian conditioning, the method in which a neutral conditional stimulus is paired with an aversive unconditional stimulus (US) to examine the development of conditioned fear responses in humans, is one such example. As one of the most widely accepted learning-based explanations for the development of pathological fears and phobias (Mineka & Zinbarg, 2006), aversive Pavlovian conditioning has important applications in the understanding and treatment of pathological fear and anxiety (Field, 2006). With prevalence rates as high as 20%, anxiety disorders are one of the most common forms of psychopathology diagnosed in children and adolescents (see review by Cartwright-Hatton, McNicol & Doubleday, 2006). Moreover, as these common and debilitating disorders typically have their origins in childhood and can persist across the lifespan, the application of aversive Pavlovian conditioning to the study of both children and adults alike is essential for furthering our scientific understanding of these disorders.

Unfortunately, research on aversive Pavlovian conditioning in humans can be restrictive. By its very definition, aversive conditioning studies must use an *aversive* US. Traditionally, electric shocks set subjectively to be “unpleasant, but not painful” and loud noises or tones have been used. A limitation of these stimuli is that they require special stimulus delivery apparatus, safety control procedures, and careful training of the experimenter to ensure their safe presentation. In addition, because electrical hazards can be associated with electric shocks, sometimes expensive stimulation hardware is required

to ensure that the participant is electrically isolated from the hazardous mains current supply. Electric shock stimuli can also be difficult to use with special populations. Children or individuals with psychiatric disorders may not have the self-awareness to determine when an electric shock is “unpleasant, but not painful”. Loud tones (e.g., 100 dB presented for 1 s) may cause pain and discomfort in children and adolescents sensitive to loud stimuli, particularly those with Fragile X syndrome, autistic spectrum disorders, and some anxiety disorders (American Psychiatric Association, 1994). Loud tones can also be associated with poor acquisition of CRs in experiments with children (e.g., Liberman, Lipp, Spence, & March, 2006). Unpleasant odours (e.g., Flor, Birbaumer, Hermann, Ziegler, & Patrick, 2002) and air puff (e.g., Suboski, 1967) have been used by some investigators, but they require special stimulus delivery systems and obedience, such as avoiding movement, that is difficult for many children.

For these reasons, we have explored the use of alternative stimuli that are aversive, not because of the intensity at which they are presented, but because of their subjective characteristics. The sound of dragging a metal fork across slate is similar to fingernails running down a chalkboard. The unpleasant nature of this sound has been confirmed in subjective ratings. Adult participants gave a mean rating of approximately 1.5 on a scale ranging from 0 = *very unpleasant* to 8 = *very pleasant* (Neumann & Waters, 2006). Similarly, a sample of youths gave a mean rating of approximately 2.0 on the same rating scale (Neumann, Waters, & Westbury, in press). Moreover, both samples rated the unpleasant sound as more unpleasant than an electric shock set to be “unpleasant, but not painful” and a loud tone. Halpern, Blake, and Hillenbrand (1986) conducted an extensive psychoacoustic study of various sounds, including the sound of dragging a metal fork

across slate. This sound was ranked as the most unpleasant of all the sounds tested, including sounds produced by rubbing two pieces of Styrofoam together, white noise, a blender motor, and compressed air. Taken together, the research findings suggest that the unpleasant sound of metal scraping on slate can be just as, or even more aversive, than a range of other stimuli.

We applied a 3 s recording of the unpleasant sound of metal scraping on slate as a US in an aversive Pavlovian conditioning procedure with healthy adults and youths (Neumann & Waters, 2006; Neumann, Waters, & Westbury, in press). Importantly, we presented the unpleasant sound at an intensity of less than 82 dB(A), which is in the normal range for environmental sounds and is similar to the intensity of sounds used in psychological research with special populations such as children with Fragile X syndrome (e.g., Frankland et al., 2004). The unpleasant sound US was associated with statistically reliable acquisition and extinction of conditioned fear responses for self-reported expectancy, pleasantness ratings, skin conductance responses, heart rate change, and startle blink modulation in adults (Neumann & Waters, 2006). Moreover, the effect sizes associated with acquisition and extinction were equal to or even exceeded that obtained with electric shock and loud tone USs when used under the same experimental conditions. The reliable conditioning and extinction of self-reported expectancy, skin conductance responses, and startle blink modulation were replicated in a sample of 13 to 17 year old youths (Neumann et al., in press). It was particularly noteworthy that the unpleasant sound elicited smaller defensive skin conductance responses than the electric shock in all our participants. Such a finding suggests that the sound was unpleasant because of its qualitative features and not because it is presented at a high intensity.

The research findings indicate that the unpleasant sound US can support the acquisition and extinction of conditioned fear across a range of age groups. While prior research has used the unpleasant sound in sample of adults and youths, its utility still needs to be demonstrated in younger samples, such as children who are 10 years and younger. On the basis of the consistency in the results across the samples studied thus far, it would be expected that strong conditioning and extinction effects will be found in young children and we are currently investigating this question. The sensitivity of the unpleasant sound US to other experimental manipulations within a Pavlovian conditioning procedure also remains to be shown. For instance, the renewal of extinguished conditioned responses following a context change after extinction has been demonstrated with an electric shock US (e.g., Neumann, Lipp, & Cory, 2007; Vansteenwegen et al., 2005). It would be expected that the unpleasant sound US should also support the renewal of conditioned fear in a similar procedure. Moreover, the application of the unpleasant sound would also allow renewal and related return of extinguished behaviour phenomena to be studied in special populations, such as children. Further research could also explore the use of other unpleasant sounds as USs. By using alternative sounds it may allow research questions to be answered when an experiment requires multiple USs to be used. The procedure would avoid confounds associated with using USs that are qualitatively different and are administered in different sensory modalities (e.g., electric shock vs. noise).

Notwithstanding these possible research directions, the unpleasant sound presents a viable and alternative US when studying aversive Pavlovian conditioning in healthy adults and special populations such as the young and the elderly. The unpleasant sound

offers a number of practical advantages. For instance, its presentation merely requires a computer fitted with headphones or speakers and no other special stimulus delivery equipment is needed (e.g., shock generator and electrodes in the case of electric shock). It is also presented at a lower intensity than the 100 dB(A) loud tones that have been applied in previous research thus increasing the safety of the experimental protocol. Finally, because it is the qualitative features of the unpleasant sound that renders it aversive, and not its intensity, it may present a more ethically acceptable means by which to present an aversive US. Such considerations hold significant promise for future applications of the unpleasant sound US when applied to examine learning-based models of the development and continuation of pathological fears and anxiety across the lifespan.

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