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Beyond the sensory: Findings from an in-depth analysis of the phenomenology of “auditory hallucinations” in schizophrenia

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Objective: Research concerning the subjective sensory qualities of auditory hallucinations (AH) in people diagnosed with schizophrenia is scarce. Our goal was to investigate the “auditoriness” of AH and their overlap with symptoms grounded in alterations of thought rather than perception.

Method: We undertook a detailed analysis of phenomenological interviews with 80 schizophrenia-spectrum voice-hearers.

Results: We coded the dominant voice patterns of our subjects and found that only a minority (17.5%) reported a dominant pattern of AH which were experienced as literally auditory. Of dominant AH patterns, 11.3% were instead described as only quasi- or partially auditory, 28.8% as involving a combination of distinctly auditory and thought-like voices, and 15% as unambiguously thought-like. In addition, 5% reported exclusively simple, short-duration AH (e.g. hearing a single word), 12.5% the misperception of actual speech or sounds, and 10% predominantly multisensory voices. We also found substantial overlap between voices and symptoms traditionally considered abnormalities of thought rather than sensation.

Conclusion: We believe these findings challenge common assumptions about AH in people diagnosed with schizophrenia, draw attention to potentially important but under-recognized characteristics of voices, and suggest a need for greater recognition of the heterogeneity of voices and the potential clinical as well as theoretical risks of conceptual over-simplification.

Keywords: hearing voices; hallucinations; schizophrenia; phenomenology

Introduction

In the late nineteenth and early–mid twentieth centuries, psychopathologists widely noted the heterogeneity of auditory (AH) and auditory verbal hallucinations (AVH) (Bleuler, 1950; Kraepelin, 1904; Sedman, 1966; Tuttle, 1902) as well as the often-blurred lines between “perceptual” and “cognitive” symptoms during the prodrome and early stages of psychosis (McGhie & Chapman, 1961). In these early papers, the non-auditory and non-perceptual experience of receiving foreign “communications” or messages was often stressed. In a comprehensive survey of the voices of McLean Hospital patients, for instance, Tuttle (1902) summarized his findings as “indicat[ing] shades of difference ranging from thoughts not recognized as belonging to the person, through those where there is a vivid conception of words though without sound, to those where the words begin to take on sound”; the

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latter – clearly auditory voices in the contemporary sense – were described as “rare” in schizophrenia.

Over the past half century, however, investigations of the phenomenology of hallucinations and other positive symptoms have often been limited by the use of standardized clinical measures that import multiple a priori suppositions including the assumption that the AH they are designed to capture are clearly auditory or perceptual (Berrios & Markova, 2012). Along these lines, most neuroimaging studies have tended to group all types of auditory hallucinations together, without attempting to parse them into phenomenological subtypes or systematically probe their actual (subjective) characteristics, including the degree to which they are in fact experienced as auditory (Berrios & Markova 2012; Van Lieshout & Goldberg, 2007).

Nevertheless, a recent study of the phenomenology of AH found that over half of the schizophrenia-spectrum participants in the study’s sample described mixed, in-between or thought-like voices rather than literally auditory AH (findings which held for AH across multiple diagnostic groups; Woods, Jones, Alderson-Day, Callard, & Fernyhough, 2015). Similarly, an earlier study of the phenomenology of AH reported lower but still notable rates of explicitly non-audible voices (10%) and only 31% described their AH as indistinguishable from actual voices (Moritz & Laroi, 2008). The conclusions we can draw from these studies are limited, however, by the fact that both relied on non-interactive internet-based surveys, allowing the researchers no opportunity to clarify ambiguous descriptions or probe participants for additional details. Other major recent phenomenological studies of AH have used either semistructured or structured measures and questionnaires, unavoidably importing multiple assumptions (as noted above), including assumptions regarding the auditoriness of the phenomena under investigation (McCarthy-Jones et al., 2014; Nayani & David, 1996).

Aims of the study

In light of the above gaps, the current study was designed to investigate the prevalence of different patterns of voice-hearing among schizophrenia-spectrum participants, including literally auditory, mixed and thought-like AH. We also examined other phenomenological characteristics (such as spatial locatability) relevant to the phenomenology of perception as well as the overlap between AH and symptoms grounded in abnormalities of thinking (e.g. thought passivity and delusions of reference) that have traditionally been considered distinct from AH.

Methods

Following university-level ethics approval, we interviewed individuals with a schizophrenia-spectrum diagnosis who reported “hearing voices” in three countries (India, Ghana and the USA). Interviews were loosely structured, lasted between 1 and 3 h and included multiple questions designed to explore the characteristics of participants’ voices including degree of auditoriness, locatability, and overlap with symptoms such as thought insertion, deletion and passivity. Substantive efforts were made to clarify ambiguous responses (such as “I can’t explain”) through careful follow-ups. The majority of interviews were conducted in English, but a portion of the non-US interviews were conducted in the participants’ native languages and subsequently translated into English. In analyzing and interpreting the non-US interviews,

the second author's cultural and ethnographic experience was carefully attended to, experience that included extended international fieldwork and conversations with local clinicians.

All transcripts were initially open-coded by the first author following the principles of qualitative content analysis (Burla et al., 2008; Schreier, 2012) using Atlas.ti. Both a-priori categories (for instance, codes concerning degree of auditoriness) and text-based (emic) categories (such as the transformation of actual speech) were identified and incorporated. Following discussion and reformulation with the second author, a comprehensive coding framework was developed and applied. Where applicable, select categories were quantized (i.e. entered as categorical or dichotomous numerical codes). In order to ensure the reliability of the codes, the first author re-coded the primary categories at two different intervals (reliability exceeded .80). The final quantized codes were entered directly into Stata (v. 13) to facilitate descriptive statistical analyses.

Given the possibility that responses from non-US participants might in part reflect linguistic/cultural differences, we report separate statistics for the US versus non-US participants as well as aggregate numbers. We also believe it is important to underscore that an aim of the current analyses was not to identify cultural differences but instead to assess the characteristics of voices noted above across the full sample. Future papers are planned with a focus on the cultural nuances of the phenomena described, which we fully acknowledge are important and worthy of dedicated examination.

Sample

Participants were 80 individuals with a lifetime diagnosis of a schizophrenia-spectrum disorder. Twenty-one of the interviews were conducted in India by research psychiatrists with additional access to clinical records. Twenty were conducted in Ghana, also with access to clinical records, and an additional 39 in the USA. Participants in each country were equally divided in gender, and the average age was 42 for the USA, 43 for India and 36 for Ghana. All but one participant reported at least one past hospitalization for schizophrenia, and all had been prescribed antipsychotics.

Results

Overview

For organizational clarity, our findings are reported in two broad sections: (1) types of AH and their prevalence in our sample; and (2) overlap with and prevalence of key thought- and language-related symptoms (specifically thought control, thought access, and attenuated voice-thought-related ego boundaries). In these sections we provide definitions, descriptive statistics and qualitative examples. As noted above, in our tables we report both aggregate findings for the full sample and separate statistics for the US versus the non-US participants for all primary codes.

General ineffability

Before presenting our primary findings, we want to emphasize the difficulty participants expressed in attempting to describe the phenomenological nuances of their experiences. Even our most articulate subjects consistently affirmed the challenge of

communicating what their voices were like and making the limited vocabulary available “work” for this purpose. Distinctions often blurred. As one participant explained:

... it becomes really, really difficult for me to distinguish (or explain the difference) between real voices, “hallucinated voices”, thoughts in my own head, other people’s thoughts, thoughts that might be circulating in the air, and then even the extent to which anything exists other than thoughts. Once everything starts to seem like a thought, then it’s really difficult because voices are thoughts, but so are visuals. [US F, early 30s]

In addition, many participants appeared more comfortable communicating what their voices were *not*, as opposed to positive descriptions of what they were. For instance, “my voices are definitely not auditory in the way that you’re speaking right now.” As researchers, our goal was to capture as much nuance as possible about what participants *did* report, but we nevertheless stress the limitations inevitably imposed on second-person phenomenology by these difficulties. While all mental experiences (e.g. of emotions or consciousness) are arguably difficult to articulate, the language around psychosis (and other very rare mental phenomena) is arguably even less well-developed, and the potential for misunderstanding considerable.

AH patterns, additional characteristics and their prevalence

Dominant AH patterns and prevalence

Table 1 describes the seven dominant voice-hearing patterns we identified and Figure 1 illustrates the distribution of patterns across the full sample. Throughout

Table 1. Dominant voice-hearing pattern definitions and examples.

Subtype	Definition	Example
Auditory	A literally auditory (audible) voice	“Sounds exactly like someone talking to me”
Mixed	Experiences separate more auditory and more thought-like voices that are distinctly different	“Sometimes I hear audible voices, but mostly voices that feel more internal and closer to thoughts”
In-between	Voice is neither fully auditory nor thought-like	“It’s more like an imagined voice, I can sort of hear it, but not in a literal way”
Thought-like	Voice experienced as foreign and alien but clearly non-auditory and thought-like	“They’re clearly thoughts, but I don’t generate them – someone else is communicating with me”
Transformed	Misperception of actual voices or sounds	“I’ll hear someone saying something to me, but at the same time I ‘hear’ something else from them and I’m not sure if I’m really hearing it or if I’m thinking it”
Limited auditory	Clearly auditory but limited to simple words, short, repeated phrases or sounds	“Sometimes I’ll just hear the word ‘no’”
Multisensory with strong visual features	Strongly multisensory descriptions, typically equally or more strongly visual than auditory; voices may communicate through images instead of words	“The voice will show me all my enemies. I will see them physically [in front of me] and [they] will say “this one is evil”

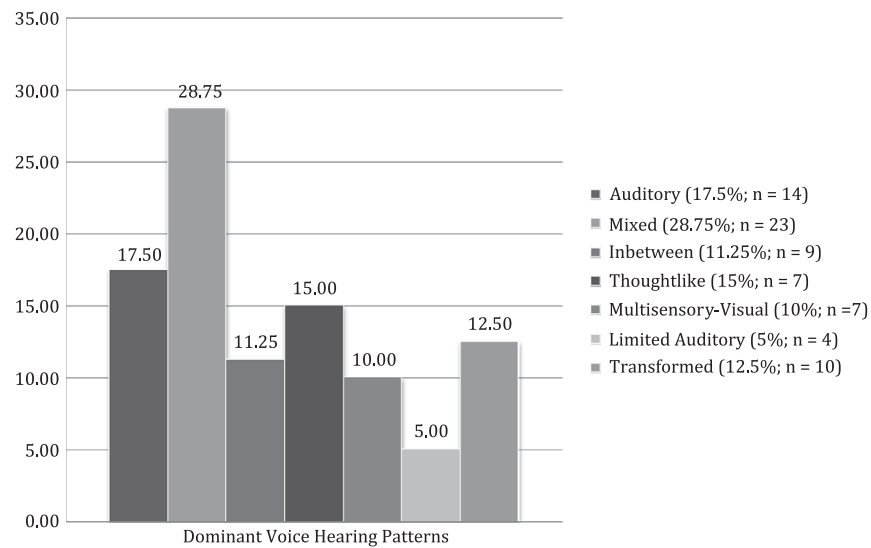


Figure 1. Dominant voice-hearing patterns across the full sample ($n = 80$).

our coding, we defined dominant AH patterns as the *predominant form that participants' voices took*. In some cases, participants also reported more limited experiences of a different voice type. For instance, some participants reported primarily non-auditory voices, but at a few points in their life had nevertheless heard a more explicitly auditory voice or hallucinated sounds.

Notably, only 17.5% (14/80) of our sample reported a dominant pattern of exclusively auditory voices of at least moderate complexity (i.e. more than a simple phrase or single word). Of dominant AH patterns, 11.3% (9/80) were instead described as only quasi- or partially auditory (or “in between a thought and a voice”), 28.75% (9/80) involved a combination of distinctly auditory and thought-like voices (e.g. one auditory voice and one thought-like voice), and 15% (12/80) exclusively thought-like voices. In addition, 5% (4/80) reported exclusively simple, short-duration AH (e.g. a single word), 12.5% (10/80) the ostensibly non-hallucinatory misperception of actual speech or sounds and 10% (8/80) predominantly multisensory voices (in most cases involving dominant visual features). Data for the US versus the non-US participants are presented in Table 3. Given the small cell sizes, we conducted Fisher's exact test for dominant AH type by cultural subsample. Fisher's test was significant ($p = .018$).

Prevalence of any auditory hallucination

While the above statistics capture participants' dominant AH patterns, a far larger number of participants – 79% (59/80) – reported at least limited experiences of clearly auditory AH. For many participants, these voices were limited in both complexity and duration (for instance, hearing a single word during a few acute episodes or having heard a repeated phrase early on that had not recurred in the past decade). Others experienced auditory AH of greater complexity and duration, but nevertheless described these as secondary to (less distressing, less affecting, less frequent than) their dominant voice pattern (e.g. thought-like voices).

Additional phenomenological characteristics. In addition to our primary AH pattern codes, we coded for several additional features that were consistently mentioned by participants (see Table 4 for summary). These included both additional types of sensory qualities as well as location. In addition to their dominant patterns, 17.4% (14/80) of subjects reported also sometimes hearing garbled, quasi-nonverbal voices, including sounds or messages which were interpreted as garbled human speech but with no decipherable words. For example:

[S]ometimes [the voices don't] make any sense at all, like someone's reaching out to try to [communicate], but they can't translate it into a language that I understand. [US F, mid 30s] [Sometimes] it's just white noise. [US M, late 30s]

A further 45% (36/80) reported at least some experience of transformed voices (see Table 1), even though this was not their dominant pattern.

When asked, 69% (55/80) of participants also reported either an inability to determine if their voices were internal or external and/or a blurring of internal and external space. Of participants, 17.5% (14/80) reported only external voices, and 15% (12/80) only internal voices. Those participants with locationally mixed or ambiguous voices frequently described experiential nuances that exceeded traditional divisions between internal and external. For instance, some reported feeling their voices migrate through parts of their body, and others voices that could freely transition between external and internal space. Nearly all participants (98%) explicitly foregrounded their lack of control over the onset and content of AH (often accompanied by the claim that something external to them must be creating the voices). Just over 23% of participants (19/80) described their voices as having some kind of physical presence, at least some of the time. For instance, one US participant described herself as physically “feeling [her voices] in her ears” even when they were not actively saying anything.

Additional characteristics of the mixed AH pattern

Subjects whose dominant AH pattern was mixed were sometimes able to describe and compare the difference between their more auditory and more thought-like voices. Of the mixed subgroup, 78% (18/23) described their thought-like voices as more semantically and/or grammatically complex than their auditory voices. None of the mixed-pattern participants reported the reverse (i.e. more complex auditory voices), but 9% (2/23) did describe auditory voices that were relatively more distressing or belligerent; 22% (5/23) also described specific conditions under which more typically thought-like voices *became* audible, for example if they ignored their voices for long periods, or during periods of heightened stress or excessive stimuli. For a few individuals, their voices *only* became auditory under these circumstances and otherwise were strictly quasi-auditory, in-between or thought-like.

Q: When you hear the voices, do you hear them with your ears or are they more in your head?

R: In my head.

Q: So you don't hear them the way that you hear my voice?

R: I sometimes hear it [like that]. If I try ignoring them inside my brain, like they come out. They start telling me [things]. [US M, early 30s]

Overlap with thought and belief symptoms

Transformed voices and delusions of reference and communication

As noted in our description of “transformed” voices above, these phenomena were often described in ways suggestive of delusions or communication of reference. Conventionally, delusions of reference have been defined as strongly held beliefs that particular – usually arbitrary and innocuous – signs or events (such as a bus pulling up, or a passenger who tugs at his beard) refer to the patient and/or carry particular personal significance. Sutker and Adams (2001) give the example of a patient who is convinced that every time someone around him laughs they are laughing at him. Delusions of communication (sometimes categorized as a distinct subtype of delusions of reference) involve false beliefs that information is being communicated to the individual, either verbally or non-verbally (Startup & Startup, 2005).

In our sample, we found that participant’s transformed voices (reported by 45% of our sample and typically described as “voices”) strongly overlapped with delusions of reference and communication, at times to such an extent that it was difficult to draw clear distinctions. For instance, several participants described people in the streets or in public areas gossiping about them (in places where they could overhear the gossip) but, when asked to clarify, referred to such experiences as “hearing voices” rather than imagining things. In some cases participants could report exactly what others were saying about them, but at other times reported merely “suspecting” that they were the focus of gossip. A few participants expressed explicit awareness that their experiences potentially fell between “delusions” and “hallucinations” or described this particular type of voice as primarily involving a “mis-hearing” of what others were actually saying. For example:

the most disturbing of [the different voice-like experiences I’ve had] is – people talking, but for the purpose of communicating or influencing me in various ways. ... It’s [mostly] unclear to me whether or not any of it is an exaggeration of [what] somebody is saying versus me “hallucinating.” I don’t think it’s hallucination, generally, I just think I’m overhearing something in a way that I’m interpreting it in a strange way [but] it’s unclear. [US M, mid-30s]

Participants most frequently reported the misperception of *speech*, but occasionally also described the semantic transformation of non-verbal sounds such as traffic noise or mechanical sounds. One participant also described the transformation of the sound of the wind blowing through the trees. As in experiences of the transformation of speech, participants often seemed uncertain as to whether they were literally hearing words or instead perceiving *non-verbal* emotions, influences or communications.

Voice overlap with thought passivity phenomena and attenuated ego boundaries

A second dominant thematic was overlap between voices and symptoms that have more conventionally been described as thought passivity (TP) phenomena (e.g. “made thoughts,” thought insertion) or as involving attenuated ego boundaries (e.g. heightened difficulty distinguished between the self and others; Nordgaard, Arnfred, Handest, & Parnas, 2008; Schneider, 1959; Wing & Nixon, 1975). Notably, not all commentators – including contemporary psychopathologists – agree that TP phenomena such as thought insertion should be classified as a qualitatively distinct phenomenon from auditory hallucinations (e.g. see Humpston & Broome, 2015).

Departing from quantitative projects that have used standardized measures to examine the co-occurrence of TP and AH, we specifically coded for descriptions of TP occurring within (or perceived as a quality of) AH. The three codes we ultimately used were “attenuated ego boundaries” (described by 60% of the sample or 48/80), “thought access” (71.3% of the sample or 57/80) and “thought control” (55% or 44 out of 80); see Table 2 for definitions of each code and Table 4 for US versus non-US prevalence statistics). Chi-square statistics computed to assess potential differences between the US and non-US samples revealed no statistically significant differences for thought control ($\chi^2(2, N = 80) = .27, p = .87$) and thought access ($\chi^2(2, N = 80) = 1.70, p = .43$), but were significant for ego boundaries ($\chi^2(2, N = 80) = 7.77, p = .02$).

In participant narratives, descriptions of these three phenomena were often overlapping and suggested an underlying “core” of (sometimes profound) experiential disruptions to subjective boundaries between self and other, between mental interiority and exteriority, and between an individual’s private thoughts and (externally accessible) oral speech. These experiences might be contrasted with those of a hypothetical voice-hearer who has no problem distinguishing between self and other, clearly recognizes the difference between hallucinated and actual voices, and whose voices speak to him or her but cannot directly access or control his or her private thoughts.

Select examples of overlapping thought passivity and ego boundary phenomena:

- And so the voice would say, well, send [your advisor] a message, so I would think hard and know that she was getting my message, and so we’d have this strange conversation when she sees me. Or I guess I thought, you know, some of the voices were [actually] real people sending me telepathic messages. (Thought Access, Ego Boundaries) [US F, early 20s]
- [The voices are] putting stuff in my head. They’re trying to – because I don’t obey and don’t listen to the voices. They put thoughts in my mind. (Thought Control) [US F, late 50s]
- Q: You say [the voices] put thoughts into your mind ...?
R: When I am thinking something, I [feel forced to] voice out their unnecessary thoughts. If I am going somewhere and come across some name, I voice out [speak] the name. (Thought Control) [India M, early 40s]
- ... it’s like when there’s many people [in a room or particular place], I think I can hear their thoughts. I can hear like all these people talking and all these

Table 2. Thought code definitions and prevalence.

Symptom code	Included phenomena	Percent (n)
Attenuated ego boundaries	Sense that other <i>people</i> can access participants’ thoughts, that voices can relay thoughts to others, diminished privacy and autonomy over thoughts, or confusion over having spoken aloud or merely “thought” something	60% (48/80)
Thought access	Voice(s) described as having direct and unmediated access to participants’ thoughts	71.3% (57/80)
Thought passivity	Voice(s) described as capable of directly manipulating or controlling participants’ thoughts and actions or “occupying” their brains/minds	55% (44/80)

Table 3. Dominant voice-hearing patterns.

Category	Percent for US and non-US sample (<i>N</i>)		Total percent (<i>N</i>)
	US	Non-US	
Auditory	12.8% (5/39)	22.0% (9/41)	17.5% (14/80)
Mixed	38.5% (15/39)	19.5% (8/41)	28.8% (23/80)
Inbetween	18.0% (7/39)	5.0% (2/41)	11.3% (9/80)
Thought-like	15.4% (6/39)	14.6% (6/41)	15.0% (12/80)
Transformed	5.0% (2/39)	19.5% (8/41)	12.5% (10/80)
Limited auditory	7.7% (3/39)	2.4% (1/41)	5.0% (4/80)
Multisensory with strong visual features	2.6% (1/39)	17.1% (7/41)	10.0% (8/80)

Table 4. Thought symptoms and voice characteristics.

Category	Percent for US and non-US participants (<i>n</i>)		Percent total sample (<i>n</i>)
	US	Non-US	
Attenuated ego boundaries	64.0% (25/39)	56.0% (23/41)	60.0% (48/80)
Thought access	74.4% (29/39)	68.3% (28/41)	71.3% (57/80)
Thought control	56.4% (22/39)	53.6% (22/41)	55.0% (44/80)
Locational ambiguity	61.5% (24/39)	48.7% (20/41)	55.0% (44/80)
Physicality	18.0% (7/39)	29.2% (12/41)	23.8% (19/80)
Garbled non-verbal voices	30.8% (12/39)	5.0% (2/41)	17.5% (14/80)
Transformed voices (accessory <i>or</i> primary)	43.6% (17/39)	43.9% (18/41)	43.8% (35/80)

things going on. I don't know how to explain it. (Ego Boundaries) [US M, mid 30s]

- I get confused about what's a voice and what's a thought, what's my thought and others' thoughts ... (Ego Boundaries) [US F, early 30s]

Fisher's exact tests examining potential correlations between these categories and dominant AH pattern were all non-significant ($p = .61$ for thought control, $p = .10$ for thought access, $p = .51$ for ego boundaries).

Discussion

In this paper we report the striking finding that only a minority (17.5%; 14/80) of the dominant AH patterns described by our sample conform to conventional definitions of AH and standardized metrics. Instead, we found a high prevalence (82.5%; 66/80) of dominant quasi-auditory, mixed, thought-like or multisensory voice-hearing patterns. In addition to their dominant AH pattern, the majority of participants also reported *multiple* other types of voices, some of which were clearly auditory, including garbled non-verbal hallucinations (17.4%) and transformed (misperceived) voices (45%). In our sample, AH were thus not only highly heterogeneous between participants but also within participant's individual experience.

In addition, we identified considerable overlap between AH and disruptions of basic (normal) thought processes, including delusions of reference, thought passivity symptoms, and attenuated ego boundaries. Thought passivity phenomena occurring within the experience of voices as well as voice-related ego boundary anomalies were both more homogeneous (i.e. described uniformly across participants) and more common than any given dominant AH pattern (i.e. ranging from 55% to 71.3% of the sample). These findings parallel recent conceptual work that has questioned conventional distinctions between thought passivity and AH and raised the possibility that disruptions of self (including self-control over thoughts) may be more essential than the sensory qualities of AH (at least in schizophrenia; Humpston & Broome, 2015; Sass & Parnas, 2003).

While these findings are preliminary, when combined with other recent studies (Moritz & Laroi, 2008; Woods et al., 2015) as well as past scholarship (e.g. Sedman, 1966; Tuttle, 1902), we believe they strongly affirm the need for further research on both the sensory and non-sensory characteristics of AH, including the development or modification of standard metrics and empirical investigation of the relationship between “sensoriness” and relevant clinical variables such as subjective distress, neurocognitive underpinnings and treatment response. While our sample was not transdiagnostic, our findings also raise provocative questions regarding differential diagnosis and the potential import of distinctions between AH grounded in more diffuse disruptions of thought, and those (possibly outside the traditional schizophrenia spectrum) that are not.

Our findings regarding the intersection of attenuated ego boundaries and voices also raise interesting questions about the relationship between voices and the self. While self-disturbances have long been invoked within the phenomenological literature on schizophrenia (e.g. Sass & Parnas, 2003), recent scholarship has pointed to potentially different – and clinically relevant – ways in which voice subtypes may implicate the self in different ways. These include experiences of “the other” in bereavement-related hallucinations (Castenovo et al., 2015) and the fragmenting of self in the context of dissociative AH (Pilton, Varese, Berry, & Bucci, 2015). Potentially fruitful connections might also be drawn with recent work that has focused on the relationship between voices and broader aspects of self – including self-concepts and self-schemas – particularly as they play out in functional recovery (Fielding-Smith et al., 2015; Thomas, Farhall, & Shawyer, 2015).

Clinical implications

In addition to the implications discussed above, we believe that our findings underscore the importance of broader clinical recognition of the heterogeneity of “voices,” of the considerable terminological and semantic difficulties involved in describing these phenomena (for both patients and clinicians) and of the risks of potential misconceptualization. Our findings also raise questions as to whether or not clinicians are always addressing what is in fact most disturbing about “voices”: many of our participants stressed the greater difficulty coping with various forms of thought disruption (including perceived loss of control over “thinking”) than with sensory overwhelm. Single continuum approaches to AH, also reflected in general audience work such as the BPS’s (2015) *Understanding Psychosis* report, may also inadvertently “normalize” the wrong phenomenological properties of AH and present a misleading view of what at least some patients are in fact struggling with.

Limitations and conclusion

In addition to sample size, important study limitations include the absence of trans-diagnostic comparison groups, the general challenges involved in interpreting complex and ineffable psychiatric phenomena, and potential cultural limitations in the analysis of non-US versus US-based accounts. We nevertheless believe that our findings challenge common assumptions about AH in schizophrenia and foreground both theoretically important and clinically relevant phenomenological distinctions and variations.

Disclosure statement

No potential conflict of interest was reported by the authors.

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