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Linking Affective and Hearing Sciences—Affective Audiology

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Abstract

A growing number of health-related sciences, including audiology, have increasingly recognized the importance of affective phenomena. However, in audiology, affective phenomena are mostly studied as a consequence of hearing status. This review first addresses anatomical and functional bidirectional connections between auditory and affective systems that support a reciprocal affect-hearing relationship. We then postulate, by focusing on four practical examples (hearing public campaigns, hearing intervention uptake, thorough hearing evaluation, and tinnitus), that some important challenges in audiology are likely affect-related and that potential solutions could be developed by inspiration from affective science advances. We continue by introducing useful resources from affective science that could help audiology professionals learn about the wide range of affective constructs and integrate them into hearing research and clinical practice in structured and applicable ways. Six important considerations for good quality affective audiology research are summarized. We conclude that it is worthwhile and feasible to explore the explanatory power of emotions, feelings, motivations, attitudes, moods, and other affective processes in depth when trying to understand and predict how people with hearing difficulties perceive, react, and adapt to their environment.

Keywords

emotion, hearing, translational, neurocognitive, psychological

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Introduction

Emotional components have emerged in the audiology literature in recent years, shedding light on how essential affective meanings carried in daily sounds (senders), and how they are perceived (receivers), could impact how we study and practice audiology. Picou et al. (2018) called for research on how patients' auditory emotional perceptions and experiences are affected by hearing loss. Kraus and White-Schwoch (2017) suggested including factors of emotions and rewards in tinnitus treatment and auditory learning. Both groups highlighted the hearing–emotion connection, suggesting the potential for a subdiscipline of affective audiology. In this review, we discuss the potential value of incorporating affect, and associated methodologies, into audiology from the vantage points of affective and hearing sciences. We provide examples of how this young field could be broadened by incorporating core affective determinants (e.g., emotions, motivations, moods, and attitudes) into audiology research and practice.

Affective Science Pertains to Audiology

Audiology concerns healthy hearing and listening in daily situations that involve auditory communication. Given that affects permeate many aspects of daily life (Zahn-Waxler, 2010), we believe mutual links could exist between the affective and hearing sciences.

Evidence From Neuroscience

Anatomical and functional connections between neural circuits supporting audition and the dominant circuits associated with emotion are well characterized and support this reciprocal link. For instance, the amygdala, a central structure in emotional information processing, is reciprocally connected to the medial geniculate nucleus of the thalamus and the auditory cortex (LeDoux et al., 1984; Viinikainen et al., 2012). This connection allows the transfer of acoustic

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features of stimuli through forward connections from auditory cortex regions to the amygdala, and the emotional valence of auditory stimuli through backward projections from the amygdala to the auditory cortex (Kumar et al., 2012). The auditory cortex also plays an equivalent and complementary role to the amygdala, decoding complex emotional sounds and sound features that evolve over time (Frühholz et al., 2014). Regardless of whether this enhanced auditory cortex activity (likely, increased auditory sensory processing) is driven by increased emotional decoding in the amygdala (Vuilleumier et al., 2004) or is a complementary emotion processing function different from the affect processing in the amygdala (Pessoa & Adolphs, 2010, 2011), the auditory cortex demonstrates stronger and more robust activity when stimulated by affective sounds than by neutral sounds, similar to the amygdala (Pessoa & Adolphs, 2010).

Animal studies show that lesions in the amygdala interfere with the development of late-conditioned novel tones (Armony et al., 1998) and the response to previously conditioned auditory stimuli (Heldt et al., 2000). These studies suggest that the amygdala influences the long-latency auditory memory network. For example, infusion of sodium salicylate into the lateral amygdala can enhance sound-evoked neural firing activity in the auditory cortex in rats (Chen et al., 2012). Early amygdala damage can alter the ability to process species-specific audio-visual vocalization in rhesus macaques (Payne & Bachevalier, 2019). Human studies have also documented impaired vocal affect perception, especially for fear and anger (Scott et al., 1997), emotion recognition from music (Gosselin et al., 2007), and verbal emotional memory (Buchanan et al., 2001), despite normal hearing in patients with amygdala lesions (Frühholz et al., 2015). These data support the reciprocal impact of the affect processing structures' function on the auditory function. Details of other bidirectional structural and functional connections between neural circuitry responsible for auditory and emotional information processing can be found in the literature, including networks associated with general affective sound processing (Frühholz et al., 2016), tinnitus (Hu et al., 2021; Kraus & Canlon, 2012), music processing (Peretz & Zatorre, 2005), and auditory hallucination (Marschall et al., 2021; Richards et al., 2021).

In addition to emotions, other aspects of affect (e.g., motivations and moods) are likely to dovetail with audiology. A typical intersection is listening effort, an attentional component of effort closely related to motivation (Sarter et al., 2006) and mood (Erber & Tesser, 1992). Listening effort exertion is presumed to follow a pattern that first increases and then decreases (inverse U-shaped) across easy to challenging listening conditions and low to high motivational arousal based on listening effort models, as people do not need much effort for easy tasks, expend higher effort for moderately difficult tasks and then effectively give up for tasks that are too hard for them (Herrmann & Johnsrude, 2020; Pichora-Fuller et al., 2016). The neural signatures of listening effort have been identified in inverse U-shaped activity as a function of speech degradation in regions such as the left lateral temporal cortex, inferior frontal cortex, premotor cortex (Davis & Johnsrude, 2003; Dimitrijevic et al., 2019; Ryan et al., 2022), and cingulo-opercular network (anterior cingulate and bilateral anterior insulae) (Eckert et al., 2009, 2016; Peelle, 2018). The cingulo-opercular network, in particular, is likely responsible for maintaining tonic alertness to make cognitive faculties available for current processing requirements (Sadaghiani & D'Esposito, 2015) and motivate goal-driven effortful behavior (Holroyd & Yeung, 2012). For example, the anterior cingulate cortex appears to integrate motivational value dimensions (e.g., monetary incentives) and behavior options into a general task value to determine the level of effort needed to sustain optimal performance (e.g., cost-benefit trade-off decision-making) (Apps & Ramnani, 2014; Croxson et al., 2009; Yee et al., 2021). The prefrontal cortex and anterior insulae of the same cingulo-opercular brain valuation system are respond differently to positive and negative information (Harlé et al., 2012; Vinckier et al., 2018). Their activities were reported to regulate individuals' emphasis on potential rewards/losses, influencing their decision on effort costs (Prévost et al., 2010; Vinckier et al., 2018). With the neural components in and beyond the auditory cortex, the listening effort could thus be considered a combination of the cognitive and affective hearing concepts.

Another typical intersection of affect and audiology is auditory emotion perception. For example, hearing loss is shown to aggravate mood and induce symptoms of depression (for review, see Canbeyli, 2022). This may occur through direct pathways such as reduced perception of spectral, temporal, and amplitude acoustic cues critical for vocal emotion processing (Barrett et al., 2020; Ren et al., 2022; Richter & Chatterjee, 2021). It may also occur through more indirect pathways. For example, reduced peripheral input yields decreased reactivity in brain structures which process emotional information (e.g., amygdala and anterior cingulate cortex), yielding decreased emotion reactivity, hedonic experience and emotion regulation functions (Husain et al., 2014; Rutherford et al., 2017; Wager et al., 2008), which may increase the risk of developing anxiety and depression (Hua et al., 2022; Ma et al., 2022; Tang et al., 2020). Individuals with unipolar depression display activity that is different from never-depressed individuals across a variety of networks subserving cognitive and emotional information processing in response to emotional stimuli (see Jaworska et al., 2015 for a review). Bupropion, an antidepressant, increases reactivity to happy voices in emotion circuits (e.g., superior temporal gyrus, superior and medial frontal gyrus, and insula) compared to the placebo (Hama et al., 2021), despite no change in behavioral performance on vocal emotion judgments. This evidence encourages us to consider the phenomena of compromised affect perception in people with hearing problems within a broader framework. For example, neural-plastic alterations may occur due to long-term hearing deprivation, and manifest as decreased functional connectivity between the amygdala and the auditory cortex, striatum, cingulate gyrus, multimodal processing areas, and frontoparietal control areas (Tang et al., 2020; Xu et al., 2019). Thus, deficits in processing vocal emotions may be partially addressed by techniques that target activity in emotion circuits developed in affective science, in conjunction with current amplification interventions (Cannon & Chatterjee, 2022; Goy et al., 2018; Paquette et al., 2018).

Evidence From Behavior

Audiology researchers are well aware of the increasing empirical evidence that hearing loss and tinnitus are associated with adverse changes in performance and affective variation (e.g., emotions, motivations, and moods), including difficulties in voice (Cannon & Chatterjee, 2019; Laugen et al., 2017; Most & Aviner, 2009; Oron et al., 2020; Picou et al., 2021), musical (Mazaheryazdi et al., 2018), and facial (Saatci et al., 2021) emotion recognition, emotion interpretation of others in certain contexts (Tsou et al., 2021), emotion regulation, and friendship development (Rieffe et al., 2018), forming social connections (Bott & Saunders, 2021; Keesom & Hurley, 2020; Shukla et al., 2020), and difficulty recovering from depression, anxiety, stress, fear, chronic fatigue, and mood changes (Burke & Naylor, 2020; Jayakody et al., 2018; Juul Jensen et al., 2018; Nordvik et al., 2018). Thus, directional paths from hearing impairment to impaired linguistic communication, to low mood have been observed (Brink & Stones, 2007). Hearing impairment is associated with increased psychiatric comorbidity in depression as well as depressive symptomatology (see Canbeyli, 2010 for review). Support for a causal relationship has also been demonstrated, as hearing aids are shown to improve mood (Brewster et al., 2020). Similarly, the effects of auditory stimulation on affective variables can be seen in the lab as auditory stimuli, particularly music, but also including beat patterns and noise stressors, are well-known to affect mood in both humans and animals (see Canbeyli, 2010 for review).

Less attention has been focused on the influence of affect on auditory phenomena. It has been reported that depression, a disorder characterized by profound affective symptomatology, can alter various aspects of auditory processing. For example, depression can impair cortical habituation to vowels and tones (Christ et al., 2008; Michael et al., 2004; Tollkötter et al., 2006) and diminish the auditory looming bias (Riskind et al., 2014). Treating depression treats some aspects of hearing loss, particularly involving perceptual asymmetries (Yovell et al., 1995). Similarly, happiness and sadness reinforce the distracting effect that deviant sounds have on the performance in auditory–visual oddball tasks by prolonging reaction times and reducing accuracy (Pacheco-Unguetti & Parmentier, 2014, 2016). Stress, an integral part of modern life, can influence auditory function in terms of tinnitus, hyperacusis, and noise-induced hearing loss (Horner, 2003; Jafari et al., 2017). Pérez-Valenzuela et al. (2019) suggested that persistent stress could produce auditory sensory deprivation, interfere with the brain–environment connection, and induce hearing impairment likely via the impaired hypothalamic–pituitary–adrenal axis in which unbalanced glucocorticoids and glucocorticoid receptors as a result of stress damage the cochlea's homeostasis and normal sensitivity (Graham & Vetter, 2011; Mazurek et al., 2010, 2012). Faulkner et al. (2021) suggested another plausible pathway via altered sensitivity to noise. The authors reported an association between persistent traumatic stress and the experience of amplified negative reactions to ambient noise, that is, noise sensitivity (Job, 1999), mediated by fear avoidance. According to the authors, stress-related hyperarousal may cause hypervigilance towards noise, yielding avoidance behaviors that provide decreased exposure to noise in the short term, but drive maintenance of noise sensitivity and social withdrawal that could lead to increased attentional load and maladaptation to hearing problem management in the long term. Physical and social acute stresses are also documented to have negative effects on auditory processing through similar pathways (see Jafari et al., 2017 for a review).

Somewhat more evidence is available on the impact of affect on listening efforts. Incentive rewards (Koelewijn et al., 2018, 2021; Zhang et al., 2019), success importance (Richter, 2016), the presence of another individual (Pielage et al., 2021), and stressful instructions (Picou, 2014) were reported to influence listeners' decisions as to when and to what extent to expend effort to pursue a specific listening goal. Sadness increases auditory distractability (Pacheco-Unguetti & Parmentier, 2014) as well as auditory deviance detection (Pinheiro et al., 2017), likely increasing listening effort.

Current Challenges in Audiology Are Affect-Related

Studying potential connections between affect and audiology, particularly regarding the effects of affect on hearing, could help to address challenges in audiology practice and inspire the development of innovative hearing health interventions and evaluation instruments. For example, affective features of acknowledging hearing impairment (e.g., shame and losing face) are suggested to be hidden influences on whether people will take advantage of services that audiologists provide, and have thus been suggested as targets for audiologists to address (Danermark, 1998).

Hearing Health Campaigns

Due to their invisible nature, hearing problems are largely underrecognized in the hearing care services' target population. Public education contributes to preliminary self-identification of vulnerability to hearing problems, which is helpful in facilitating prevention and early intervention efforts. Global hearing health campaigns have rapidly grown over the last two decades under the leadership of the World Health Organization World Hearing Day initiative (Chadha & Cieza, 2017, 2018). However, challenges remain in formulating effective motivational message content and devising approaches that translate motivation into action (Sawyer et al., 2019) before the global low hearing intervention rate can be substantially changed (Chien & Lin, 2012; Davis et al., 2016; Ferguson et al., 2017; Hartley et al., 2010; Zhao et al., 2015).

There is a barrier between the known hearing risks/problems, and the unknown health/life concerns and priorities in the target population (Hommes et al., 2018; Tamaskar et al., 2000). Addressing this barrier by matching messages to individuals' affective states, goals, and attitudes could help increase persuasive power (Teeny et al., 2021), and may help to formulate concerns that are different from what hearing professionals assume the target population would need and care about, as has been reported for depression (Siegle et al., 2019).

Attention in hearing health campaigns (domestic and global) is almost exclusively paid to non-affective recipient characteristics (e.g., sex, age, and clinical hearing conditions) according to the annual reports of registered worldwide campaign activities on the World Hearing Day official website (https://worldhearingday.org). As an example of the potential impact of this approach, cultural differences have been observed to affect approaching and avoiding orientation (Hamamura et al., 2009; Zhang et al., 2021) such that affective goals (e.g., "feeling good") are prioritized in American and European cultures, but explicitly avoided in Chinese individuals. And yet, hearing campaigns in China have been consistent with the American/European model of recommending hearing intervention to improve positive affect (e.g., "feel better" and "happy living") (Liang & Liu, 2021). An affective audiology perspective would suggest, instead, the potential utility of targeting affectively prioritized features in Chinese culture, for example, being stronger support for one's family. Cultural differences have also been observed in other facets that could affect hearing campaign messaging such as creativity (Lubart, 2010), the need for cognition (Zhang et al., 2021), hedonic-utilitarian values (Ozen & Kodaz, 2012), self-construal and affective valence (Kafetsios et al., 2018), and attitude function (Choi et al., 2020). Using more affective language with hedonic-oriented recipients (Rocklage & Fazio, 2020) or cognitive language with cognition-oriented recipients (Haddock & Maio, 2019) may thus be useful. Nevertheless, affective science also suggests the utility of minimizing negative interpretations by recipients, including boredom (Clark et al., 2008), perception of attempts at manipulation (Briñol et al., 2017), or unfair or stereotypic judgments about groups (Derricks & Earl, 2019).

Other dimensions in effective persuasive communication are explicitly related to affect. The sources of the message (e.g., experts, government authorities, or representatives from specific groups) impact the level of trust, confidence, and comfort in the target recipients (Kruglanski et al., 2005). The setting/context in which messages are delivered can use affective associations to promote persuasion and action-taking (Breves & Heber, 2020; Hasford et al., 2015). It may thus be beneficial to explore the persuasion-related and affective psychology literature to strengthen hearing health public campaigns.

Intervention Uptake

Low hearing intervention uptake has been an ongoing challenge (Davis & Smith, 2013; Orji et al., 2020). It mainly manifests as not using hearing aids/cochlear implants/assistive listening devices when one should or not engaging in auditory rehabilitation programs when one could benefit from them (Simpson et al., 2019). We summarized a consolidated list of the investigated nonaudiological factors influencing hearing aid uptake and use based on the extensive reviews by Knudsen et al. (2010) (included 39 studies between 1980 and 2009), Jenstad and Moon (2011) (included 14 studies between 1990 and 2010), Meyer and Hickson (2012) (included 22 studies between 1990 and 2010), McCormack and Fortnum (2013) (included 10 articles between 2000 and 2012), and Knoetze et al. (2023) (included 42 studies between 2011 and 2022). These review articles were selected to cover a fairly long time window of the literature without gaps (from 1980 to 2022) and a wide age range (from 18 to 95 years old). Non-audiological factors outlined in the review articles were merged into a complementary list of barriers and facilitators to hearing help-seeking and hearing aid uptake (see Table 1). Among the 127 articles included in the above reviews, there were 43 duplicate articles, which were removed from the article count in Table 1.

Aside from demographic factors, most non-audiological factors appeared to be affective and related to stigma (of hearing loss as well as hearing aid use) and identity/attitudinal beliefs (Barker et al., 2017; Meyer et al., 2014). As a study by Ruusuvuori et al. (2021) and from the self-reports of participants with hearing loss/hearing aids during narrative interviews (Scharp & Barker, 2021; Wallhagen, 2010), little progress has been observed over the past decade on changing stigma at the societal, interpersonal, or individual levels, despite efforts such as moving hearing aids culturally from being medical devices to fashion accessories like glasses, which have more complex stigma profiles (Harris et al., 1982) and for which inclusion of modern aesthetics have

Table 1. Nonaudiological Factors Influencing Hearing Aid (HA) Uptake and Use With Number of Supporting Studies (in Parenthesis).

Factor	HA uptake	HA use
Age	± (26)	
Education	± (12)	
Sex	± (22)	
Socioeconomic status	+ (12)	
General health	− (6)	
Locus of internal control	+ (2)	
Ego strength	+ (1)	
Cognitive anxiety	+ (2)	
Distress	± (2)	
Depression	± (1)	
Technology commitment	+ (2)	
Stigma	− (5)	
Concern regarding the cost	− (2)	
Language level used by audiologists	− (1)	
Denial	− (1)	
Readiness for change	+ (4)	
Autonomous motivation	+ (2)	
Self-acceptance	− (1)	
Self-efficacy	± (2)	
Maladaptive behaviors	− (1)	
Subjective norm	+ (2)	
Subjective norm * Trust	+ (1)	
Attitudes toward behavior and control	+ (2)	
Attitude toward own hearing loss	+ (4)	+ (3)
Attitude toward hearing aids	+ (3)	+ (4)
Self-reported hearing difficulties	+ (9)	+ (3)
Counselling		+ (2)
Dexterity (impression about the audiologist)		+ (2)
Lifetime experience with hearing aids		+ (2)
Hysteria		+ (1)
Expectations		+ (1)
Number of major life events		+ (1)
Adaptation period		− (1)
Depression/obsession		− (1)
Socioeconomic status: income level		− (1)
Activity of daily living		− (1)
Medication		− (1)

Note: "+" indicates a positive association between the factor and the outcome, "–" indicates a negative association, and "±" indicates a controversial association including no association.

been demonstrated to decrease stigma (Dos Santos et al., 2022). Thus, learning from research on affective features such as stigma from social psychology and affective science may help audiology researchers and clinicians to increase hearing aid use and develop more acceptable interventions.

For example, most reported stigmas in audiology regard self-judgment and perceptions of judgment by others, including attitudes about the nature of the person (e.g., being whole vs. not whole, able vs. disabled, smart vs. cognitively impaired), ageism (e.g., being an "old fogey"), and vanity (e.g., being unattractive) (Preminger & Laplante-Lévesque, 2014; Wallhagen, 2010). Bos et al. (2013), in agreement with Goffman (2009), theorized that public stigma is at the root of other stigma manifestations (i.e., self-stigma, stigma by association, and structural stigma). Given the evidence that self-perception changes may arise from hearing loss/hearing aid use (Barker et al., 2017; Hogan et al., 2009), we speculate that for hearing loss and/or hearing aid use, self-stigma may also feed into public stigma, particularly if hearing impairments engender confusion and frustration in communication. If that were the case, focusing on stigma reduction at the individual level might be important in addition to the public level. Specific approaches to stigma reduction, which might apply to audiology, appear effective, including introducing a new "label" as in weight-related problems (DePierre et al., 2013), using competence messages as in individuals with mental illness based on expectation states and affect control theories (Kroska & Harkness, 2021), and embracing a continuum (psychopathology and normality are separate points on a fluid continuum) rather than categorical (psychopathology and normality occupy distinct social categories separated by a rigid boundary) belief towards mental health conditions (Thibodeau, 2020).

The neuroscience of stigma is also increasingly well understood, involving the ventral anterior cingulate cortex (associated with emotional self-regulation, affective information processing, and social feedback), medial prefrontal cortex, amygdala, insula, and right orbital gyrus (associated with social knowledge) (Krendl et al., 2008; Moor et al., 2012; Quadflieg et al., 2009; Wraga et al., 2007). This work suggests the potential for novel interventions for stigma belief formation and maintenance rooted in neuroscience.

Motivation may help to initiate the self-stigma reduction process. The health belief model of D'Haese et al. (2018) emphasizes the utility of motivation in facilitating change in health behaviors and perceptions. Thus, reminding individuals with hearing impairment who are not sufficiently motivated to accept that their hearing problems present an opportunity to unlock self-improvement (e.g., being stronger, more open-minded, understanding, or patient) might help move them toward the hearing status they need and want.

Full Picture of an Impaired Auditory System

The affective states/moods of the respondents are rarely evaluated at the time of testing in most hearing assessments. Given the bidirectional relationships between hearing and affect which we have described, assessing the affective state throughout a quantitative and qualitative hearing assessment might give a fuller picture of the dynamic functional range (e.g., possible potential) of an impaired auditory system.

Small effects across a variety of studies suggest that affective features have some, if limited impact on auditory perception at the basic pure tone level. For instance, positive and negative word primes facilitate high- and low-pitch tone perception, respectively, although the tones alone are not judged to have an affective valence (Weger et al., 2007). Similarly, angry voice prompts modulate auditory spatial attention and facilitate neutral pure tone detection (Ceravolo et al., 2016). Arousal affects the threshold at which masked stimuli can be perceived (Bolders et al., 2017). People high in arousal give higher magnitude estimates to the loudness of a 1,000-Hz 80-dB SPL tone than those low in arousal under stress (Dess & Edelheit, 1998). Hand-holding, which decreases reactivity in brain areas that are reactive to threats (Coan et al., 2006), decreases reactivity to startling sounds (Kerr et al., 2018). In auditory brainstem responses to speech, subcortical neural activity increased as early as 20 ms after stimulus onset for negative compared with neutral speech (Wang et al., 2009). Auditory P300 amplitudes and area-under-the-curve are larger when a sad mood is induced (Yamamoto et al., 2000). Mood-congruent brain potentials are observed for auditory stimuli (e.g., larger N400 event-related potentials for negative stimuli in negative moods) (Egidi & Nusbaum, 2012). Although many of the abovementioned effects are fairly small, they suggest the potential for affective information to affect some patients seen in daily audiology practice. As these effects may be larger for some patients than others, evaluating variation in hearing ability under different affective conditions at the individual patient level may provide useful hints for fine-tuning hearing aids in different listening programs, or may help to guide clinicians' psychosocial advice to clients.

Affective states also impact high-level attention, memory, reasoning, and responding cognitive processes (Mitchell & Phillips, 2007) which interact with hearing. For example, music-induced positive mood is associated with increases in the event-related brain potential response to distractor sounds (e.g., N1/MMN) (Putkinen et al., 2017). Spies et al. (1996) tested participants on a simple word span task (short-term verbal memory) and a more complex reading span task (working memory) following mood induction. They found that while negative mood did not decrease the executive capacity, positive mood resulted in greater deficits in the complex span task than in the simple word span task. Cognitive reasoning and response processes related to hearing can be impacted by affective factors with many other similar examples (Schwarz & Clore, 1983; Tiedens & Linton, 2001).

Affective variables also appear to affect how people understand and relate to their hearing problems. For example, people with lower moods rate themselves as having hearing-loss-related quality of life issues (Preminger & Meeks, 2010). Negative affective states induced by the COVID-19 pandemic have been observed to worsen self-perceived tinnitus loudness, increase annoyance, and decrease quality of life (Aydoğan et al., 2022).

There are many theories of how affective states could affect sensory and cognitive processing that may underlie the above-mentioned phenomena. For example, Schwarz (1990, 2011) suggests that negative affective states inform us that our current situation is problematic and an action might be needed to change it; therefore, effortful, detail-oriented, analytical processing and risk-avoiding strategies are fostered to maximize positive outcomes. By contrast, positive affective states inform us that the current situation is safe and satisfactory. They may not signal that a particular action or cognitive effort is required other than by following the currently active goals, resulting in a global top-down processing style and medium-risk approaches (Bless et al., 1996). Hence, affective states might elicit different motivations and effort exertions. Bower (1981) proposes that cognitive and sensory processing will often be mood-congruent due to spreading activation from representations of recalled mood-congruent memories. Gendolla (2000) proposes that cognitive processes and hedonic motivation act as mediators of mood–behavior linkage. Thus, audiologists working to understand affective influences on hearing have a wealth of theory, as well as empirical data to appeal to.

That said, affective influences on other sensory domains may be better explored than hearing, and factors such as processing motivation and capacity (Fiske & Neuberg, 1990) could vary differentially across modalities. Thus, more data on affect/sensory-processing in the auditory domain may be useful to acquire, particularly as is relevant to audiology examinations. For example, whether there are ranges for routine audiological examinations that affect changes in performance, or whether amplification prescriptions for hearing loss and sound treatment for tinnitus account for the potential affect-dependent boosting or hindering of the hearing perception abilities. Potentially accounting for affective style could help to promote individualized treatment, increasing user satisfaction and compliance. It may also be useful to examine whether self-affect-regulation strategies compensate for the cognitive decline associated with hearing problems, including lack of motivation to listen, misinterpretation of emotional vocal sounds in social environments, and negative judgment bias on quality of life and well-being caused by hearing problems.

Tinnitus

Personalizing treatment for tinnitus has been a challenge in research or clinical practice (Mazurek, 2018; Simoes et al., 2021) as the experience of tinnitus is very individual (Hall et al., 2016). Attending to affective features may help in this endeavor. Largely nonaffective characteristics are often considered in tinnitus such as severity, duration, and presence of comorbidities; affective features are relegated to consideration of clinically relevant individual characteristics such as anxiety (Kumbul et al., 2022) and depression (Baguley et al., 2013; Van der Wal et al., 2020). However, it remains unclear why some people are distressed by tinnitus while others are not. Similarly, the wide spectrum of therapeutic strategies for tinnitus treatment could indirectly address affective features, but these are not centralized, for example, in interventions ranging from transcranial magnetic and vagus nerve stimulation, cochlear implant electrical stimulation, cognitive behavioral therapy or sound therapy (Lopez-Escamez & Perez-Carpena, 2022) to antidepressants (Baldo et al., 2012); their outcomes vary and the positive effects on tinnitus perception modification are often short-lasting (Czornik et al., 2022; Katiri et al., 2021).

Affect-directed approaches might be helpful to move closer to precision tinnitus treatment. For example, in light of the evidence that tinnitus and emotion both depend on time-of-day (Heller et al., 2021; Probst et al., 2017; Wright & Woods, 2020), Simoes et al. (2022) adopted ecological momentary assessment (EMA) by using a tinnitus mobile app to track daily tinnitus symptoms and psychological variables in 278 app users between 2014 and 2020. They found that emotional arousal, overall stress, mood, and concentration influenced tinnitus loudness and distress on the day and the subsequent days at the individual level.

More generally, accounting for the affect could improve tinnitus treatments. In a randomized controlled trial, Westin et al. (2011) compared the effects of Acceptance and Commitment Therapy (ACT) with Tinnitus Retraining Therapy (TRT) on tinnitus impact, and showed that ACT, which consists of mindfulness and acceptance training, significantly outperformed TRT on tinnitus impact, evaluated by the Tinnitus Handicap Inventory (Newman et al., 1996). Similarly, a small sample randomized controlled trial demonstrated that a mindfulness meditation/cognitive behavioral therapy (CBT) approach of four sessions led to a significant reduction in tinnitus-related distress (Sadlier et al., 2008). These findings suggest that adopting methods from affective science could impact tinnitus recovery.

Such affect-directed approaches may enhance available tinnitus treatments by taking into account the fluctuation of emotions and tinnitus over time so as to provide an integrated and adaptive protocol for each individual tinnitus sufferer. For example, when a treatment is prescribed for a tinnitus patient based on a cross-sectional evaluation of tinnitus loudness and distress, there will be times when the mood fluctuation changes the tinnitus loudness and distress so much so that the outcomes are drifted away from the prescribed goal. Antidepressants and CBT, in particular, are well known to have effects on emotion. More specific affective modifications such as incorporating emotion regulation strategies could explicitly address emotional features (Picó-Pérez et al., 2017).

Data-driven tinnitus intervention recommender systems, such as the tinnitus research initiative (TRI) database (Landgrebe et al., 2010) and the Tinnitus-Assessments, Causes and Treatments (TIN-ACT) database (TIN-ACT, 2017), may thus benefit from including affective features to improve their performance.

Incorporating Affect Into Audiology

The previous section showcased examples of how research in affect-related disciplines could expand our thinking about specific challenges in audiology. There may be more connections between affect and hearing to explore once audiology scientists become better-versed in affective constructs and assessment methodologies.

Access to Affective Constructs

Affect is a general concept that refers to consciously accessible feelings. These are associated with emotions, physical sensations, motivations, attitudes, moods, and affective traits (Fredrickson, 2001), constructs that both intersect and differ. Comprehensive definitions of core affective determinants can be found in the affective science literature, for example, "emotion" as concerning momentary affective states on the order of seconds to minutes (Barrett et al., 2016; Cabanac, 2002; Reeve, 2018), "motivation" as concerning action tendencies largely governed by reward and punishment (Buck, 1988; Peters, 2015; Reeve, 2018), "mood" as concerning sustained emotion states on the order of hours to days (Barrett et al., 2016; Batson et al., 1992; Ekkekakis, 2012; Portner, 2018), and "attitude" as concerning beliefs and their application to emotional appraisals (Eagly & Chaiken, 1998; Greenwald, 1968; Schwarz, 2007). In relation to hearing/listening, we suggest applying the following distinctions when searching for relevant literature. The "emotion" literature can inform how affective intensity and hedonic content (pleasure/displeasure) interact with how one hears and listens in the moment. Literature on "motivation" can help to suggest why one prefers to listen under certain conditions over others. Literature on "mood" can inform how sustained affective states affect hearing performance. Literature on "attitude" can inform about how one's beliefs shape the perceived acoustic information.

Advances in affective science have produced some useful resources enabling people from other disciplines quickly locate affective constructs of interest in structured ways. One such resource is the Research Domain Criteria matrix launched by the National Institute of Mental Health (Insel et al., 2010), in which the matrix rows represent various constructs grouped hierarchically into broad function domains (i.e., negative valence systems, positive valence, cognitive systems, social processes, arousal and regulatory systems, and sensorimotor systems), and the columns denote levels of analysis (i.e., genetic, molecular, cellular, circuit, individual, family environment, and social context). This corpus of constructs could help to explore possible affect pathways associated with hearing/listening and provide information about the frequently used paradigms in studying those constructs. For example, audiology researchers may find studying the connection between strategic listening effort allocation and two distinct action tendencies, approach, and avoidance (grouped in the negative valence systems), worthwhile. This could be done via the fear and reward neural circuits using behavioral approach paradigms. Audiology researchers may also be interested in studying emotion-regulation strategies (e.g., mindfulness meditation, cognitive reappraisal, and acceptance) for tinnitus treatment based on the salience and executive network circuits activated during rumination-induction paradigms (e.g., Brandeis et al., in press).

Appealing to other affect science literature may help audiologists to disambiguate emotional constructs. For example, Ekman (1992) posits a discrete and limited set of basic emotions (e.g., fear, happiness, sadness, calmness, sorrow, and shame), each with unique neural, behavioral, psychological, and physiological manifestations. Standardized emotion-evoking stimuli using this framework are available, for example, Cowen et al. (2021). Alternately, a common dimensional framework, for example, Russell (1980), holds that emotions can be placed on a circumplex defined by valence (pleasure–displeasure continuum) and arousal/alertness (activation–deactivation continuum) axes (Barrett, 2006; Larsen & Diener, 1992). Discrete emotions can thus be understood as reflecting linear combinations of valence and arousal (Posner et al., 2005). Typical emotion-inducing stimuli, validated in line with this theory, include the International Affective Picture System (Lang, 2005), International Affective Digital Sounds (Bradley & Lang, 2007), and Affective Norms for English Words (Bradley & Lang, 1999). Both of these frameworks, as well as many others, have been extensively used in the affective science literature, as shown in Table 2, and each has advantages that the audiology researchers can build on. Thus, there are no lack of potentially well-fitting theoretical frameworks for the aspiring affective audiologist to appeal to.

Measurement of Affective Constructs

Audiology and affective science frequently make use of similar assessment technologies as shown in Table 2 (see Supplemental Material document with reference for Table 2). Thus, assessment of affective components can be readily integrated into hearing research and clinical practice where adequate technologies are available, potentially leading to new treatment and personalization targets. Cognizance of affective moderation of hearing assessment measures may also illustrate alternate interpretations for data which is routinely acquired in audiology. For example, the cingulo-opercular neural network activity captured by functional brain imaging measurements can simultaneously reflect listening effort in difficult speech perception tasks (Eckert et al., 2016) and affective-related functions such as alertness maintenance (Coste & Kleinschmidt, 2016; Sadaghiani & D'Esposito, 2015) and self-awareness of difficulty in action selection (Desender et al., 2021). This overlap raised the question of what is being measured in terms of listening effort (Francis & Love, 2019): is it cognition, affects, or both? Is it possible to investigate the demanded (associated with task properties), exerted (actual effort expenditure), and self-assessed (feelings about effort) efforts separately? Acknowledging these relationships thus situations audiology constructs in a wider range of perspectives, so that explanations of hearing/listening behaviors are not limited to the sensory and cognitive domains. As in hearing literature (Başar-Eroglu et al., 1992), nuances such as the time windows over which reactivity are assessed are equally important to attend to in the emotion domain (Papousek et al., 2011; Siegle et al., 2008, 2015).

Other psychophysiological measurements, long used in cognitive and affective sciences but rarely in audiology, are rapidly becoming popular as objective approaches to evaluate auditory information processing and the related conscious control in hearing research. Thus, the cognitive and affective science literature may have guidelines to appeal to for accurate recording, preprocessing, analysis, reporting, and interpretation involving a wide variety of cognitive and affective influences on the employed measures, for example, pupillary reactivity (Steinhauer et al., 2022), heart rate and heart rate variability (Berntson et al., 1997; Jennings et al., 1981), electrodermal activity (Boucsein et al., 2012), electroencephalogram (Keil et al., 2014; Pivik et al., 1993), event-related potentials (Picton et al., 2000), respiration (Ritz et al., 2002), electromyography (Fridlund & Cacioppo, 1986), startle eye-blink electromyography (Blumenthal et al., 2005), magnetoencephalography (Keil et al., 2014), impedance cardiography (Sherwood et al., 1990), functional near-infrared spectroscopy (Yücel et al., 2021), and functional magnetic resonance imaging (Poldrack et al., 2008).

Methodological Considerations

There are unique considerations that introduce complexity into the use and measurement of affective features, some of which may interact with how they are applied in the context of audiology. We list a number of these considerations in this section.

Affective reactivity may be moderated by beliefs. For example, anger is often assumed to promote aggression (Anderson & Bushman, 2002), and excitement to promote creativity (Baas et al., 2008). These effects depend on participants' expectations/beliefs in these effects (Tamir & Bigman, 2018). Similarly, attitudinal belief in success likelihood promotes actual success in emotion regulation tests (Bigman et al., 2016).

Affective factors may modulate the success of hearing interventions. If people with biological hearing problems have mentally adapted to them using efficient coping strategies and/or highly supportive families and communities, aggressive interventions in such scenarios might introduce stigma yielding negative affect, which could compromise the effectiveness of the interventions.

Table 2. Representative Audiology and Affective Constructs Measured by Various Qualifying Method Categories. The Same Table, With Relevant References for Each Construct, is Included as a Supplement.

Category	Audiology constructs	Affective constructs
Autonomic nervous system physiological measures (e.g., electrodermal response, heart rate, heart rate variability, blood pressure, pupil dilation, sweating, and skin temperature)	Sound detection; Speech perception; Ambiguous speech comprehension; Auditory processing speed; Exerted listening effort.	Arousal; Valence; Vigilance; Emotional salience; Habituation; Rumination Motivation; Fatigue; Engagement; Alertness; Stress.
Central nervous system physiological measures (e.g., functional magnetic resonance imaging, electroencephalography, functional near-infrared spectroscopy, positron emission tomography)	Tinnitus perception; Hyperacusis; Linguistic processing of speech; Affective speech processing; Sound localization; Auditory attention; Auditory memory; Auditory discrimination; Auditory plasticity; Hearing-related emotional impairment.	Affect discrimination; Affective personality; Emotional self-monitoring/regulation; Affective decision-making; Interoceptive self-monitoring; Affective disturbances; Affective response; Emotional contagion; umination.
Behavioral measures (i.e., response time and performance accuracy)	Hearing sensitivity; Auditory discrimination; Speech perception; Speech recognition; Speech comprehension; Auditory attention; Auditory adaptation/acclimatization; Auditory emotion recognition; Exerted listening effort.	Emotion perception and recognition (e.g., excitement, elation, joy, surprise, calmness, sadness, anger, gratitude, disgust, fear, attractiveness, and shame); Emotion expression; Approach–avoidance.
Self-reported measures (e.g., survey, visual analog rating)	Perceived disability; Assessed listening effort; Experienced listening effort; Hearing-related emotion experience (e.g., loneliness, social isolation, depression, stress, distress, anxiety, hearing acceptance, and satisfaction with amplification).	Emotion experience (e.g., appreciation, happiness, relaxation, calmness, excitement, sadness, anger, fear, stress, disgust, envy, shame, guilt, pride, satisfaction, awe, craving, loneliness, empathy, frustration, mental pain, contempt, anxiety, depression); Emotion regulation; Need for affect; Affective attitude.

Coherence across the experiential, behavioral, and physiological responses to emotions is of only moderate magnitude (Mauss et al., 2005), just as various listening effort measurements lack correlation (Alhanbali et al., 2019; Lau et al., 2019). Coherence varies depending on the test conditions; therefore, multiple measures of affective variables may be desirable for complementary interpretations of experimental results.

Although only correct trials are generally analyzed in audiology studies, physiological reactivity to incorrect trials carries important affective information (e.g., stress, boredom, or fatigue) (Amodio et al., 2008; Salomone et al., 2021; Yakobi et al., 2021). Performance is often operationalized in terms of error rate (lapses in attention) and reaction times (processing time), both of which are sensitive to internal (e.g., specific combinations of task parameters used) and external (e.g., time of day, personality, sex, environment, motivation, anticipation, and mood) factors which can interact with affect. Including the incorrect/error trials in the psychophysiological analysis could help investigate the origins of the listeners' capabilities in error detection and remedial actions such as error inhibition, immediate error correction, and error compensation.

Unlike the fairly stable development of hearing loss with age, affective features change with development and are subject to many moderators. For instance, emotion understanding develops throughout childhood, adolescence, and sometimes into adulthood (Kramer & Lagattuta, 2022). Emotion regulation is expected to mature through adolescence as prefrontal brain regions mature, though this trajectory may vary depending on socioeconomic status and its impact on the family's emotional context (Herd et al. (2020)). Similarly, the well-documented increased preference for attending to and remembering positive information over negative information with age might depend on cognitive load and/or perceived time horizon at evaluation (Carstensen & DeLiema, 2018). The complexity of developmental variations in affect with age implies that age and associated moderation effects may be useful to account for when assessing interactions between hearing problems and affective states.

While most auditory research is based on the investigation of fine-grained differences in auditory perception requiring high-level acoustic standardization and calibration across systems and settings, the study of affective speech perception may benefit from data collection under less precisely controlled environmental conditions (e.g., the Internet) to reveal more ecologically valid estimates of affect-related hearing (Honing & Ladinig, 2008). Knoll et al. (2011) provided compelling support for the validity of conducting emotional speech perception experiments via the Internet, specifically when giving participants the freedom to choose the volume level, environmental set-up, and stimuli reproduction system. They were able to replicate the laboratory-controlled affective speech ratings in this, less controlled, Internet environment.

Summary and Conclusions

We have suggested that affect has strong influences on how we perceive and behave in the world. Our goal in the present selective review was to demonstrate that affective factors could impact hearing/listening functions (sensitivity and cognition) and experiences. We have thus suggested augmenting the current literature on affective phenomena as health outcomes of hearing problems in audiology science to account for potential moderating roles of affect on hearing assessments, and more broadly, to highlight a wide variety of potential links between affective science and audiology. Our hope is that exploiting these links will help overcome ongoing challenges in hearing health service research.

We have further suggested that future clinical practice and research aimed at identifying the contribution of affective factors to hearing/listening phenomena can build on general theories in affective science and the methods developed to investigate them. For example, if clinicians are already informally checking clients' feelings during the appointment, endorsing items from formal lists of emotional descriptors (e.g., Watson et al., 1988) could help to standardize these assessments. Asking clients about relationships between their emotional states and their hearing could also be useful. If clients report affect-mediated hearing problems, then clinicians may want to consider administering a mood-induction prior to standardized hearing assessment, potentially by using the types of standardized emotion-evoking stimuli mentioned earlier. If reported hearing problems involve emotion recognition, it may be useful to check hearing in response to calibrated emotional stimuli designed for emotion recognition evaluation, such as the Ryerson Audio-Visual Database of Emotional Speech and Song (RAVDESS) (Livingstone & Russo, 2018), expanded International Affective Digital Sounds database (Yang et al., 2018), diagnostic analysis of nonverbal accuracy (DANVA) (Nowicki & Duke, 2001), or the Hoosier Vocal Emotions Corpus (Darcy & Fontaine, 2020). A test result consistent with the client's report (e.g., hearing is worse in terms of elevated pure tone thresholds or decreased speech intelligibility/vocal emotion perception when in an upset or anxious mood) might suggest a need to modify the current intervention to foster personalized optimal hearing device use, such as activating a new listening program in the hearing aids with amplifications specific for listening during highly anxious periods, and/or creating an individualized daily hearing aid wearing schedule based on the client's mood changes. If hearing-related distress exists, psychological therapies such as acceptance and commitment therapy, investigated by Molander et al. (2018) can be considered. Consideration of affective, as well as hearing outcome measures may also be warranted. We are optimistic that as audiology and affective science become ever more integrated, more practical uses of each discipline in the other's practices may emerge.

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Supplemental Material

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References

Alhanbali, S., Dawes, P., Millman, R. E., & Munro, K. J. (2019). Measures of listening effort are multidimensional. *Ear &*

Hearing, 40(5), 1084–1097. https://doi.org/10.1097/AUD.0000000000000697

Amodio, D. M., Master, S. L., Yee, C. M., & Taylor, S. E. (2008). Neurocognitive components of the behavioral inhibition and activation systems: Implications for theories of self-regulation. *Psychophysiology*, *45*, 11–19. https://doi.org/10.1111/j.1469-8986.2007.00609.x.

Anderson, C. A., & Bushman, B. J. (2002). Human aggression. *Annual Review of Psychology*, *53*(1), 27–51. https://doi.org/10.1146/annurev.psych.53.100901.135231

Apps, M. A., & Ramnani, N. (2014). The anterior cingulate gyrus signals the net value of others' rewards. *The Journal of Neuroscience*, *34*(18), 6190–6200. https://doi.org/10.1523/JNEUROSCI.2701-13.2014

Armony, J. L., Quirk, G. J., & LeDoux, J. E. (1998). Differential effects of amygdala lesions on early and late plastic components of auditory cortex spike trains during fear conditioning. *Journal of Neuroscience*, *18*(7), 2592–2601. https://doi.org/10.1523/JNEUROSCI.18-07-02592.1998

Aydoğan, Z., Çinar Satekin, M., Ocak, E., & Tokgöz Yilmaz, S. (2022). Effects of the coronavirus disease 2019 pandemic on subjective tinnitus perception. *The Journal of Laryngology & Otology*, *136*(5), 410–413. https://doi.org/10.1017/S0022215122000640

Baas, M., De Dreu, C. K., & Nijstad, B. A. (2008). A meta-analysis of 25 years of mood-creativity research: Hedonic tone, activation, or regulatory focus? *Psychological Bulletin*, *134*(6), 779–806. https://doi.org/10.1037/a0012815

Baguley, D., McFerran, D., & Hall, D. (2013). Tinnitus. *Lancet*, *382*(9904), 1600–1607. https://doi.org/10.1016/S0140-6736(13)60142-7

Baldo, P., Doree, C., Molin, P., McFerran, D., & Cecco, S. (2012). Antidepressants for patients with tinnitus. *The Cochrane Database of Systematic Reviews*, *2012*(9), 1–29. https://doi.org/10.1002/14651858.CD003853

Barker, A. B., Leighton, P., & Ferguson, M. A. (2017). Coping together with hearing loss: A qualitative meta-synthesis of the psychosocial experiences of people with hearing loss and their communication partners. *International Journal of Audiology*, *56*(5), 297–305. https://doi.org/10.1080/14992027.2017.1286695

Barrett, K. C., Chatterjee, M., Caldwell, M. T., Deroche, M. L. D., Jiradejvong, P., Kulkarni, A. M., & Limb, C. J. (2020). Perception of child-directed versus adult-directed emotional speech in pediatric cochlear implant users. *Ear & Hearing*, *41*(5), 1372–1382. https://doi.org/10.1097/AUD.0000000000000862

Barrett, L. F. (2006). Are emotions natural kinds? *Perspectives on Psychological Science*, *1*(1), 28–58. https://doi.org/10.1111/j.1745-6916.2006.00003.x

Barrett, L. F., Lewis, M., & Haviland-Jones, J. M. (2016). *Handbook of emotions*. Guilford Publications.

Başar-Eroglu, C., Başar, E., Demiralp, T., & Schürmann, M. (1992). P300-response: Possible psychophysiological correlates in delta and theta frequency channels. A review. *International Journal of Psychophysiology*, *13*(2), 161–179. https://doi.org/10.1016/0167-8760(92)90055-G

Batson, C. D., Shaw, L. L., & Oleson, K. C. (1992). Differentiating affect, mood, and emotion: Toward functionally based conceptual distinctions. In M. S. Clark (Ed.), *Emotion* (pp. 294–326). Sage Publications, Inc.

Berntson, G. G., Thomas Bigger, J. Jr, Eckberg, D. L., Grossman, P., Kaufmann, P. G., Malik, M., Nagaraja, H. N., Porges, S. W., Saul, J. P., & Stone, P. H. (1997). Heart rate variability: Origins, methods, and interpretive caveats. *Psychophysiology*, *34*(6), 623–648. https://doi.org/10.1111/j.1469-8986.1997.tb02140.x

Bigman, Y. E., Mauss, I. B., Gross, J. J., & Tamir, M. (2016). Yes, I can: Expected success promotes actual success in emotion regulation. *Cognition and Emotion*, *30*(7), 1380–1387. https://doi.org/10.1080/02699931.2015.1067188

Bless, H., Clore, G. L., Schwarz, N., Golisano, V., Rabe, C., & Wölk, M. (1996). Mood and the use of scripts: Does a happy mood really lead to mindlessness? *Journal of Personality and Social Psychology*, *71*(4), 665–679. https://doi.org/10.1037/0022-3514.71.4.665

Blumenthal, T. D., Cuthbert, B. N., Filion, D. L., Hackley, S., Lipp, O. V., & Van Boxtel, A. (2005). Committee report: Guidelines for human startle eyeblink electromyographic studies. *Psychophysiology*, *42*(1), 1–15. https://doi.org/10.1111/j.1469-8986.2005.00271.x

Bolders, A. C., Band, G. P. H., & Stallen, P. J. M. (2017). Inconsistent effect of arousal on early auditory perception. *Frontiers in Psychology*, *29*(8), 447–464. https://doi.org/10.3389/fpsyg.2017.00447

Bos, A. E., Pryor, J. B., Reeder, G. D., & Stutterheim, S. E. (2013). Stigma: Advances in theory and research. *Basic and Applied Social Psychology*, *35*(1), 1–9. https://doi.org/10.1080/01973533.2012.746147

Bott, A., & Saunders, G. (2021). A scoping review of studies investigating hearing loss, social isolation and/or loneliness in adults. *International Journal of Audiology*, *60*(Sup 2), 30–46. https://doi.org/10.1080/14992027.2021.1915506

Boucsein, W., Fowles, D. C., Grimnes, S., Ben-Shakhar, G., Roth, W. T., Dawson, M. E., & Filion, D. L. (2012). Publication recommendations for electrodermal measurements. *Psychophysiology*, *49*(8), 1017–1034. https://doi.org/10.1111/j.1469-8986.2012.01384.x

Bower, G. H. (1981). Mood and memory. *American Psychologist*, *36*(2), 129–148. https://doi.org/10.1037/0003-066X.36.2.129

Bradley, M. M., & Lang, P. J. (1999). Affective norms for English words (ANEW): Instruction manual and affective ratings. *Technical report C-1, the center for research in psychophysiology*, University of Florida, *30*(1), 25–36.

Bradley, M. M., & Lang, P. J. (2007). The international affective digitized sounds (2nd Edition; IADS-2): Affective ratings of sounds and instruction manual. *Technical report B-3*, University of Florida, Gainesville, Fl.

Brandeis, B. O., Siegle, G. J., Franzen, P., Soehner, A., Hasler, B., McMakin, D., Young, K., & Buysse, D. J. (in press). Subjective and neural reactivity during savoring and rumination. *Cognitive Affective and Behavioral Neuroscience*, 1–13. https://doi.org/10.3758/s13415-023-01123-2

Breves, P., & Heber, V. (2020). Into the wild: The effects of 360° immersive nature videos on feelings of commitment to the environment. *Environmental Communication*, *14*(3), 332–346. https://doi.org/10.1080/17524032.2019.1665566

Brewster, K. K., Pavlicova, M., Stein, A., Chen, M., Chen, C., Brown, P. J., Roose, S. P., Kim, A. H., Golub, J. S., Brickman, A., Galatioto, J., Kuhlmey, M., & Rutherford, B. R. (2020). A pilot randomized controlled trial of hearing aids to improve mood and cognition in older adults. *International Journal of Geriatric Psychiatry*, *35*(8), 842–850. https://doi.org/10.1002/gps.5311

Brink, P., & Stones, M. (2007). Examination of the relationship among hearing impairment, linguistic communication, mood, and social engagement of residents in complex continuing-care facilities. *The Gerontologist*, *47*(5), 633–641. https://doi.org/10.1093/geront/47.5.633

Briñol, P., Petty, R. E., Santos, D., & Mello, J. (2017). Meaning moderates the persuasive effect of physical actions: Buying, selling, touching, carrying, and cleaning thoughts as if they were commercial products. *Journal of the Association for Consumer Research*, *2*(4), 460–471. https://doi.org/10.1086/693561

Buchanan, T. W., Denburg, N. L., Tranel, D., & Adolphs, R. (2001). Verbal and nonverbal emotional memory following unilateral amygdala damage. *Learning & Memory*, *8*(6), 326–335. https://doi.org/10.1101/lm.40101

Buck, R. (1988). *Human motivation and emotion*. John Wiley & Sons.

Burke, L. A., & Naylor, G. (2020). Daily-life fatigue in mild to moderate hearing impairment: An ecological momentary assessment study. *Ear & Hearing*, *41*(6), 1518–1532. https://doi.org/10.1097/AUD.0000000000000888

Cabanac, M. (2002). What is emotion? *Behavioural Processes*, *60*(2), 69–83. https://doi.org/10.1016/S0376-6357(02)00078-5

Canbeyli, R. (2010). Sensorimotor modulation of mood and depression: An integrative review. *Behavioural Brain Research*, *207*(2), 249–264. https://doi.org/10.1016/j.bbr.2009.11.002

Canbeyli, R. (2022). Sensory stimulation via the visual, auditory, olfactory and gustatory systems can modulate mood and depression. *European Journal of Neuroscience*, *55*(1), 244–263. https://doi.org/10.1111/ejn.15507

Cannon, S. A., & Chatterjee, M. (2019). Voice emotion recognition by children with mild to moderate hearing loss. *Ear & Hearing*, *40*(3), 477–492. https://doi.org/10.1097/AUD.0000000000000637

Cannon, S. A., & Chatterjee, M. (2022). Age-related changes in voice emotion recognition by postlingually deafened listeners with cochlear implants. *Ear & Hearing*, *43*(2), 323–334. https://doi.org/10.1097/AUD.0000000000001095

Carstensen, L. L., & DeLiema, M. (2018). The positivity effect: A negativity bias in youth fades with age. *Current Opinion In Behavioral Sciences*, *19*, 7–12. https://doi.org/10.1016/j.cobeha.2017.07.009

Ceravolo, L., Frühholz, S., & Grandjean, D. (2016). Modulation of auditory spatial attention by angry prosody: An fMRI auditory dot-probe study. *Frontiers in Neuroscience*, *12*(10), 216–227. https://doi.org/10.3389/fnins.2016.00216

Chadha, S., & Cieza, A. (2017). Promoting global action on hearing loss: World hearing day. *International Journal of Audiology*, *56*(3), 145–147. https://doi.org/10.1080/14992027.2017.1291264

Chadha, S., & Cieza, A. (2018). World Health Organization and its initiative for ear and hearing care. *Otolaryngologic Clinics of North America*, *51*(3), 535–542. https://doi.org/10.1016/j.otc.2018.01.002

Chen, G. D., Manohar, S., & Salvi, R. (2012). Amygdala hyperactivity and tonotopic shift after salicylate exposure. *Brain Research*, *1485*, 63–76. https://doi.org/10.1016/j.brainres.2012.03.016

Chien, W., & Lin, F. R. (2012). Prevalence of hearing aid use among older adults in the United States. *Archives of Internal Medicine*, *172*(3), 292–293. https://doi.org/10.1001/archinternmed.2011.1408

Choi, Y. K., Seo, Y., Wagner, U., & Yoon, S. (2020). Matching luxury brand appeals with attitude functions on social media across cultures. *Journal of Business Research*, *117*, 520–528. https://doi.org/10.1016/j.jbusres.2018.10.003

Christ, M., Michael, N., Hihn, H., Schüttke, A., Konrad, C., Baune, B. T., Jansen, A., & Pfleiderer, B. (2008). Auditory processing of sine tones before, during and after ECT in depressed patients by fMRI. *Journal of Neural Transmission (Vienna, Austria: 1996)*, *115*(8), 1199–1211. https://doi.org/10.1007/s00702-008-0036-5

Clark, J. K., Wegener, D. T., & Fabrigar, L. R. (2008). Attitude accessibility and message processing: The moderating role of message position. *Journal of Experimental Social Psychology*, *44*(2), 354–361. https://doi.org/10.1016/j.jesp.2006.12.001

Coan, J. A., Schaefer, H. S., & Davidson, R. J. (2006). Lending a hand: Social regulation of the neural response to threat. *Psychological Science*, *17*(12), 1032–1039. https://doi.org/10.1111/j.1467-9280.2006.01832.x

Coste, C. P., & Kleinschmidt, A. (2016). Cingulo-opercular network activity maintains alertness. *Neuroimage*, *128*, 264–272. https://doi.org/10.1016/j.neuroimage.2016.01.026

Cowen, A. S., Keltner, D., Schroff, F., Jou, B., Adam, H., & Prasad, G. (2021). Sixteen facial expressions occur in similar contexts worldwide. *Nature*, *589*(7841), 251–257. https://doi.org/10.1038/s41586-020-3037-7

Croxson, P. L., Walton, M. E., O'Reilly, J. X., Behrens, T. E., & Rushworth, M. F. (2009). Effort-based cost–benefit valuation and the human brain. *Journal of Neuroscience*, *29*(14), 4531–4541. https://doi.org/10.1523/JNEUROSCI.4515-08.2009

Czornik, M., Malekshahi, A., Mahmoud, W., Wolpert, S., & Birbaumer, N. (2022). Psychophysiological treatment of chronic tinnitus: A review. *Clinical Psychology & Psychotherapy*, *29*(4), 1236–1253. https://doi.org/10.1002/cpp.2708

Danermark, B. D. (1998). Hearing impairment, emotions and audiological rehabilitation: A sociological perspective. *Scandinavian Audiology*, *27*(4), 125–131. https://doi.org/10.1080/010503998420757

Darcy, I., & Fontaine, N. M. G. (2020). The Hoosier vocal emotions corpus: A validated set of North American English pseudo-words for evaluating emotion processing. *Behavior Research Methods*, *52*(2), 901–917. https://doi.org/10.3758/s13428-019-01288-0

Davis, A., McMahon, C. M., Pichora-Fuller, K. M., Russ, S., Lin, F., Olusanya, B. O., Chadha, S., & Tremblay, K. L. (2016). Aging and hearing health: The life-course approach. *The Gerontologist*, *56*(Suppl 2), S256–S267. https://doi.org/10.1093/geront/gnw033

Davis, A., & Smith, P. (2013). Adult hearing screening: Health policy issues—What happens next? *American Journal of Audiology*, *22*(1), 167–170. https://doi.org/10.1044/1059-0889(2013/12-0062)

Davis, M. H., & Johnsrude, I. S. (2003). Hierarchical processing in spoken language comprehension. *The Journal of Neuroscience: The Official Journal of the Society for Neuroscience*, *23*(8), 3423–3431. https://doi.org/10.1523/JNEUROSCI.23-08-03423.2003

DePierre, J. A., Puhl, R. M., & Luedicke, J. (2013). A new stigmatized identity? Comparisons of a "food addict" label with other stigmatized health conditions. *Basic and Applied Social Psychology*, *35*(1), 10–21. https://doi.org/10.1080/01973533.2012.746148

Derricks, V., & Earl, A. (2019) Information targeting increases the weight of stigma: Leveraging relevance backfires when people feel judged. *Journal of Experimental Social Psychology*, *82*, 277–293. https://doi.org/10.1016/j.jesp.2018.12.003

Desender, K., Teuchies, M., Gonzalez-Garcia, C., De Baene, W., Demanet, J., & Brass, M. (2021). Metacognitive awareness of difficulty in action selection: The role of the cingulo-opercular network. *Journal of Cognitive Neuroscience*, *33*(12), 2512–2522. https://doi.org/10.1162/jocn_a_01773

Dess, N. K., & Edelheit, D. (1998). The bitter with the sweet: The taste/stress/temperament nexus. *Biological Psychology*, *48*(2), 103–119. https://doi.org/10.1016/S0301-0511(98)00014-3

D'Haese, P. S., M De Bodt., V Van Rompaey., & P Van de Heyning. (2018). Awareness of hearing loss in older adults: Results of a survey conducted in 500 subjects across 5 European countries as a basis for an online awareness campaign. *INQUIRY: The Journal of Health Care Organization, Provision, and Financing*, *55*, 1–9. https://doi.org/10.1177/0046958018759421

Dimitrijevic, A., Smith, M. L., Kadis, D. S., & Moore, D. R. (2019). Neural indices of listening effort in noisy environments. *Scientific Reports*, *9*(1), 1–10. https://doi.org/10.1038/s41598-019-47643-1

Dos Santos, A. D. P., Ferrari, A. L. M., Medola, F. O., & Sandnes, F. E. (2022). Aesthetics and the perceived stigma of assistive technology for visual impairment. *Disability and Rehabilitation: Assistive Technology*, *17*(2), 152–158. https://doi.org/10.1080/17483107.2020.1768308

Eagly, A., & Chaiken, S. (1998). *Handbook of Social Psychology* (Vol. 1, pp. 269–322). McGraw-Hill.

Eckert, M. A., Menon, V., Walczak, A., Ahlstrom, J., Denslow, S., Horwitz, A., & Dubno, J. R. (2009) At the heart of the ventral attention system: The right anterior insula. *Human Brain Mapping*, *30*(8), 2530–2541. https://doi.org/10.1002/hbm.20688

Eckert, M. A., Teubnerrhodes, S., & Vaden, K Jr. (2016) Is listening in noise worth it? The neurobiology of speech recognition in challenging listening conditions. *Ear & Hearing*, *37*(Suppl 1), 101S. https://doi.org/10.1097/AUD.0000000000000300

Egidi, G., & Nusbaum, H. C. (2012). Emotional language processing: How mood affects integration processes during discourse comprehension. *Brain and Language*, *122*(3), 199–210. https://doi.org/10.1016/j.bandl.2011.12.008

Ekkekakis, P. (2012). *Affect, mood, and emotion* (pp. 249–225). Human Kinetics.

Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion*, *6*(3-4), 169–200. https://doi.org/10.1080/02699939208411068

Erber, R., & Tesser, A. (1992). Task effort and the regulation of mood: The absorption hypothesis. *Journal of Experimental Social Psychology*, *28*(4), 339–359. https://doi.org/10.1016/0022-1031(92)90050-T

Faulkner, J. W., Snell, D. L., Shepherd, D., & Theadom, A. (2021). Turning away from sound: The role of fear avoidance in noise sensitivity following mild traumatic brain injury. *Journal of Psychosomatic Research*, *151*, 1–7. https://doi.org/10.1016/j.jpsychores.2021.110664

Ferguson, M. A., Kitterick, P. T., Chong, L. Y., Edmondson-Jones, M., Barker, F, & Hoare, D. J. (2017) Hearing aids for mild to moderate hearing loss in adults. *Cochrane Database of Systematic Reviews*, *9*(9), 1–37. https://doi.org/10.1002/14651858

Fiske, S. T., & Neuberg, S. L. (1990) A continuum of impression formation, from category-based to individuating processes: Influences of information and motivation on attention and interpretation. *Advances in Experimental Social Psychology*. Elsevier, *23*, 1–74.

Francis, A. L., & Love, J. (2019). Listening effort: Are we measuring cognition or affect, or both? *Wiley interdisciplinary reviews. Cognitive Science*, *11*(1), 1514–1531. https://doi.org/10.1002/wcs.1514

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist*, *56*(3), 218–226. https://doi.org/10.1037/0003-066X.56.3.218

Fridlund, A. J., & Cacioppo, J. T. (1986). Guidelines for human electromyographic research. *Psychophysiology*, *23*(5), 567–589. https://doi.org/10.1111/j.1469-8986.1986.tb00676.x

Frühholz, S., Hofstetter, C., Cristinzio, C., Saj, A., Seeck, M., Vuilleumier, P., & Grandjean, D. (2015). Asymmetrical effects of unilateral right or left amygdala damage on auditory cortical processing of vocal emotions. *Proceedings of the National Academy of Sciences*, *112*(5), 1583–1588. https://doi.org/10.1073/pnas.1411315112

Frühholz, S., Trost, W., & Grandjean, D. (2014). The role of the medial temporal limbic system in processing emotions in voice and music. *Progress in Neurobiology*, *123*, 1–17. https://doi.org/10.1016/j.pneurobio.2014.09.003

Frühholz, S., Trost, W., & Kotz, S. A. (2016). The sound of emotions—towards a unifying neural network perspective of affective sound processing. *Neuroscience & Biobehavioral Reviews*, *68*, 96–110. https://doi.org/10.1016/j.neubiorev.2016.05.002

Gendolla, G. H. (2000). On the impact of mood on behavior: An integrative theory and a review. *Review of General Psychology*, *4*(4), 378–408. https://doi.org/10.1037/1089-2680.4.4.378

Goffman, E. (2009) *Stigma: Notes on the management of spoiled identity* (pp. 23–25). Touchstone.

Gosselin, N., Peretz, I., Johnsen, E., & Adolphs, R. (2007). Amygdala damage impairs emotion recognition from music. *Neuropsychologia*, *45*(2), 236–244. https://doi.org/10.1016/j.neuropsychologia.2006.07.012

Goy, H., Pichora-Fuller, M. K., Singh, G., & Russo, F. A. (2018). Hearing aids benefit recognition of words in emotional speech but not emotion identification. *Trends in Hearing*, *22*, 1–16. https://doi.org/10.1177/2331216518801736

Graham, C. E., & Vetter, D. E. (2011). The mouse cochlea expresses a local hypothalamic-pituitary-adrenal equivalent signaling system and requires corticotropin-releasing factor receptor 1 to establish normal hair cell innervation and cochlear sensitivity. *The Journal of Neuroscience*, *31*(4), 1267–1278. https://doi.org/10.1523/JNEUROSCI.4545-10.2011

Greenwald, A. G. (1968). On defining attitude and attitude theory. *Psychological Foundations of Attitudes*, *99*, 361–388. https://doi.org/10.1016/B978-1-4832-3071-9.50020-9

Haddock, G., & Maio, G. R. (2019). Inter-individual differences in attitude content: Cognition, affect, and attitudes. *Advances in Experimental Social Psychology*. *Elsevier*, *59*, 53–102. https://doi.org/10.1016/bs.aesp.2018.10.002

Hall, D. A., Haider, H., Szczepek, A. J., Lau, P., Rabau, S., Jones-Diette, J., Londero, A., Edvall, N. K., Cederroth, C. R., Mielczarek, M., Fuller, T., Batuecas-Caletrio, A., Brueggemen, P., Thompson, D. M., Norena, A., Cima, R. F., Mehta, R. L., & Mazurek, B. (2016). Systematic review of outcome domains and instruments used in clinical trials of tinnitus treatments in adults. *Trials*, *17*(1), 270. https://doi.org/10.1186/s13063-016-1399-9

Hama, T., Koeda, M., Ikeda, Y., Tateno, A., Kawara, T., Suzuki, H., & Okubo, Y. (2021). Bupropion increases cerebral activation in auditory affective processing: A randomized controlled fMRI study. *Neuroscience Letters*, *749*, 1–8. https://doi.org/10.1016/j.neulet.2021.135716

Hamamura, T., Meijer, Z., Heine, S. J., Kamaya, K., & Hori, I. (2009). Approach–avoidance motivation and information processing: A cross-cultural analysis. *Personality and Social Psychology Bulletin*, *35*(4), 454–462. https://doi.org/10.1177/0146167208329512

Harlé, K. M., Chang, L. J., van't Wout, M., & Sanfey, A. G. (2012). The neural mechanisms of affect infusion in social economic decision-making: A mediating role of the anterior insula. *Neuroimage*, *61*(1), 32–40. https://doi.org/10.1016/j.neuroimage.2012.02.027

Harris, M. B., Harris, R. J., & Bochner, S. (1982) Fat, four-eyed, and female: Stereotypes of obesity, glasses, and gender. *Journal of Applied Social Psychology*, *12*(6), 503–516. https://doi.org/10.1111/j.1559-1816.1982.tb00882.x

Hartley, D., Rochtchina, E., Newall, P., Golding, M., & Mitchell, P. (2010). Use of hearing aids and assistive listening devices in an older Australian population. *Journal of the American Academy of Audiology*, *21*(10), 642–653. https://doi.org/10.3766/jaaa.21.10.4

Hasford, J., Hardesty, D. M., & Kidwell, B. (2015). More than a feeling: Emotional contagion effects in persuasive communication. *Journal of Marketing Research*, *52*(6), 836–847. https://doi.org/10.1509/jmr.13.0081

Heldt, S., Sundin, V., Willott, J. F., & Falls, W. A. (2000). Posttraining lesions of the amygdala interfere with fear-potentiated startle to both visual and auditory conditioned stimuli in C57BL/6J mice. *Behavioral Neuroscience*, *114*(4), 749–759. https://doi.org/10.1037/0735-7044.114.4.749

Heller, A. S., Stamatis, C. A., Puccetti, N. A., & Timpano, K. R. (2021) The distribution of daily affect distinguishes internalizing and externalizing spectra and subfactors. *Journal of Abnormal Psychology*, *130*(4), 319–332. https://doi.org/10.1037/abn0000670

Herd, T., King-Casas, B., & Kim-Spoon, J. (2020). Developmental changes in emotion regulation during adolescence: Associations with socioeconomic risk and family emotional context. *Journal of Youth and Adolescence*, *49*(7), 1545–1557. https://doi.org/10.1007/s10964-020-01193-2

Herrmann, B., & Johnsrude, I. S. (2020) A model of listening engagement (MoLE). *Hearing Research*, *397*, 108–116. https://doi.org/10.1016/j.heares.2020.

Hogan, A., O'Loughlin, K., Davis, A., & Kendig, H. (2009). Hearing loss and paid employment: Australian population survey findings. *International Journal of Audiology*, *48*(3), 117–122. https://doi.org/10.1080/14992020802449008

Holroyd, C. B., & Yeung, N. (2012). Motivation of extended behaviors by anterior cingulate cortex. *Trends in Cognitive Sciences*, *16*(2), 122–128. https://doi.org/10.1016/j.tics.2011.12.008

Hommes, R. E., Borash, A. I., Hartwig, K., & DeGracia, D. (2018). American Sign language interpreters perceptions of barriers to healthcare communication in deaf and hard of hearing patients. *Journal of Community Health*, *43*(5), 956–961. https://doi.org/10.1007/s10900-018-0511-3

Honing, H., & Ladinig, O. (2008). The potential of the internet for music perception research: A comment on lab-based versus web-based studies *Empirical musicology Review*, *3*(1), 4–8. http://dx.doi.org/10.18061/emr.v11i1.4958

Horner, K. C. (2003). The emotional ear in stress. *Neuroscience & Biobehavioral Reviews*, *27*(5), 437–446. https://doi.org/10.1016/S0149-7634(03)00071-X

Hu, J., Cui, J., Xu, J.-J., Yin, X., Wu, Y., & Qi, J. (2021) The neural mechanisms of tinnitus: A perspective from functional magnetic resonance imaging. *Frontiers Neuroscience*, *15*(11), 1–8. https://doi.org/10.3389/fnins.2021.621145

Hua, J. C., Xu, X. M., Xu, Z. G., Xue, Y., Xu, J. J., Hu, J. H., Wu, Y., & Chen, Y. C. (2022). Abnormal cerebellar network and effective connectivity in sudden and long-term sensorineural hearing loss. *Frontiers in Aging Neuroscience*, *14*, 964349. https://doi.org/10.3389/fnagi.2022.964349

Husain, F. T., Carpenter-Thompson, J. R., & Schmidt, S. A. (2014). The effect of mild-to-moderate hearing loss on auditory and emotion processing networks. *Frontiers in Systems Neuroscience*, *8*, 1–13. https://doi.org/10.3389/fnsys.2014.00010

Insel, T., Cuthbert, B., Garvey, M., Heinssen, R., Pine, D. S., Quinn, K., Sanislow, C., & Wang, P. (2010). Research domain criteria (RDoC): Toward a new classification framework for research on mental disorders. *American Journal of Psychiatry*, *167*(7), 748–751. https://doi.org/10.1176/appi.ajp.2010.09091379

Jafari, Z., Kolb, B. E., & Mohajerani, M. H. (2017) Effect of acute stress on auditory processing: A systematic review of human studies. *Reviews in the Neurosciences*, *28*(1), 1–13. https://doi.org/10.1515/revneuro-2016-0043

Jaworska, N., Yang, X. R., Knott, V., & MacQueen, G. (2015). A review of fMRI studies during visual emotive processing in major depressive disorder. *The World Journal of Biological Psychiatry*, *16*(7), 448–471. https://doi.org/10.3109/15622975.2014.885659

Jayakody, D. M., Almeida, O. P., Speelman, C. P., Bennett, R. J., Moyle, T. C., Yiannos, J. M., & Friedland, P. L. (2018). Association between speech and high-frequency hearing loss and depression, anxiety and stress in older adults. *Maturitas*, *110*, 86–91. https://doi.org/10.1016/j.maturitas.2018.02.002

Jennings, J. R., Bberg, W. K., Hutcheson, J. S., Obrist, P., Porges, S., & Turpin, G. (1981). *Publication guidelines for heart rate studies in man*. Wiley Online Library.

Jenstad, L., & Moon, J. (2011). Systematic review of barriers and facilitators to hearing aid uptake in older adults. *Audiology Research*, *1*(1), 91–96. https://doi.org/10.4081/audiores.2011.e25

Job, R. S. (1999). Noise sensitivity as a factor influencing human reaction to noise. *Noise and Health*, *1*(3), 57–68.

Juul Jensen, J., Callaway, S. L., Lunner, T., & Wendt, D. (2018). Measuring the impact of tinnitus on aided listening effort using pupillary response. *Trends in Hearing*, *22*, 2331216518795340. https://doi.org/10.1177/2331216518795340

Kafetsios, K., Hess, U., & Nezlek, J. B. (2018). Self-construal, affective valence of the encounter, and quality of social interactions: Within and cross-culture examination. *The Journal of Social Psychology*, *158*(1), 82–92. https://doi.org/10.1080/00224545.2017.1305326

Katiri, R., Hall, D. A., Killan, C. F., Smith, S., Prayuenyong, P., & Kitterick, P. T. (2021). Systematic review of outcome domains and instruments used in designs of clinical trials for interventions that seek to restore bilateral and binaural hearing in adults with unilateral severe to profound sensorineural hearing loss ('single-sided deafness'). *Trials*, *22*(1), 1–20. https://doi.org/10.1186/s13063-021-05160-5

Keesom, S. M., & Hurley, L. M. (2020). Silence, solitude, and serotonin: Neural mechanisms linking hearing loss and social isolation. *Brain Sciences*, *10*(6), 367. https://doi.org/10.3390/brainsci10060367

Keil, A., Debener, S., Gratton, G., Junghöfer, M., Kappenman, E. S., Luck, S. J., Luu, P., Miller, G. A., & Yee, C. M. (2014). Committee report: Publication guidelines and recommendations for studies using electroencephalography and magnetoencephalography. *Psychophysiology*, *51*(1), 1–21. https://doi.org/10.1111/psyp.12147

Kerr, M., Siegle, G. J., & Orsini, J. (2018). Voluntary Arousing Negative Experiences (VANE): Why We Like to Be Scared. *Emotion*, *19*(4), 682–698. https://doi.org/10.1037/emo0000470

Knoetze, M., Manchaiah, V., Mothemela, B., & Swanepoel, W. (2023). Factors influencing hearing help-seeking and hearing aid uptake in adults: A systematic review of the past decade. *Trends in Hearing*, *27*, 1–27. https://doi.org/10.1177/23312165231157255

Knoll, M. A., Uther, M., & Costall, A. (2011) Using the Internet for speech research: An evaluative study examining affect in speech. *Behaviour & Information Technology*, *30*(6), 845–851. https://doi.org/10.1080/0144929X.2011.577192

Knudsen, L. V., Oberg, M., Nielsen, C., Naylor, G., & Kramer, S. E. (2010). Factors influencing help seeking, hearing aid uptake, hearing aid use and satisfaction with hearing aids: A review of the literature. *Trends in Amplification*, *14*(3), 127–154. https://doi.org/10.1177/1084713810385712

Koelewijn, T., Zekveld, A. A., Lunner, T., & Kramer, S. E. (2018). The effect of reward on listening effort as reflected by the pupil dilation response. *Hearing Research*, *367*, 106–112. https://doi.org/10.1016/j.heares.2018.07.011

Koelewijn, T., Zekveld, A. A., Lunner, T., & Kramer, S. E. (2021). The effect of monetary reward on listening effort and sentence recognition. *Hearing Research*, *406*, 1–17. https://doi.org/10.1016/j.heares.2021.108255

Kramer, H. J., & Lagattuta, K. H. (2022). Developmental changes in emotion understanding during middle childhood In *The Oxford Handbook of Emotional Development* (pp. 157–161). Oxford University Press.

Kraus, K. S., & Canlon, B. (2012). Neuronal connectivity and interactions between the auditory and limbic systems. Effects of noise and tinnitus. *Hearing Research*, *288*(1-2), 34–46. https://doi.org/10.1016/j.heares.2012.02.009

Kraus, N., & White-Schwoch, T. (2017). Feel the vibrations: Understanding the hearing-emotion connection. *The Hearing Journal*, *70*(9), 52–53.

Krendl, A. C., Richeson, J. A., Kelley, W. M., & Heatherton, T. F. (2008). The negative consequences of threat: A functional magnetic resonance imaging investigation of the neural mechanisms underlying women's underperformance in math. *Psychological Science*, *19*(2), 168–175. https://doi.org/10.1111/j.1467-9280.2008.02063.x

Kroska, A., & Harkness, S. K. (2021). Information vs. inspiration: Evaluating the effectiveness of mental illness stigma-reduction messages. *Social Science Research*, *96*, 143–152. https://doi.org/10.1016/j.ssresearch.2021.102543

Kruglanski, A. W., Raviv, A., Bar-Tal, D., Raviv, A., Sharvit, K., Ellis, S., & Mannetti, L. (2005) Says who? Epistemic authority effects in social judgment. *Advances Experimental Social Psychology*, *37*, 345–392. https://doi.org/10.1016/S0065-2601(05)37006-7

Kumar, S., von Kriegstein, K., Friston, K., & Griffiths, T. D. (2012). Features versus feelings: Dissociable representations of the acoustic features and valence of aversive sounds. *Journal of Neuroscience*, *32*(41), 14184–14192. https://doi.org/10.1523/JNEUROSCI.1759-12.2012

Kumbul, Y. C., Işik, Ü, Kiliç, F., Sivrice, M. E., & Akin, V. (2022). Evaluation of anxiety sensitivity, anxiety, depression, and attention deficit hyperactivity disorder in patients with tinnitus. *Noise & Health*, *24*(112), 13–19. https://doi.org/10.4103/nah.nah_75_21

Landgrebe, M., Zeman, F., Koller, M., Eberl, Y., Mohr, M., Reiter, J., Staudinger, S., Hajak, G., & Langguth, B. (2010). The Tinnitus Research Initiative (TRI) database: A new approach for delineation of tinnitus subtypes and generation of predictors for treatment outcome. *BMC Medical Informatics and Decision Making*, *10*(1), 42. https://doi.org/10.1186/1472-6947-10-42

Lang, P. J. (2005). International affective picture system (IAPS): Affective ratings of pictures and instruction manual. *Technical Report*.

Larsen, R. J., & Diener, E. (1992). Promises and problems with the circumplex model of emotion.

Lau, M. K., Hicks, C., Kroll, T., & Zupancic, S. (2019). Effect of auditory task type on physiological and subjective measures of listening effort in individuals with normal hearing. *Journal of Speech, Language, and Hearing Research*, *62*(5), 1549–1560. https://doi.org/10.1044/2018_JSLHR-H-17-0473

Laugen, N. J., Jacobsen, K. H., Rieffe, C., & Wichstrøm, L. (2017). Emotion understanding in preschool children with mild-to-severe hearing loss. *The Journal of Deaf Studies and Deaf Education*, *22*(2), 155–163. https://doi.org/10.1093/deafed/enw069

LeDoux, J. E., Sakaguchi, A., & Reis, D. J. (1984). Subcortical efferent projections of the medial geniculate nucleus mediate emotional responses conditioned to acoustic stimuli. *The Journal of Neuroscience*, *4*(3), 683–698. https://doi.org/10.1523/JNEUROSCI.04-03-00683.1984

Liang, W., & Liu, T. (2021). Caring for hearing health and making life colorful—Review and prospect of the national "Ear Day" publicity and education activities (in Chinese). *Journal of Audiology and Speech Pathology*, *29*, 125–127.

Livingstone, S. R., & Russo, F. A. (2018). The Ryerson Audio-Visual Database of Emotional Speech and Song (RAVDESS): A dynamic, multimodal set of facial and vocal expressions in North American English. *PLoS One*, *13*(5), e0196391. https://doi.org/10.1371/journal.pone.0196391

Lopez-Escamez, J. A., & Perez-Carpena, P. (2022). Technological Advances in the Diagnosis and Management of Tinnitus. *Journal Of Clinical Medicine*, *11*.

Lubart, T. (2010). Cross-cultural perspectives on creativity. In *The Cambridge Handbook of Creativity* (pp. 265–278). Cambridge University Press.

Ma, W., Zhang, Y., Li, X., Liu, S., Gao, Y., Yang, J., Xu, L., Liang, H., Ren, F., Gao, F., & Wang, Y. (2022). High-frequency hearing loss is associated with anxiety and brain structural plasticity in older adults. *Frontiers in Aging Neuroscience*, *14*, 821537. https://doi.org/10.3389/fnagi.2022.821537

Marschall, T. M., Ćurčić-Blake, B., Brederoo, S. G., Renken, R. J., Linszen, M. M., Koops, S., & Sommer, I. E.. (2021). Spontaneous brain activity underlying auditory hallucinations in the hearing-impaired. *Cortex*, *136*, 1–13. https://doi.org/10.1016/j.cortex.2020.12.005

Mauss, I. B., Levenson, R. W., McCarter, L., Wilhelm, F. H., & Gross, J. J. (2005). The tie that binds? Coherence among emotion experience, behavior, and physiology. *Emotion*, *5*(2), 175. https://doi.org/10.1037/1528-3542.5.2.175

Mazaheryazdi, M., Aghasoleimani, M., Karimi, M., & Arjmand, P. (2018). Perception of musical emotion in the students with cognitive and acquired hearing loss. *Iranian Journal of Child Neurology*, *12*(2), 41–48.

Mazurek, B. (2018). Tinnitus-new challenge and therapeutic approaches. *HNO*, *66*(S2), 47–48. https://doi.org/10.1007/s00106-018-0478-5

Mazurek, B., Haupt, H., Olze, H., & Szczepek, A. J. (2012). Stress and tinnitus-from bedside to bench and back. *Frontiers in Systems Neuroscience*, *6*, 47. https://doi.org/10.3389/fnsys.2012.00047

Mazurek, B., Stöver, T., Haupt, H., Klapp, B. F., Adli, M., Gross, J., & Szczepek, A. J. (2010). The significance of stress: Its role in the auditory system and the pathogenesis of tinnitus. *HNO*, *58*(2), 162–172. https://doi.org/10.1007/s00106-009-2001-5

McCormack, A., & Fortnum, H. (2013). Why do people fitted with hearing aids not wear them? *International Journal of Audiology*, *52*(5), 360–368. https://doi.org/10.3109/14992027.2013.769066

Meyer, C., & Hickson, L. (2012). What factors influence help-seeking for hearing impairment and hearing aid adoption in older adults? *International Journal of Audiology*, *51*(2), 66–74. https://doi.org/10.3109/14992027.2011.611178

Meyer, C., Hickson, L., Lovelock, K., Lampert, M., & Khan, A. (2014). An investigation of factors that influence help-seeking for hearing impairment in older adults. *International Journal of Audiology*, *53*(sup1), S3–S17. https://doi.org/10.3109/14992027.2013.839888

Michael, N., Ostermann, J., Sörös, P., Schwindt, W., & Pfleiderer, B. (2004). Altered habituation in the auditory cortex in a subgroup of depressed patients by functional magnetic resonance imaging. *Neuropsychobiology*, *49*(1), 5–9. https://doi.org/10.1159/000075331

Mitchell, R. L., & Phillips, L. H. (2007). The psychological, neurochemical and functional neuroanatomical mediators of the effects of positive and negative mood on executive functions. *Neuropsychologia*, *45*(4), 617–629. https://doi.org/10.1016/j.neuropsychologia.2006.06.030

Molander, P., Hesser, H., Weineland, S., Bergwall, K., Buck, S., Jäder Malmlöf, J., Lantz, H., Lunner, T., & Andersson, G. (2018). Internet-based acceptance and commitment therapy for psychological distress experienced by people with hearing problems: A pilot randomized controlled trial. *Cognitive Behaviour Therapy*, *47*(2), 169–184. https://doi.org/10.1080/16506073.2017.1365929

Moor, B. G., Güroğlu, B., de Macks, Z. A. O., Rombouts, S. A., Van der Molen, M. W., & Crone, E. A. (2012). Social exclusion and punishment of excluders: Neural correlates and developmental trajectories. *Neuroimage*, *59*(1), 708–717. https://doi.org/10.1016/j.neuroimage.2011.07.028

Most, T., & Aviner, C. (2009). Auditory, visual, and auditory-visual perception of emotions by individuals with cochlear implants, hearing AIDS, and normal hearing. *Journal of Deaf Studies and Deaf Education*, *14*(4), 449–464. https://doi.org/10.1093/deafed/enp007

Newman, C. W., Jacobson, G. P., & Spitzer, J. B. (1996). Development of the tinnitus handicap inventory. *Archives of Otolaryngology - Head and Neck Surgery*, *122*(2), 143–148. https://doi.org/10.1001/archotol.1996.01890140029007

Nordvik, Ø., Heggdal, P. O. L., Brännström, J., Vassbotn, F., Aarstad, A. K., & Aarstad, H. J. (2018). Generic quality of life in persons with hearing loss: A systematic literature review. *BMC Ear, Nose and Throat Disorders*, *18*(1), 1–13. https://doi.org/10.1186/s12901-018-0051-6

Nowicki, S., & Duke, M. P. (2001). *Interpersonal sensitivity: Theory and measurement* (pp. 129–132). Psychology Press.

Orji, A., Kamenov, K., Dirac, M., Davis, A., Chadha, S., & Vos, T. (2020). Global and regional needs, unmet needs and access to hearing aids. *International Journal of Audiology*, *59*(3), 166–172. https://doi.org/10.1080/14992027.2020.1721577

Oron, Y., Levy, O., Avivi-Reich, M., Goldfarb, A., Handzel, O., Shakuf, V., & Ben-David, B. M. (2020). Tinnitus affects the relative roles of semantics and prosody in the perception of emotions in spoken language. *International Journal of Audiology*, *59*(3), 195–207. https://doi.org/10.1080/14992027.2019.1677952

Ozen, H., & Kodaz, N. (2012). Utilitarian or hedonic? A cross cultural study in online shopping. *Organizations and Markets in Emerging Economies*, *3*(2), 80–90. https://doi.org/10.15388/omee.2012.3.2.14269

Pacheco-Unguetti, A. P., & Parmentier, F. B. (2014). Sadness increases distraction by auditory deviant stimuli. *Emotion*, *14*(1), 203–213. https://doi.org/10.1037/a0034289

Pacheco-Unguetti, A. P., & Parmentier, F. B. (2016) Happiness increases distraction by auditory deviant stimuli. *British Journal of Psychology*, *107*(3), 419–433. https://doi.org/10.1111/bjop.12148

Papousek, I., Paechter, M., & Lackner, H. K. (2011). Delayed psychophysiological recovery after self-concept-inconsistent negative performance feedback. *International Journal of Psychophysiology*, *82*(3), 275–282. https://doi.org/10.1016/j.ijpsycho.2011.09.013

Paquette, S., Ahmed, G. D., Goffi-Gomez, M. V., Hoshino, A. C. H., Peretz, I., & Lehmann, A. (2018). Musical and vocal emotion perception for cochlear implants users. *Hearing Research*, *370*, 272–282. https://doi.org/10.1016/j.heares.2018.08.009

Payne, C., & Bachevalier, J. (2019) Early amygdala damage alters the way rhesus macaques process species-specific audio-visual vocalizations. *Behavioral Neuroscience*, *133*(1), 1–17. https://doi.org/10.1037/bne0000285

Peelle, J. E. (2018). Listening effort: How the cognitive consequences of acoustic challenge are reflected in brain and behavior. *Ear & Hearing*, *39*(2), 204–214. https://doi.org/10.1097/AUD.0000000000000494

Peretz, I., & Zatorre, R. J. (2005). Brain organization for music processing. *Annual Review of Psychology*, *56*(1), 89–114. https://doi.org/10.1146/annurev.psych.56.091103.070225

Pérez-Valenzuela, C., Terreros, G., & Dagnino-Subiabre, A. (2019). Effects of stress on the auditory system: An approach to study a common origin for mood disorders and dementia. *Reviews in the Neurosciences*, *30*(3), 317–324. https://doi.org/10.1515/revneuro-2018-0018

Pessoa, L., & Adolphs, R. (2010). Emotion processing and the amygdala: From a 'low road' to 'many roads' of evaluating biological significance. *Nature Reviews Neuroscience*, *11*(11), 773–782. https://doi.org/10.1038/nrn2920

Pessoa, L., & Adolphs, R. (2011). Emotion and the brain: Multiple roads are better than one. *Nature Reviews Neuroscience*, *12*(7), 425–425. https://doi.org/10.1038/nrn2920-c2

Peters, R. S. (2015). *The concept of motivation* (pp. 86–89). Taylor & Francis.

Pichora-Fuller, M. K., Kramer, S. E., Eckert, M. A., Edwards, B., Hornsby, B. W., Humes, L. E., Lemke, U., Lunner, T., Matthen, M., & Mackersie, C. L. (2016). Hearing impairment and cognitive energy: The framework for understanding effortful listening (FUEL). *Ear & Hearing*, *37*(1), 5S–27S. https://doi.org/10.1097/AUD.0000000000000312

Picó-Pérez, M., Radua, J., Steward, T., Menchón, J. M., & Soriano-Mas, C. (2017). Emotion regulation in mood and anxiety disorders: A meta-analysis of fMRI cognitive reappraisal studies. *Progress in Neuro-Psychopharmacology & Biological Psychiatry*, *79*, 96–104. https://doi.org/10.1016/j.pnpbp.2017.06.001

Picou, E. M. (2014). Increasing motivation changes subjective reports of listening effort and choice of coping strategy. *International Journal of Audiology*, *53*(6), 418–426. https://doi.org/10.3109/14992027.2014.880814

Picou, E. M., Rakita, L., Buono, G. H., & Moore, T. M. (2021). Effects of increasing the overall level or fitting hearing aids on emotional responses to sounds. *Trends in Hearing*, *25*, 1–13. https://doi.org/10.1177/23312165211049938

Picou, E. M., Singh, G., Goy, H., Russo, F., Hickson, L., Oxenham, A. J., Buono, G. H., Ricketts, T. A., & Launer, S. (2018). Hearing, emotion, amplification, research, and training workshop: Current understanding of hearing loss and emotion perception and priorities for future research. *Trends in Hearing*, *22*, 1–20. https://doi.org/10.1177/2331216518803215

Picton, T. W., Bentin, S., Berg, P., Donchin, E., Hillyard, S., Johnson, R., Miller, G., Ritter, W., Ruchkin, D., & Rugg, M. (2000). Guidelines for using human event-related potentials to study cognition: Recording standards and publication criteria. *Psychophysiology*, *37*(2), 127–152. https://doi.org/10.1111/1469-8986.3720127

Pielage, H., Zekveld, A. A., Saunders, G. H., Versfeld, N. J., Lunner, T., & Kramer, S. E. (2021). The presence of another individual influences listening effort, but not performance. *Ear and Hearing*, *42*(6), 1577–1589. https://doi.org/10.1097/AUD.0000000000001046

Pinheiro, A. P., Barros, C., Dias, M., & Niznikiewicz, M. (2017). Does emotion change auditory prediction and deviance detection? *Biological Psychology*, *127*, 123–133. https://doi.org/10.1016/j.biopsycho.2017.05.007

Pivik, R. T., Broughton, R. J., Coppola, R., Davidson, R. J., Fox, N., & Nuwer, M. R. (1993). Guidelines for the recording and quantitative analysis of electroencephalographic activity in research contexts. *Psychophysiology*, *30*(6), 547–558. https://doi.org/10.1111/j.1469-8986.1993.tb02081.x

Poldrack, R. A., Fletcher, P. C., Henson, R. N., Worsley, K. J., Brett, M., & Nichols, T. E. (2008). Guidelines for reporting an fMRI study. *Neuroimage*, *40*(2), 409–414. https://doi.org/10.1016/j.neuroimage.2007.11.048

Portner, P. (2018). *Mood* (pp. 79–90). Oxford University Press.

Posner, J., Russell, J. A., & Peterson, B. S. (2005). The circumplex model of affect: An integrative approach to affective neuroscience, cognitive development, and psychopathology. *Development and Psychopathology*, *17*(03), 715–734. https://doi.org/10.1017/S0954579405050340

Preminger, J. E., & Laplante-Lévesque, A. (2014). Perceptions of age and brain in relation to hearing help-seeking and rehabilitation. *Ear & Hearing*, *35*(1), 19–29. https://doi.org/10.1097/AUD.0b013e31829c065c

Preminger, J. E., & Meeks, S. (2010). The influence of mood on the perception of hearing-loss related quality of life in people with hearing loss and their significant others. *International Journal of Audiology*, *49*(4), 263–271. https://doi.org/10.3109/14992020903311396

Prévost, C., Pessiglione, M., Météreau, E., Cléry-Melin, M.-L., & Dreher, J.-C. (2010). Separate valuation subsystems for delay and effort decision costs. *Journal of Neuroscience*, *30*(42), 14080–14090. https://doi.org/10.1523/JNEUROSCI.2752-10.2010

Probst, T., Pryss, R. C., Langguth, B., Rauschecker, J. P., Schobel, J., Reichert, M., Spiliopoulou, M., Schlee, W., & Zimmermann, J. (2017) Does tinnitus depend on time-of-day? An ecological momentary assessment study with the "TrackYourTinnitus" application. *Frontiers in Aging Neuroscience*, *9*, 253. https://doi.org/10.3389/fnagi.2017.00253

Putkinen, V., Makkonen, T., & Eerola, T. (2017). Music-induced positive mood broadens the scope of auditory attention. *Social Cognitive and Affective Neuroscience*, *12*(7), 1159–1168. https://doi.org/10.1093/scan/nsx038

Quadflieg, S., Turk, D. J., Waiter, G. D., Mitchell, J. P., Jenkins, A. C., & Macrae, C. N. (2009) Exploring the neural correlates of social stereotyping. *Journal of Cognitive Neuroscience*, *21*(8), 1560–1570. https://doi.org/10.1162/jocn.2009.21091

Reeve, J. (2018) *Understanding motivation and emotion* (pp. 103–131). John Wiley & Sons.

Ren, L., Zhang, Y., Zhang, J., Qin, Y., Zhang, Z., Chen, Z., Wei, C., & Liu, Y. (2022). Voice emotion recognition by Mandarin-speaking children with cochlear implants. *Ear & Hearing*, *43*(1), 165–180. https://doi.org/10.1097/AUD.0000000000001085

Richards, S. E., Hughes, M. E., Woodward, T. S., Rossell, S. L., & Carruthers, S. P. (2021). External speech processing and auditory verbal hallucinations: A systematic review of functional neuroimaging studies. *Neuroscience Biobehaviour. Revew*, (131), 663–687. https://doi.org/10.1016/j.neubiorev.2021.09.006

Richter, M. (2016). The moderating effect of success importance on the relationship between listening demand and listening effort. *Ear & Hearing*, *37*(Suppl 1), 111S–117S. https://doi.org/10.1097/AUD.0000000000000295

Richter, M. E., & Chatterjee, M. (2021). Weighting of prosodic and lexical-semantic cues for emotion identification in spectrally degraded speech and with cochlear implants. *Ear & Hearing*, *42*(6), 1727–1740. https://doi.org/10.1097/AUD.0000000000001057

Rieffe, C., Broekhof, E., Eichengreen, A., Kouwenberg, M., Veiga, G., da Silva, B. M. S., van der Laan, A., & Frijns, J. H. M.

(2018). Friendship and emotion control in pre-adolescents with or without hearing loss. *Journal of Deaf Studies and Deaf Education*, *23*(3), 209–218. https://doi.org/10.1093/deafed/eny012

Riskind, J. H., Kleiman, E. M., Seifritz, E., & Neuhoff, J. (2014). Influence of anxiety, depression and looming cognitive style on auditory looming perception. *Journal of Anxiety Disorders*, *28*(1), 45–50. https://doi.org/10.1016/j.janxdis.2013.11.005

Ritz, T., Dahme, B., Dubois, A. B., Folgering, H., Fritz, G. K., Harver, A., Kotses, H., Lehrer, P. M., Ring, C., & Steptoe, A. (2002). Guidelines for mechanical lung function measurements in psychophysiology. *Psychophysiology*, *39*(5), 546–567. https://doi.org/10.1111/1469-8986.3950546

Rocklage, M. D., & Fazio, R. H. (2020). The enhancing versus backfiring effects of positive emotion in consumer reviews. *Journal of Marketing Research*, *57*(2), 332–352. https://doi.org/10.1177/0022243719892594

Russell, J. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, *39*(6), Í16I–I178.

Rutherford, B. R., Brewster, K., Golub, J. S., Kim, A. H., & Roose, S. P. (2017). Sensation and psychiatry: linking age-related hearing loss to late-life depression and cognitive decline. *American Journal of Psychiatry*, *175*(3), 215–224. https://doi.org/10.1176/appi.ajp.2017.17040423.

Ruusuvuori, J. E., Aaltonen, T., Koskela, I., Ranta, J., Lonka, E., Salmenlinna, I., & Laakso, M. (2021). Studies on stigma regarding hearing impairment and hearing aid use among adults of working age: A scoping review. *Disability And Rehabilitation*, *43*(3), 436–446. https://doi.org/10.1080/09638288.2019.1622798

Ryan, D. B., Eckert, M. A., Sellers, E. W., Schairer, K. S., McBee, M. T., Jones, M. R., & Smith, S. L. (2022). Impact of effortful word recognition on supportive neural systems measured by alpha and theta power. *Ear & Hearing*, *43*(5), 1549–1562. https://doi.org/10.1097/AUD.0000000000001211

Saatci, Ö., Geden, H., Güneş Çiftçi, H., Çiftçi, Z., Arıcı Düz, Ö., & Yulug, B. (2021). Decreased facial emotion recognition in elderly patients with hearing loss reflects diminished social cognition. *Annuals Otology Rhinology Laryngology*, *131*(6), 671–677. https://doi.org/10.1177/00034894211040057

Sadaghiani, S., & D'Esposito, M. (2015). Functional characterization of the cingulo-opercular network in the maintenance of tonic alertness. *Cerebral Cortex*, *25*(9), 2763–2773. https://doi.org/10.1093/cercor/bhu072

Sadlier, M., Stephens, S. D., & Kennedy, V. (2008). Tinnitus rehabilitation: A mindfulness meditation cognitive behavioural therapy approach. *The Journal of Laryngology & Otology*, *122*(1), 31–37. https://doi.org/10.1017/S0022215107007438

Salomone, M., Burle, B., Fabre, L., & Berberian, B. (2021). An electromyographic analysis of the effects of cognitive fatigue on online and anticipatory action control. *Frontiers Human Neuroscience*, *14*, 1–15. https://doi.org/10.3389/fnhum.2020.615046.

Sarter, M., Gehring, W. J., & Kozak, R. (2006). More attention must be paid: The neurobiology of attentional effort. *Brain Research Reviews*, *51*(2), 145–160. https://doi.org/10.1016/j.brainresrev.2005.11.002

Sawyer, C. S., Munro, K. J., Dawes, P., O'Driscoll, M. P., & Armitage, C. J. (2019). Beyond motivation: Identifying targets for intervention to increase hearing aid use in adults. *International Journal of Audiology*, *58*(1), 53–58. https://doi.org/10.1080/14992027.2018.1534007

Scharp, K. M., & Barker, B. A. (2021). "I have to social norm this": Making meaning of hearing loss from the perspective of adults who use hearing aids. *Health Communication*, *36*(6), 774–781. https://doi.org/10.1080/10410236.2020.1712523

Schwarz, N. (1990). *Feelings as information: Informational and motivational functions of affective states* (pp. 14–26). The Guilford Press.

Schwarz, N. (2007). Attitude construction: Evaluation in context. *Social Cognition*, *25*(5), 638–656. https://doi.org/10.1521/soco.2007.25.5.638

Schwarz, N. (2011). *Handbook of Theories of Social Psychology* (Vol. 1, pp. 289–308). Sage.

Schwarz, N., & Clore, G. L. (1983) Mood, misattribution, and judgments of well-being: Informative and directive functions of affective states. *Journal of Personality and Social Psychology*, *45*(3), 513–523. https://doi.org/10.1037/0022-3514.45.3.513

Scott, S. K., Young, A. W., Calder, A. J., Hellawell, D. J., Aggleton, J. P., & Johnsons, M. (1997). Impaired auditory recognition of fear and anger following bilateral amygdala lesions. *Nature*, *385*(6613), 254–257. https://doi.org/10.1038/385254a0

Sherwood, A., Allen, M. T., Fahrenberg, J., Kelsey, R. M., Lovallo, W. R., & Van Doornen, L. J. (1990). Methodological guidelines for impedance cardiography. *Psychophysiology*, *27*(6), 1–23. https://doi.org/10.1111/j.1469-8986.1990.tb03189.x

Shukla, A., Harper, M., Pedersen, E., Goman, A., Suen, J. J., Price, C., Applebaum, J., Hoyer, M., Lin, F. R., & Reed, N. S. (2020). Hearing Loss. *Loneliness, and Social Isolation: A Systematic Review. Otolaryngology–Head and Neck Surgery,.162*(5), 622–633. https://doi.org/10.1177/0194599820910377

Siegle, G. J., Cramer, A. O., van Eck, N. J., Spinhoven, P., Hollon, S. D., Ormel, J., Strege, M., & Bockting, C. L. (2019) Where are the breaks in translation from theory to clinical practice (and back) in addressing depression? An empirical graph-theoretic approach. *Psychological Medicine*, *49*(16), 2681–2691. https://doi.org/10.1017/S003329171800363X

Siegle, G. J., D'Andrea, W., Jones, N., Hallquist, M. N., Stepp, S. D., Fortunato, A., Morse, J. Q., & Pilkonis, P. A. (2015). Prolonged physiological reactivity and loss: Association of pupillary reactivity with negative thinking and feelings. *International Journal of Psychophysiology: Official Journal Of The International Organization of Psychophysiology*, *98*(2), 310–320. https://doi.org/10.1016/j.ijpsycho.2015.05.009

Siegle, G. J., Ichikawa, N., & Steinhauer, S. (2008). Blink before and after you think: Blinks occur prior to and following cognitive load indexed by pupillary responses. *Psychophysiology*, *45*(5), 679–687. https://doi.org/10.1111/j.1469-8986.2008.00681.x

Simoes, J., Bulla, J., Neff, P., Pryss, R., Marcrum, S. C., Langguth, B., & Schlee, W. (2022). Daily contributors of tinnitus loudness and distress: An ecological momentary assessment study. *Frontiers in Neuroscience*, *16*, 883665. https://doi.org/10.3389/fnins.2022.883665

Simoes, J. P., Daoud, E., Shabbir, M., Amanat, S., Assouly, K., Biswas, R., Casolani, C., Dode, A., Enzler, F., Jacquemin, L., Joergensen, M., Kok, T., Liyanage, N., Lourenco, M., Makani, P., Mehdi, M., Ramadhani, A.L., Riha, C., Santacruz, J. L., Schiller, A., Schoisswohl, S., Trpchevska, N., & Genitsaridi, E. (2021). Multidisciplinary tinnitus research: Challenges and future directions from the perspective of early stage researchers. *Frontiers in Aging Neuroscience*, *13*, 647285. https://doi.org/10.3389/fnagi.2021.647285

Simpson, A. N., Matthews, L. J., Cassarly, C., & Dubno, J. R. (2019). Time from hearing aid candidacy to hearing aid adoption: A longitudinal cohort study. *Ear & Hearing*, *40*(3), 468–476. https://doi.org/10.1097/AUD.0000000000000641

Spies, K., Hesse, F., & Hummitzsch, C. (1996). Mood and capacity in Baddeley's model of human memory. *Zeitschrift für Psychologie mit Zeitschrift für angewandte Psychologie*, *204*(4), 367–381.

Steinhauer, S. R., Bradley, M. M., Siegle, G. J., Roecklein, K. A., & Dix, A. (2022). Publication guidelines and recommendations for pupillary measurement in psychophysiological studies. *Psychophysiology*, *59*(4), e14035. https://doi.org/10.1111/psyp.14035

Tamaskar, P., Malia, T., Stern, C., Gorenflo, D., Meador, H., & Zazove, P. (2000). Preventive attitudes and beliefs of deaf and hard-of-hearing individuals. *Archives of Family Medicine*, *9*(6), 518–525, discussion 526. https://doi.org/10.1001/archfami.9.6.518

Tamir, M., & Bigman, Y. E. (2018). Expectations influence how emotions shape behavior. *Emotion*, *18*(1), 15–25. https://doi.org/10.1037/emo0000351

Tang, T. Y., Luan, Y., Jiao, Y., Zhang, J., Ju, S. H., & Teng, G. J. (2020) Disrupted amygdala connectivity is associated with elevated anxiety in sensorineural hearing loss. *Frontiers in Neuroscience*, *14*, 616348. https://doi.org/10.3389/fnins.2020.616348

Teeny, J. D., Siev, J. J., Briñol, P., & Petty, R. E. (2021) A review and conceptual framework for understanding personalized matching effects in persuasion. *Journal of Consumer Psychology*, *31*(2), 382–414. https://doi.org/10.1002/jcpy.1198

Thibodeau, R. (2020). Continuum belief, categorical belief, and depression stigma: Correlational evidence and outcomes of an online intervention. *Stigma and Health*, *5*(4), 404–412. https://doi.org/10.1037/sah0000211

Tiedens, L. Z., & Linton, S. (2001). Judgment under emotional certainty and uncertainty: The effects of specific emotions on information processing. *Journal of Personality and Social Psychology*, *81*(6), 973–988. https://doi.org/10.1037/0022-3514.81.6.973

TIN-ACT (2017). Tinnitus - Assessment, Causes and Treatments (TIN-ACT). Homepage. Available online at: https://www.tinact.eu/

Tollkötter, M., Pfleiderer, B., Sörös, P., & Michael, N. (2006). Effects of antidepressive therapy on auditory processing in severely depressed patients: A combined MRS and MEG study. *Journal of Psychiatric Research*, *40*(4), 293–306. https://doi.org/10.1016/j.jpsychires.2005.09.003

Tsou, Y.-T., Li, B., Kret, M. E., Frijns, J. H., & Rieffe, C. (2021). Hearing status affects children's emotion understanding in dynamic social situations: An eye-tracking study. *Ear & Hearing*, *42*(4), 1024–1033. https://doi.org/10.1097/AUD.0000000000000994

Van der Wal, A., Luyten, T., Cardon, E., Jacquemin, L., Vanderveken, O. M., Topsakal, V., Van de Heyning, P., De Hertogh, W., Van Looveren, N., Van Rompaey, V., Michiels, S., & Gilles, A. (2020). Sex differences in the response to different tinnitus treatments. *Frontiers in Neuroscience*, *14*, 422. https://doi.org/10.3389/fnins.2020.00422

Viinikainen, M., Kätsyri, J., & Sams, M. (2012). Representation of perceived sound valence in the human brain. *Human Brain Mapping*, *33*(10), 2295–2305. https://doi.org/10.1002/hbm.21362

Vinckier, F., Rigoux, L., Oudiette, D., & Pessiglione, M. (2018). Neuro-computational account of how mood fluctuations arise and affect decision making. *Nature Communications*, *9*(1), 1–12. https://doi.org/10.1038/s41467-018-03774-z

Vuilleumier, P., Richardson, M. P., Armony, J. L., Driver, J., & Dolan, R. J. (2004). Distant influences of amygdala lesion on visual cortical activation during emotional face processing. *Nature Neuroscience*, *7*(11), 1271–1278. https://doi.org/10.1038/nn1341

Wager, T. D., Davidson, M. L., Hughes, B. L., Lindquist, M. A., & Ochsner, K. N. (2008). Prefrontal-subcortical pathways mediating successful emotion regulation. *Neuron*, *59*(6), 1037–1050. https://doi.org/10.1016/j.neuron.2008.09.006

Wallhagen, M. I. (2010). The stigma of hearing loss. *The Gerontologist*, *50*(1), 66–75. https://doi.org/10.1093/geront/gnp107

Wang, J., Nicol, T., Skoe, E., Sams, M., & Kraus, N. (2009). Emotion modulates early auditory response to speech. *Journal of Cognitive Neuroscience*, *21*(11), 2121–2128. https://doi.org/10.1162/jocn.2008.21147

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*(6), 1063–1070. https://doi.org/10.1037/0022-3514.54.6.1063

Weger, U. W., Meier, B. P., Robinson, M. D., & Inhoff, A. W. (2007). Things are sounding up: Affective influences on auditory tone perception. *Psychonomic Bulletin & Review*, *14*(3), 517–521. https://doi.org/10.3758/BF03194100

Westin, V. Z., Schulin, M., Hesser, H., Karlsson, M., Noe, R. Z., Olofsson, U., Stalby, M., Wisung, G., & Andersson, G. (2011) Acceptance and commitment therapy versus tinnitus retraining therapy in the treatment of tinnitus: A randomised controlled trial. *Behaviour Research and Therapy*, *49*(11), 737–747. https://doi.org/10.1016/j.brat.2011.08.001

Wraga, M., Helt, M., Jacobs, E., & Sullivan, K. (2007) Neural basis of stereotype-induced shifts in women's mental rotation performance. *Social Cognitive and Affective Neuroscience*, *2*(1), 12–19. https://doi.org/10.1093/scan/nsl041

Wright, A. G. C., & Woods, W. C. (2020). Personalized models of psychopathology. *Annual Review of Clinical Psychology*, *16*(1), 49–74. https://doi.org/10.1146/annurev-clinpsy-102419-125032

Xu, X. M., Jiao, Y., Tang, T. Y., Zhang, J., Salvi, R., & Teng, G. J. (2019) Inefficient involvement of insula in sensorineural hearing loss. *Frontiers in Neuroscience*, *13*, 133. https://doi.org/10.3389/fnins.2019.00133

Yakobi, O., Boylan, J., & Danckert, J. (2021). Behavioral and electroencephalographic evidence for reduced attentional control and performance monitoring in boredom. *Psychophysiology*, *58*(6), e13816. https://doi.org/10.1111/psyp.13816

Yamamoto, M., Morita, K., Tomita, Y., Tsuji, K., Kawamura, K., & Maeda, H. (2000). Effect of facial affect stimuli on auditory and visual P300 in healthy subjects. *The Kurume Medical Journal*, *47*(4), 285–290. https://doi.org/10.2739/kurumemedj.47.285

Yang, W., Makita, K., Nakao, T., Kanayama, N., Machizawa, M. G., Sasaoka, T., Sugata, A., Kobayashi, R., Hiramoto, R., Yamawaki, S., Iwanaga, M., & Miyatani, M. (2018). Affective auditory stimulus database: An expanded version of the international affective digitized sounds (IADS-E). *Behavior Research Methods*, *50*(4), 1415–1429. https://doi.org/10.3758/s13428-018-1027-6

Yee, D. M., Crawford, J. L., Lamichhane, B., & Braver, T. S. (2021). Dorsal anterior cingulate cortex encodes the integrated incentive motivational value of cognitive task performance. *The Journal of Neuroscience*, *41*(16), 3707–3720. https://doi.org/10.1523/JNEUROSCI.2550-20.2021

Yovell, Y., Sackeim, H. A., Epstein, D. G., Prudic, J., Devanand, D. P., McElhiney, M. C., Settembrino, J. M., & Bruder, G. E. (1995). Hearing loss and asymmetry in major depression. *The Journal of Neuropsychiatry and Clinical Neurosciences*, *7*(1), 82–89. https://doi.org/10.1176/jnp.7.1.82

Yücel, M. A., Lühmann, A. V., Scholkmann, F., Gervain, J., Dan, I., Ayaz, H., Boas, D., Cooper, R. J., Culver, J., & Elwell, C. E. (2021). Best practices for fNIRS publications. *Neurophotonics*, *8*(1), 012101. https://doi.org/10.1117/1.NPh.8.1.012101

Zahn-Waxler, C. (2010). Socialization of emotion: Who influences whom and how? *New Directions for Child and Adolescent Development*, *2010*(128), 101–109. https://doi.org/10.1002/cd.271

Zhang, M., Siegle, G. J., McNeil, M. R., Pratt, S. R., & Palmer, C. (2019). The role of reward and task demand in value-based strategic allocation of auditory comprehension effort. *Hearing Research*, *381*, 107775. https://doi.org/10.1016/j.heares.2019.107775

Zhang, M., Zhu, B., Yuan, C., Zhao, C., Wang, J., Ruan, Q., Han, C., Bao, Z., Chen, J., Arceneaux, K. V., Wielen, R. V., & Siegle, G. J. (2021). Are need for affect and cognition culture dependent? Implications for global public health campaigns: A cross-sectional study. *BMC Public Health*, *21*(1), 693. https://doi.org/10.1186/s12889-021-10689-w

Zhao, F., Manchaiah, V., Claire, L. S., Danermark, B., Jones, L., Brandreth, M., Krishna, R., & Goodwin, R. (2015). Exploring the influence of culture on hearing help-seeking and hearing-aid uptake. *International Journal of Audiology*, *54*(7), 435–443. https://doi.org/10.3109/14992027.2015.1005848