

The Perceptual Characteristics of Voice-Hallucinations in Deaf People: Insights into the Nature of Subvocal Thought and Sensory Feedback Loops

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The study of voice-hallucinations in deaf individuals, who exploit the visuomotor rather than auditory modality for communication, provides rare insight into the relationship between sensory experience and how “voices” are perceived. Relatively little is known about the perceptual characteristics of voice-hallucinations in congenitally deaf people who use lip-reading or sign language as their preferred means of communication. The existing literature on hallucinations in deaf people is reviewed, alongside consideration of how such phenomena may fit into explanatory subvocal articulation hypotheses proposed for auditory verbal hallucinations in hearing people. It is suggested that a failure in subvocal articulation processes may account for voice-hallucinations in both hearing and deaf people but that the distinct way in which hallucinations are experienced may be due to differences in a sensory feedback component, which is influenced by both auditory deprivation and language modality. This article highlights how the study of deaf people may inform wider understanding of auditory verbal hallucinations and subvocal processes generally.

Key words: deafness/auditory verbal hallucinations/psychosis/subvocal articulation/British sign language (BSL)/sensory feedback loop

Introduction

The study of how voice-hallucinations are uniquely experienced among deaf people, who cannot hear speech but use lip-reading or sign language as their primary means of communication, provides an exciting opportunity to reflect on the nature of auditory verbal hallucinations (AVH) generally. In particular, it allows a unique test of one of the major theories of AVH, the subvocal articulation hypothesis.

This theory suggests that auditory voice-hallucinations result from the misattribution of inner speech to an external locus of control.^{1,2} It posits that the form of the hallucination mirrors subvocal thought processes, which in hearing individuals are predominantly speech-based. Deaf people form a highly individuated population in terms of their experience with language and sensory input. One consequence is that the considerably greater diversity in the ways that language and subvocal thought processes develop in deaf individuals may be reflected in how they perceive voice-hallucinations. The subvocal thought hypothesis would predict that the perceptual characteristics of an individual's experiences of voice-hallucinations may map onto their own experiences, with spoken or signed languages, of total deafness or of hearing sound either before they became deaf or through the use of residual hearing and hearing aids. Thus, it would be plausible that true auditory hallucinations would be confined to deaf people who at some point in their lives had heard speech.³ Research to date has been preoccupied with the question of whether the “voices” described by people born profoundly deaf are truly auditory in nature, as well as documenting the alternative perceptual forms that voice-hallucinations may take in deaf individuals. In the first part of this article, the existing literature is outlined, and methodological shortcomings are evaluated. The discussion then moves on to consider the adequacy of subvocal articulation models in accounting for “voice” phenomena in deaf people, and what contributions the study of deaf hallucinators might make to broader understanding of subvocal feedback loops.

Prevalence of Schizophrenia and Voice-Hallucinations Among Deaf People

Voice-hallucinations have traditionally been seen as a core symptom of schizophrenia,^{4,5} and most of the literature focuses on this diagnostic group. The prevalence of schizophrenia within the deaf community appears to be roughly equivalent to the general population, although no reliable epidemiological data exists.^{6–8} Around half of all deaf people diagnosed with schizophrenia report experiencing “voices,” during which

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they sense someone communicating with them in the absence of any external stimulus.^{9,10} This closely parallels prevalence rates of auditory verbal hallucinations (AVH) in hearing people with schizophrenia (50–70%).^{11,12} There is no evidence reported for increased frequency of psychotic hallucinations in congenitally deaf people. However, greater proportions of visual and tactile/somatic hallucinations have been noted.^{3,10,13} Around 50% of deaf people with a diagnosis of schizophrenia report visual hallucinations, and a similar proportion describe tactile/somatic hallucinations, despite the low occurrence of these phenomena in schizophrenia generally (15% and 5%, respectively¹⁴). Interestingly, both types of hallucination usually co-occur with reports of “voices,”¹⁰ raising the possibility of a direct relationship between these phenomena.

Perceptual Characteristics of Voice-Hallucinations

Auditory verbal hallucinations in hearing people have been reported as having a relatively clear-cut, speech-based, auditory quality, and the majority of individuals report similar experiences in terms of perceptual characteristics.^{15–17} “Voices” are perceived as similar to external speech, with variations in loudness, pitch constancy, content, and linguistic complexity,¹⁸ which closely mirror experience with listening to real speech. The “voices” are often clearly personified, and accent, gender, and familiarity of speaker can be detected.¹⁹ There is greater uncertainty about the exact nature of the “voices” reported by prelingually deaf people. Research has been sparse, and to date little headway has been made in determining subjective experiences of how deaf people experience “voices” in terms of precise perceptual characteristics. There is a lack of brain imaging or experimental studies, and no research has been conducted to compare how “voices” are perceived by those who were born deaf and those who lost their hearing after acquiring speech. Early accounts of verbal hallucinations among the deaf^{20–24} were largely descriptive. Authors were baffled by the incongruity of the apparent auditory characteristics of the hallucinations observed in deaf patients. Explanations were limited to “voices” as an expression of the deep-seated desire to be hearing (“wish fulfillment”²⁵) or the misperception of vibrations or air currents.²⁴ More recent studies using qualitative interviews have been convinced by the auditory quality of hallucinations in deaf people,^{25,26} even among those born profoundly deaf.¹⁰ Du Feu and McKenna¹⁰ interviewed 10 congenitally, profoundly deaf respondents and noted that they described their hallucinations using signs that can be glossed in English as “HEARD,” “SHOUT,” “VOICES,” or “TALK.” The notion that hallucinators who were born profoundly deaf *hear* auditory-verbal phenomena of which they have no experience might suggest an anatomical basis for perceptual abnormalities

within the primary auditory cortex. This is a theory that is unlikely, however, since neuroimaging studies show that hearing individuals who are actively experiencing voice-hallucinations show activity in the auditory association cortex, rather than primary auditory areas.²⁷

Descriptions of voice-hallucinations by deaf people lack clear-cut auditory features. Questions about acoustic properties such as pitch, volume, or accent are often met with a disdainful response, such as “How do I know? I’m deaf!”²⁸ Even when deaf subjects reported being able to “HEAR” a voice, they could not give detailed descriptions of auditory quality²⁹ but were usually able to relay the message received, identify “voice” ownership, and attach affective connotations. It is possible that the lack of auditory description reflects an inability of deaf individuals to conceptually frame and describe truly auditory phenomena due to a lack of experience with sound. Alternatively, the problem may lie with the process of deduction. The conviction that born-deaf individuals are perceiving and interpreting auditory phenomena of which they have little or no experience may be an artifact of diagnostic classifications that are epistemologically constructed around notions of hearing and speech and the audiocentric way in which interrogative questions are often framed during research interviews. This would increase the likelihood that sound-based values may be attributed or inferred. The conclusion that it is possible for born profoundly deaf people to *hear* “voices”¹⁰ may arise due to inadequate deconstruction of the concept of “voices,” since it cannot be assumed that what congenitally deaf individuals describe as a “voice” is really the same phenomenon as that described by hearing individuals. For example, the use of the British sign language (BSL) signs for “HEARD,” “SHOUT,” “VOICES,” or “TALK” does not automatically bestow audiological qualities since the same signs are frequently used in BSL to connote communication acts in general, whether they are through speech and lip-reading or sign language.

It is difficult to reconcile a purely auditory account with the huge diversity of phenomena reported by deaf hallucinators. Thacker and Kinlocke²⁹ describe a range of different perceptual features, including a sense of being signed or fingerspelled to, vibrations felt within the body, and visual hallucinations. Du Feu and McKenna reported sensations of being touched, abdominal twisting, bursting, and other people inside their bodies.¹⁰ No single explanatory account has been offered to date. One suggestion is that “voices” in deaf people should be conceived as “message” or “communication” hallucinations, which might be received via a sense of simply knowing what is said, without a clear perceptual agent.²⁸ A further possibility is that deaf hallucinators might experience a visual or motor perception of the spoken or signed articulations of the “voice” agent. This is plausible since normal language processing in deaf people, watching sign language or lip-reading speech, involves direct perception of the

movements of the language articulators: the hands and mouth. Thacker²⁸ gives examples of individuals who claimed they were lip-reading a vague visual percept but could not clearly see a face, or who felt they were being fingerspelled to by a persecutor but were not able to see the hands distinctly. These findings suggest that percepts may be experienced in the “mind’s eye” rather than as a truly visual entity, although further research is needed. This theory would explain the raised incidence of apparently “visual” hallucinations among deaf people as undiscerning diagnosticians may mistake subvisual percepts for primary visual hallucinations. This distinction is an important one not only for the purpose of diagnosis and treatment but also because it may reveal much about the mechanisms underlying the generation of voice-hallucinations generally.

Methodological Issues

Research has reached a relative impasse in discerning the exact nature of the “voices” reported by prelingually deaf people. Some authors report that deaf people can “hear” auditory “voices,” while others are less convinced. Perhaps such stalemating has occurred due to a fascinated preoccupation with the question of whether it is possible for a born profoundly deaf person to *hear* “voices,” rather than widening the scope of research to explore heterogeneity in how “voices” are perceived within this diverse population. There has been inadequate consideration of within-group differences and little attempt to control for variables crucial in deafness research, such as degree and age of onset of deafness, use of residual hearing, age of first language acquisition, differences in language exposure and fluency, parental hearing status, and educational placement in oral or signing environments.³⁰

Progress has also been hindered by difficulties in accessing the subjective experiences of deaf participants, who are asked to try and communicate difficult-to-introspect phenomena to researchers who usually have no personal experience of a deaf person’s conceptual worldview and lack the requisite sign language skills (“investigator effect”).³¹ The reliance of researchers on sign language interpreters to communicate with deaf participants means that subjectivity becomes further obscured during the translation process.³² To date, research has relied exclusively on case and interview studies. These methodologies are highly dependent on the ability of the participant to express their experiences. This may be compromised by several factors, which will be dealt with more thoroughly elsewhere, including difficulties with introspecting perceptual processes that may not be available to conscious awareness, difficulties encoding bizarre phenomena into language that makes sense to those who have no personal experience of deafness and/or hallucinations, and researcher failure to adequately deconstruct the notions

of “hearing” and “voices” during the interpretation process. Thus, a case can be made for exploring heterogeneity in how “voices” are perceived; using deaf investigators who are fluent in sign language and familiar with deaf conceptualizations, which may otherwise be overlooked; and developing methods that allow deaf participants to make their subjectivity operant.

In summary, despite apparent perceptual homogeneity in the verbal hallucinations of hearing people, there is wide diversity in phenomena reported by deaf hallucinators, with little known about the precise perceptual characteristics and no single authoritative explanation currently available. While some qualitative studies have suggested an auditory quality to such hallucinations, methodological shortcomings mean that this assertion remains tenuous.

Implications for the Subvocal Thought Hypothesis

The second part of this article explores the question of whether “voice” phenomena in deaf people can be accounted for by the most widely cited theory of AVH, the subvocal thought hypothesis. This is one of a number of theories that have been advanced to explain AVH in hearing people, including perceptual system deficits,^{33–35} abnormal meta-representational abilities,^{36,37} impaired monitoring of intended speech,³⁸ discourse failure,³⁹ disorder of consciousness,^{40–42} misidentification of imagination,⁴³ weakening of memory storage processes,^{44,45} and impairment of the ability to monitor source of willed intentions to act.⁴⁶ These theories are not mutually exclusive but pitch explanations at different levels without offering a complete causal model. The subvocal thought hypothesis^{1,2,36} is the most promising both in terms of identifying the underlying mechanism for AVH generally and providing an explanation that can equally account for the occurrence of voice-hallucinations in deaf people.

There is a growing consensus in the literature that AVH occurs due to deficient source-monitoring of subvocal thoughts.^{2,36,46} This model attributes voice-hallucinations to failures in self-monitoring, which result in subvocal thought processes being misinterpreted as external to the self.³⁶ Individuals experiencing AVH will fail to recognize that their “voices” embody their own internally generated thoughts and will often seek alternative explanations for their genesis. The subvocal thought hypothesis evolved from earlier theories of motor processing.^{46,47} In particular, source-monitoring theories posit that premotor commands signaling intent to move are monitored in the brain prior to any actual execution of movement, allowing the organism to correct erroneous responses before they are commissioned. When exteroceptive sensory feedback is withheld, necessitating internal monitoring of action, people with schizophrenia show a reduced ability to correct motor errors.⁴⁸ Disruptions in premotor source-monitoring result in the individual failing to

recognize their own intent to act, and their own actions will be perceived as externally controlled and alien, perhaps explaining delusions of control in schizophrenia.⁴⁶

Frith^{36,46} proposed that a source monitor might also mediate actions that have no overt movement component, such as inner speech. There is persuasive evidence, from studies of working memory⁴⁹ and auditory-verbal imagery,⁵⁰ that inner speech is represented in the brain as an articulatory rather than an auditory code. For example, evidence of a strong motor-kinaesthetic component to subvocalization comes from the observation that both finger tapping and phoneme repetition disrupt auditory imagery tasks requiring judgments about silently imagined words.⁵¹ Inner speech consists of subvocal motor representations, which are coded in terms of the articulatory gestures that would be required to produce overt speech and exploit a premotor articulation program. Thus, AVH results specifically from deficient source-monitoring of subvocal speech so that internal thoughts are misidentified as originating externally.³⁶

Experimental and neuroimaging evidence provide support for this hypothesis. Hallucinators show a specific deficit in remembering the source of words when they are self-generated.^{52,53} They are more likely to misattribute self-production to the experimenter (“externalizing bias”)^{54–57} or to believe that words that they read silently were produced out loud.⁵⁸ By contrast, there is no evidence for misinterpretation of externally based signals or a deficit in perceptual acuity.^{59,60} Scanning studies demonstrate that both subvocal speech^{27,61} and AVH^{62–64} activate brain circuitry implicated in premotor articulatory rehearsal, including the left frontal supplementary motor area, dorsolateral prefrontal cortex, and the language association cortices of the temporal lobes. The subvocal thought hypothesis goes some way toward demystifying AVH; however, more precise delineation of the spectrum of mental representation from inchoate thoughts to more fully formed inner speech and the stage(s) at which misattribution may occur is needed.

Reconciling a Subvocal Articulation Model With “Voice” Phenomena Observed in Deaf People

It is possible to harness a subvocal articulation model to “voice” phenomena in deaf signers. The areas of the brain employed for language processing in deaf signers are remarkably similar to those used by speech in hearing people. Neuroimaging studies have demonstrated that deaf signers exhibit similar lateralization and show activation in traditional language-processing regions, including bilateral prefrontal regions and the superior temporal gyrus.^{65,66} Differences in activation can be attributed to differences in the modality of sensory input. Deaf people watching sign language show less activation in primary and secondary auditory cortices but greater activity in the posterior occipito-temporo regions.⁶⁵ Interestingly, inner signing

in deaf people activates identical regions to inner speech in hearing individuals, suggesting that once input differences are removed, subvocal processes may share a common substrate. McGuire and colleagues conducted PET scan studies examining covert speech articulation in hearing participants⁶⁷ and covert sign articulation in deaf participants.⁶⁸ They found that internal generation of British sign language sentences by deaf participants activated the left inferior frontal substrates that have been observed to be the seat of subvocal speech in hearing individuals who are silently articulating English sentences. Therefore, subvocal articulation does not appear to be modality specific and might equally be engaged by speech or sign.

Broader research into cognitive processing in deaf people suggests that, despite differences in modality, the processing of sign language resembles speech in that it exploits an articulatory code at neural processing levels. Sign language has been observed to be stored in working memory on the basis of its articulatory rather than iconic visual properties.⁶⁹ Studies of articulatory suppression suggest that memory rehearsal systems engaged by signers are similar in structure to those engaged by speech in those who can hear.^{70,71} Literature on speech perception in hearing people suggests that speech acts are perceived in terms of the articulatory gestures made to produce them, rather than purely acoustic analysis (categorical perception and the McGurk effect^{72,73}). Suggestive evidence exists for similar “analysis by synthesis”⁷⁴ processes in sign language perception. Emmorey and colleagues⁷⁵ note that during comprehension tasks signers perceive a mirror image of the movements that they would produce if they were signing themselves. Signers are more accurate at matching room layout to a signed description when rotation is required, and this effect was not seen in an equivalent nonlinguistic task. This discrepancy reduces the likelihood that signers were employing superior rotation of internal imagery and suggests that signers may instead perceive signs in terms of the articulations necessary to produce the sign themselves. It is pertinent that articulatory, rather than purely visual or auditory, properties seem to underpin the processing of both sign and speech. It is therefore conceivable that disconnections in subvocal circuitry will cause voice-hallucinations in signers that mirror those seen in speakers. Equally, a subvocal theory based on faulty monitoring of premotor articulation can explain hallucinations in deaf people who sign and those who use spoken communication, without the need for separate explanatory models.

The Nature of the Perceptual Feedback Loop in Voice-Hallucinations

While there is no need to invoke a separate causal mechanism for “voice” phenomena in deaf individuals, there are crucial differences in how hallucinations are experienced. Hearing people report vivid auditory imagery

during voice-hallucinations, whereas deaf people are uncertain about auditory properties and often report visual or somatic analogues. It is possible that these differences may arise from differences in the perceptual feedback loop thought to be component to subvocalization.⁷⁶ If subvocalization is primarily a form of motor imagery, perceptual feedback may vary depending on the modality of the subvocal articulation. Thus, a hearing individual might perceive an auditory trace ancillary to motor subvocalization of their thoughts, and the same process may result in a visual or kinaesthetic percept for signers.

Auditory Feedback Loop in Hearing Individuals

During overt speech, monitoring of auditory feedback is necessary for comparing the utterance produced with that intended, allowing for the interception of errors.^{77,78} Feed-forward models posit that motor networks make adjustments by comparing expected and actual auditory feedback during speech production. Ford⁷⁹ suggests that communication between the frontal lobes, where speech is generated, and the temporal lobes, where it is perceived, occurs through a corollary discharge mechanism that prepares the temporal lobes for the expected sound. If there is disrupted synchrony between predicted and actual auditory feedback, motor corrections are made. For example, delayed auditory feedback has a disruptive effect on normal speech but remediates speech in people with a developmental stutter.⁸⁰ Supportive evidence for feed-forward models comes from the finding that suppression occurs in the auditory cortex for self-productions but not when listening to the speech of others, suggesting that the feed-forward system dampens event potentials related to one's own voice.⁷⁹

Grush suggests that representations of expected sensory feedback also underpin subvocal speech processes, enabling the generation of internal auditory imagery based on that predicted by subvocal motor acts.⁸¹ In hallucinating individuals, a failure in the source-monitoring, feed-forward system underpinning subvocal speech would lead them to experience auditory imagery, which would be misattributed as externally generated. There is evidence that for hearing individuals, speech articulations and auditory feedback may be inexorably bound. For example, it is known that lip-reading silently produced speech activates the left superior temporal sulcus, an area implicated in the integration of auditory and visuomotor components of speech perception.^{65,82} However, it is not known whether representations of inner speech will always produce an ancillary auditory trace. Indeed, it has been suggested that the perception of a little "voice" in your mind may only occur during conditions of stress or cognitive challenge.⁸³ There is a need for clarification of the exact perceptual nature of the "voices" experienced by hearing people. It may be that the strong coupling of subvocal articulation (Broca's area) and analysis of acoustic input

(Wernicke's area) is intensified in those with AVH,⁸⁴ so that hallucinations are experienced as having the same vividness and clarity as external speech.⁸⁵ However, since the primary auditory cortex is not activated during AVH imagery,^{50,86} it is more likely that individuals perceive auditory percepts related to speech generation⁷⁶ rather than true auditory perception. Although voice-hearers talk about "hearing" a voice with auditory qualities, descriptions are often vague, and they have difficulties in reporting precise acoustic characteristics.⁸⁷ It may be that further research on perceptual characteristics in hearing individuals will lead to a notion of a more degraded, vague auditory percept than is currently assumed.

Nature of the Feedback Loop: What Can Be Learned From Deaf Individuals?

The study of deaf people with voice-hallucinations might shed particular light on the nature of the feedback loop component of voice-hallucinations. The existence of deaf people who rely solely on spoken communication allows us to examine the effect of an absence of audition on sensory feedback occurring during subvocal speech, while studying deaf signers provides a window of insight into the effect of language modality on the feedback loop.

It is known that deaf speech-readers with spoken English as a first language show significantly less activation of the left superior temporal regions than hearing speech-readers. MacSweeney and colleagues speculate that when audition is absent in early life, there is a reduced binding between audition and articulation, which is replaced by increased functional connectivity between articulation and the visual motion processing regions.⁸⁸ For these individuals, representations of speech are likely to consist of motor imagery tracking the position of the speech musculature during articulation, along with a visuomotor representation of speech produced by others. Further research might reveal that deaf hallucinators are describing a visuomotor percept when they describe a sensation of lip-reading speech during voice-hallucinations. It is possible that some congenitally deaf people will also experience auditory trace feedback. Very few people are born totally deaf, and even profoundly deaf people who use amplification to exploit residual hearing may have some awareness of the sounds that usually accompany their own perception or production of speech. It is possible that some deaf people do form representations of the auditory consequences of articulation, albeit at a rudimentary level. This might explain the phenomenon of deaf people who insist they are hearing something when they experience "voices."

Sensory feedback mechanisms for sign language are likely to be different in nature from those for speech in hearing people. The articulators in sign language do not produce a secondary by-product in the way that the speech musculature modulates sound waves. In sign language the articulations themselves are directly perceived. However,

feed-forward models can also account for visual-motor imagery.⁸¹ A study of overt and covert arm movements by Gentili and colleagues provides suggestive evidence that a feed-forward system predicts the motion of the arm in different dynamic states, and these representations are used both for sensorimotor control and for the generation of internal motor imagery.⁸⁹ Sign language comprehension bilaterally activates the putamen, a region implicated in the imagery of hand movements.⁶⁶ Deaf people can call up volitional imagery of someone else signing to them in the same way that a hearing person may be able to imagine the sounds of someone speaking to them. It therefore does not seem ridiculous that deaf hallucinators might sense a vague percept of hands or mouth articulating the “voice” messages received. This would account for du Feu and McKenna’s¹⁰ participant who perceived his thoughts as signed “out loud.” He experienced his thoughts as being simultaneously signed outside his own head as if he could see them. It is possible he was experiencing imagery of the articulations underlying his subvocal thoughts.

This leads to the question of whether these hallucinatory images should be considered to be visual or motor representations. It is possible that signers combine visual and kinaesthetic percepts into a central representation, in a way that is similar to integrated auditory-kinaesthetic representations in hearing people.⁸¹ However, an important difference exists for deaf people producing signs because the visual feedback received during self-production is substantially different from that received during comprehension. Future research may reveal that mental representations of sign language are primarily kinaesthetic because muscular feedback predominates how an individual would experience their own productions. The role of visual feedback provided by concurrent visual monitoring of hand movement in the lower periphery of vision during sign production has not yet been systematically studied. A further question is whether the raised incidence of tactile/somatic hallucinations among deaf people might be attributed to a sensory feedback loop or to other explanations such as increased somatization as a way of explaining highly counterintuitive phenomena. It is possible that because sign language production involves tracking the arms in space, hallucinations might result in premotor kinaesthetic traces that might be experienced as bizarre somatic sensations. Further research is needed to develop feed-back models for sign language and to further our understanding of how modality and sensory feedback shape the perceptual quality of hallucinatory experience.

Conclusion

Studying deaf people who report “voices” provides insight into the relationship between sensory experience and the perception of “voices” in both deaf and hearing people. In particular, it allows an evaluation of the subvocal articulation hypothesis as an explanation for audi-

tory verbal hallucinations and increases our potential for understanding subvocal feedback loops. It is suggested that the phenomena observed in deaf people with voice-hallucinations can be accounted for by a subvocal articulation model and that both deaf and hearing hallucinators fundamentally misattribute articulatory representations. Differences in the perceptual characteristics of deaf people’s voice-hallucinations are attributed to differences in the structure of a sensory feedback loop, which is reliant upon neural connections that are shaped by sensory input and language modality. Inconsistencies in previous phenomenological accounts of the ways in which “voices” are perceived may simply reflect many different types of deaf experience. Therefore, a case can be made for methodologies that explore heterogeneity in “voice” perception. To this end, Atkinson and colleagues conducted a factor analysis study (to be reported elsewhere) examining the relationship between the perceptual characteristics of voice-hallucinations and individual experience of language and sound within a diverse group of deaf people with a diagnosis of schizophrenia.⁹⁰ It is suggested that using deaf investigators and methodologies that draw upon a deaf worldview will allow deaf participants to make their subjectivity operant, enabling further understanding of their perception of voice-hallucinations. Refining methodology will allow a unique window of insight into the experience of deaf hallucinators that holds great relevance for theories of hallucinations and mental representations generally. There is scope for exploring how spoken and sign language subvocalizations are represented in the mind and the extent to which these representations are independent of, or dependent on, language modality. In particular, it is not known how far auditory-motor representations of speech involve a visual component, or whether hearing people ever experience visual imagery of “voice”-articulations. The diverse phenomena observed in the literature pertaining to deaf people suggest that language representations may contain multifaceted sensory information. A reevaluation of the perceptual characteristics of AVH in those that can hear is warranted since it may reveal more diverse routes to the perception of voice-hallucinations than is currently assumed.

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