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# Prevalence and nature of multi-sensory and multi-modal hallucinations in people with first episode psychosis

Robert Dudley<sup>a,b,\*</sup>, Florence Watson<sup>c</sup>, Lucy O'Grady<sup>a</sup>, Charlotte Aynsworth<sup>a</sup>, Guy Dodgson<sup>a</sup>, Stephanie Common<sup>c</sup>, Ben-Alderson Day<sup>d</sup>, Charles Fernyhough<sup>d</sup>

<sup>a</sup> Early Intervention in Psychosis Services, Cumbria, Northumberland, Tyne and Wear NHS Foundation Trust, St. Nicholas Hospital, Jubilee Road, Newcastle Upon Tyne, NE3 3XT, United Kingdom

<sup>b</sup> Department of Psychology, University of York, York YO10 5DD United Kingdom

<sup>c</sup> Tees, Esk and Wear Valley NHS Trust, Wessex House, Falcon Court, Stockton on Tees TS18 3TX, United Kingdom

<sup>d</sup> University of Durham, Stockton Road, Durham DH1 3LE, United Kingdom

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## ABSTRACT

Hallucinations can occur in single or multiple sensory modalities. This study explored how common these experiences were in people with first episode of psychosis ( $n = 82$ ). Particular attention was paid to the number of modalities reported and whether the experiences were seen to be linked temporally and thematically. It was predicted that those people reporting a greater number of hallucinations would report more delusional ideation, greater levels of distress generally and lower functioning. All participants reported hallucinations in the auditory domain, given the nature of the recruitment. The participants also reported a range of other unusual sensory experiences, with visual and tactile hallucinations being reported by over half. Moreover, single sensory experiences or unimodal hallucinations were less common than two or more hallucination modalities which was reported by 78% of the participants. The number of hallucinations was significantly associated with greater delusional ideation and higher levels of general distress, but not with reduced functioning. It is clear there is a need to refine psychological treatments so that they are better matched to the actual experiences reported by people with psychosis. Theoretical implications are also considered.

## 1. Introduction

Around 70–80% of people with psychosis report hearing things that others do not (McCarthy-Jones et al., 2017). The high prevalence, and associated distress of auditory hallucinations has understandably contributed to a comparative neglect of experiences occurring in other sensory modalities. However, when asked, people with psychosis often report visual (VH, 27%), olfactory (5.8–9.6% OH), and tactile (9.3–19.3% TH) hallucinations (McCarthy-Jones et al., 2017). Lim et al. (2016) found that life-time reporting of hallucinations in two or more sensory modalities was twice as frequent (53%) as single sensory or uni-modal hallucinations (27%). Interest in the range of hallucinatory experience is one of the 'hot spots' for research identified by the International Consortium of Hallucination Research (ICHR; Waters et al., 2014) as much remains unknown about the prevalence, nature, causes and impact of hallucinations across sensory modalities.

A number of recent studies indicate that for clinical groups,

experiences in multiple modalities are seemingly common. For example, in a transdiagnostic group of attenders at a voices clinic (100% AH), there was a high rate of co-occurring VH (81.3%), OH (35%), GH, (13.8%) and TH (52.5%) experiences. Few (27.9%) reported only unimodal AH experiences. Of those with multiple hallucinations; 43.8% reported two modalities, 37.5% three, 11.3% four and 7.5% five modalities. Those with most hallucinations reported higher levels of anxiety (Badcock et al., 2021).

Toh and colleagues explored the nature of hallucinations in a group who were primarily recruited owing the presence of AH and psychosis (Toh et al., 2019). 53% of the sample reported VH, 46% TH, 36% OH, and 18% GH. Similarly, a review of case notes of 50 people with first episode psychosis found a high rate of a range of hallucinatory experiences (88% AH, 68% VH, 26% TH, 8% OH) (Isaacson et al., 2022).

There are indications that a greater "dose" of hallucinations is associated with more traumatic and adverse experiences (Badcock et al., 2021) and poorer clinical outcomes. For instance, where people report

\* Corresponding author at: Gateshead Early Intervention in Psychosis service, Dryden Centre, Evistones Road, Low Fell, Gateshead, NE9 5UR, United Kingdom.  
E-mail address: [rob.dudley@cntw.nhs.uk](mailto:rob.dudley@cntw.nhs.uk) (R. Dudley).

co-morbid auditory and visual hallucinations this was associated with heightened delusional thinking and negative affect (Oorschot et al., 2012).

To date, the exploration of these experiences has largely been retrospective, limited in the breadth of questions asked and often relied on self-report meaning that crucial questions about the nature of these experiences have been missed (Badcock et al., 2021; Dudley et al., 2019; McCarthy-Jones et al., 2017; Toh et al., 2019, 2020). For this reason, a number of researchers (Dudley et al., 2018; Montagnese et al., 2021) recommend systematically exploring the number of domains reported, using semi structured interviews, conducted face-to-face with trained interviewers who can determine whether they are temporally related (occurring at the same or different times; i.e. simultaneous or serial), and related in terms of the perceived origin or source (Toh et al., 2022a).

Toh and colleagues (Toh et al., 2022b) proposed a framework to distinguish unimodal, multisensory and multimodal experiences. Multisensory hallucinations refers to hallucinations in two or more sensory modes occurring at discrete time points and/or with negligible overlap in content. Multimodal hallucinations are ones that occur at the same time. Multimodal hallucinations were first described by Chesterman and Boast (1994) as ‘hallucinations in different sensory modalities occurring simultaneously and appearing to be emanating from a single source’ (Chesterman and Boast, 1994; p. 279). Toh et al. (2022b) slightly extend the definition of multimodal hallucinations and suggest they can also occur at different times, in which case they must have a great deal of relatedness. Toh et al. (2022b) give the example of someone who perceived a vision of angels and heard the voice of God. They argued this would constitute a multimodal hallucination (whether simultaneous or serial), even though these experiences may not be ascribed to the same entity as they are thematically related and seen as personally meaningful. When they are not temporally related then relatedness of thematic content becomes key. Thematic consistencies take precedence over a narrow focus on origin.

Knowing whether hallucinations are unimodal, multisensory or multimodal may have important theoretical implications (Ferryhough, 2019). One group of theories suggest that hallucinations are generated solely within specific perceptual systems that determine the modality of the hallucination as in the Perception and Attention Deficit model for visual hallucinations (Graham et al., 2011; Makin et al., 2013) presumably reflecting a reliance on different neurobiological mechanisms (Girgis et al., 2021). Other authors suggest a core impairment in a central reality testing mechanism which, in combination with specific sensory biases, leads to hallucinations in specific modalities. This may imply some shared causation of hallucinations in different modalities (Ferryhough 2019) possibly helping explain multisensory experiences. Other theories emphasise that perceptions are best understood as the outcome of processes that generate internal representations that are tested against sensory evidence (Parr et al., 2018). These predictive coding models imply that experience in one sensory modality (e.g. visual) would increase the expectation of congruent experiences in other sensory modalities (e.g. auditory, or tactile) increasing the likelihood of multimodal related hallucinations.

In terms of relationships with psychosis more generally, hallucinations in more than one modality could have a “double or triple whammy effect” (Ferryhough, 2016), as they take on greater significance, potentially increasing the chance of a “delusional” explanation further increasing distress. Seeing, hearing and smelling Christ or the devil will likely have a greater emotional effect than just seeing a chest of drawers whilst hearing a dog bark. Hence, experiencing more unusual sensory experiences generally (multisensory), or multimodal hallucinations in particular could drive a search for meaning and lead to the development of delusional explanations for these odd experiences (Maher, 1974).

In terms of clinical implications, existing psychological treatments focus mainly on auditory experiences (Dodgson et al., 2021) and there is limited evidence for treating non-auditory experiences like VH (Thomson et al., 2017; Wilson et al., 2016), and none have explicitly

considered how to treat multisensory or multimodal experiences. If people’s experiences are generally multisensory or multimodal then current treatments may be mismatched to people’s needs which may help explain the relatively modest benefit of psychological therapies for psychosis generally (Turner et al., 2020) and AH specifically (McCarthy-Jones et al., 2014).

So, in keeping with the recommendations of the ICHR (Waters et al., 2014) the present study examined the prevalence and nature of hallucinations across the various sensory domains in people with psychosis to establish (i) the frequency of different hallucinations reported by people with first episode psychosis, (ii) whether people report hallucinations in one single modality (unimodal hallucinations) or report more than one modality of hallucination.

However, unlike previous reports this work also asks whether experiences are temporally and/or thematically related. This systematic test of the Toh et al. (2022b), framework allows consideration of whether people with psychosis report multisensory/multimodal hallucinations, and if so, the most common combinations.

In terms of impacts of these multisensory/multimodal hallucinations it was predicted that where people report a greater number of hallucination domains these will be associated with greater delusional ideation (Oorschot et al., 2012), greater levels of distress in general (Badcock et al., 2021) and lower functioning (Oorschot et al., 2012).

## 2. Methods

### 2.1. Participants

Participants ( $n = 82$ ) were recruited from the Managing Unusual Sensory Experiences in First Episode Psychosis (MUSE FEP) trial (Dudley et al., 2022). 45% ( $n = 37$ ) were female and 55% ( $n = 45$ ) were male. The mean age was 30.40 years ( $sd = 10.34$ ). 91% were White which is representative of the local population (Office for National Statistics 2018). 28% ( $n = 23$ ) were in work, 13% ( $n = 11$ ) were studying and 50% ( $n = 41$ ) of individuals were not in employment.

To participate in the trial participants had to meet inclusion criteria detailed in full in Dudley et al. (2022) that included being aged 16 and above, being involved in an Early Intervention in Psychosis (EIP) service, diagnosed according to ICD-11 criteria for schizophrenia, schizoaffective disorder or entry criteria for an EIP service, have a history of auditory hallucinations for at least four weeks and to consider their hallucinations as a main difficulty. Both individuals on antipsychotic treatment, and those who declined to take medication, were included, as long as no medication changes had occurred in the previous month. At the time of recruitment 57 (69.5%) were prescribed an antipsychotic medication (18 were not on antipsychotic, and for 7 it was not recorded at the time). In addition, 52 (63.4%) were prescribed an additional psychiatric medication, 23 (28%) were not, and data was not available for 7. Exclusion criteria were hallucinations/psychosis with a known biological basis, a primary diagnosis of substance misuse/dependency, currently involved in psychological therapy.

### 2.2. Procedure

Participants were assessed on a specifically designed interview measure of multi-sensory/modal experiences as well as other validated, standardised measures used as part of the trial. Potentially many sensory domains are experienced but (Toh et al., 2022), recommend asking about five primary senses (AH, VH, TH, OH, GH). For the interview, we followed the approach used by Niles and colleagues in which somatic/tactile and also olfactory/gustatory were treated as equivalent (Niles et al., 2019). All assessments were carried out by 2 assessors (FW, LOG) trained in the use of the measure.

## 2.3. Measures

### 2.3.1. Multi modal hallucinations interview

Participants took part in a semi-structured interview developed with input from people with lived experience, clinicians and researchers. Participants were asked about their experiences in the last month. Participants were informed that hallucinations across a number of modalities were common and that the focus was on ones that occurred when awake, and not under the influence of drink or drugs. Questions covered hallucinations in a range of modalities (i.e., auditory, visual, somatic/tactile, olfactory/gustatory). Participants provided a description of their experiences and were systematically asked whether these were experienced at the same or different times (simultaneous or serial) and whether they were perceived to be related and whether they shared a common source/origin/identity or were understood to be unrelated. To help in this process examples were provided of related and unrelated experiences. For example, seeing a man and hearing his voice would be a related experience whereas seeing a dog but hearing the voice of a woman was an example of unrelated hallucinations. Each experience was rated by the participants on a nominal scale (0–100) indicating how strongly they believed it to be real (conviction) and how much distress it caused.

**Psychotic Symptom Rating Scales (PSYRATS, (Haddock et al., 1999))** delusions subscale is a clinician administered semi-structured interview. It consists of 6 items assessing the multidimensional aspects of delusions (such as distress, preoccupation, and conviction). It asks about beliefs in the last week. Higher scores represent more distress/conviction and impact of delusions. It is widely used with people with psychosis and has acceptable psychometric properties.

**The short Depression, Anxiety and Stress Scales (DASS; Lovibond and Lovibond, 1995)** is a 21 item self-report questionnaire assessing symptoms of anxiety, depression and stress in the last week. Higher scores indicate higher levels of distress. It is validated and used with a wide range of groups, including people with psychosis.

**The process of recovery questionnaire (QPR; Neil et al., 2009)** is a user-defined measure, assessing subjective recovery in intrapersonal and interpersonal functioning asking about the last seven days. It was developed for people with psychosis related issues, and is validated for that group. Higher scores represent higher levels of recovery, and functioning.

### 2.4. Data analytic strategy

There was no missing data. All descriptions of experiences were checked to ensure they met the definition of a hallucination (see David, 2004) rather than unusual experiences like illusions etc. Classification as to whether a hallucination was multisensory or multimodal was made according to the definition of Toh et al. (2022b) by considering if the experiences were described as serial or simultaneous in nature, and whether they were perceived to share the same source/origin. For example, people would describe a visual hallucination in which they saw a man, and heard him speak. This would be simultaneous and related and categorised as a multimodal experience. A person reporting smelling aftershave and later hearing the voice of a woman would be serial and unrelated and so be categorised as multisensory experience if it was not perceived to originate from the same source, and had no personal or thematic relationship. People reported some experiences to be related as they were attributed to explanations about illness and that this led to them having hallucinations. People would say they saw and heard things as owing to psychosis, for instance. These were not coded as related in the Toh et al. 2022b framework, as the focus was on relatedness of origin of the experience not a causal explanation of why people have hallucinations or psychosis. Based on these dimensions, experiences were classed as unimodal, multisensory or multimodal. Any disagreement was discussed with members of the team (RD, CA) and resolved.

The first questions of the study were descriptive and data is reported

in terms of frequencies and percentages of hallucinations. In considering whether more experiences were related to greater delusional ideation, general distress, and poorer functioning, a correlation of the number of hallucinations and delusions, the levels of stress, depression and anxiety and perceived functioning was undertaken.

### 2.5. Ethical considerations

The data was collected as part of the MUSE FEP trial (Dudley et al., 2022).

The trial obtained ethical approval from the NHS Yorkshire and Humber-Sheffield Research Ethics Committee (21/YH/0090) and Health Research Authority (IRAS 292,150). Participants gave full informed consent for the study.

## 3. Results

The first area of interest was the range of experiences reported in the last month. Given the entry requirement for the study, all participants reported auditory hallucinations (100%), then 52.4% (43/82) reported visual hallucinations, the same percentage reported somatic/tactile (52.4%, 43/82), and olfactory /gustatory (33%, 27/82) were also quite common.

The second question was whether unimodal experiences were more common than hallucinations in multiple domains. Participants reported 1 ( $n = 18$  22%) sensory modality, 2 ( $n = 28$ , 34.1%), 3 ( $n = 24$ , 29.3%) or 4 ( $n = 12$ , 15.9%) sensory modalities. Hallucinations in multiple modalities was the norm (78%).

For the people with more than auditory hallucinations alone ( $n = 64$ ) they reported 117 hallucinatory experiences in the last month that were categorised as serial, simultaneous, related or not according to the relevant definition (Toh et al., 2022b). The table shows the number of people reporting each type (multisensory and/or multimodal) of hallucinatory experiences. Multimodal experiences were often reported (72/117 or 62%).

The data in Table 1 report the frequency with which multisensory or multimodal hallucinations were reported, but not the specific nature of these. This is detailed in Table 2 where for each person ( $n = 64$ ) the nature of their reported experiences in terms of whether they were serial, or simultaneous, related or not, and whether they reported some or many combinations of these.

Table 2 indicates that people could experience a wide range of hallucinatory experiences. No one reported only simultaneous experiences, but simultaneous experiences in combination with other serial experiences were most frequent. that 44 of the group of people with first episode of psychosis report hallucinations occurring at the same time as each other but always in the context of other serial experiences (italicised in the table).

As noted, people reported many experiences, and the domains in which multisensory and multimodal hallucinations were experienced in were recorded. As can be seen in the figures below Figs. 1–4, for serial experiences, auditory hallucinations were often experienced in a number of combinations with other domains. For simultaneous experiences it is more distinct that the experiences tend to be auditory and visual, or auditory and tactile (see Figs. 1–4).

Finally, scores on the PSYRATS delusion scale ( $M = 13.96$   $sd=7.18$ ),

**Table 1**  
Nature of hallucinatory experiences reported in more than the auditory domain ( $n = 117$  reported experiences).

Hallucinations	Serial	Simultaneous
Related	25**	24**
Not related	45*	23**

\* Classed as multisensory.

\*\* Classed as multimodal.



**Table 2**  
Combination of hallucinatory experiences.

Combination of hallucinations	n
Serial related	4
Serial unrelated	15
Simultaneous related	0
Simultaneous unrelated	0
Serial related; Serial unrelated	1
Serial related; Simultaneous related	16
Serial related; Simultaneous unrelated	1
Serial unrelated; Simultaneous related	3
Serial unrelated; Simultaneous unrelated	17
Simultaneous related; Simultaneous unrelated	0
Serial related; Serial unrelated; Simultaneous related	4
Serial related; Serial unrelated; Simultaneous unrelated	0
Serial unrelated; Simultaneous related; Simultaneous unrelated	3
Serial related; Serial unrelated; Simultaneous related; Simultaneous unrelated	0

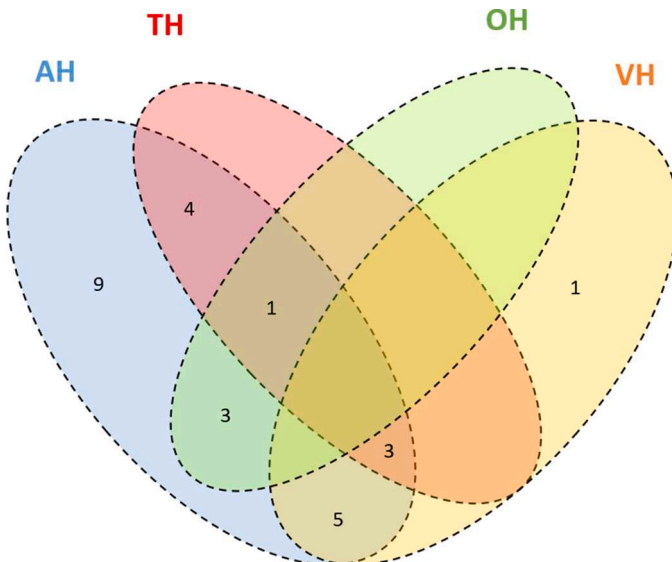


Fig. 1. Serial, related.

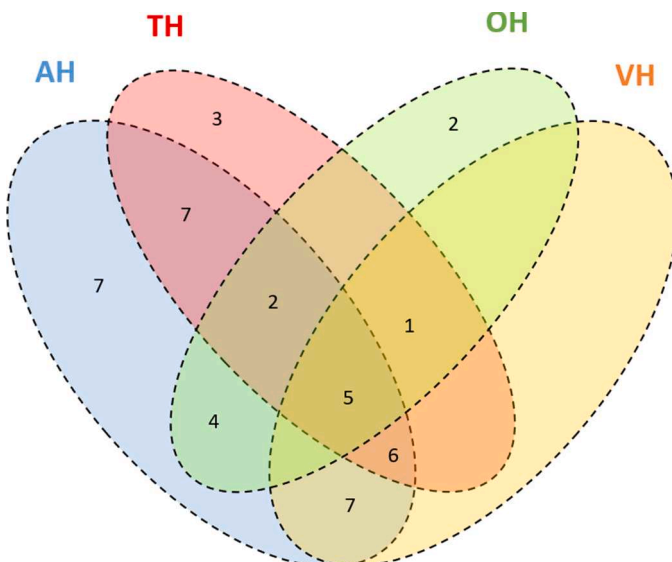


Fig. 2. Serial, unrelated.

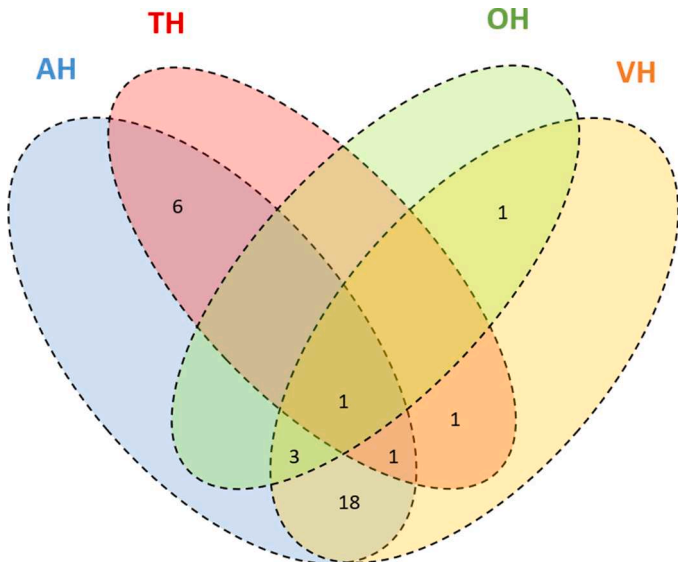


Fig. 3. Simultaneous, related.

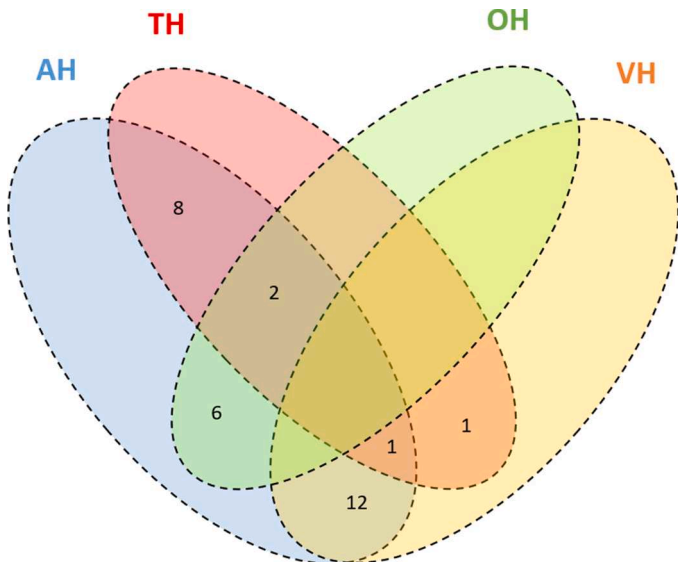


Fig. 4. Simultaneous, unrelated.

the DASS (Total  $M = 39.72$   $sd=10.83$ ; Stress  $M = 14.24$   $sd=3.99$ ; Anxiety  $M = 11.57$   $sd=4.29$ ; Depression  $M = 13.90$   $sd=5.06$ ) and QPR ( $M = 27.13$   $sd=10.83$ ) were considered in relation to the number of hallucinations ( $M = 2.45$   $sd= 0.98$ ) using non-parametric correlations. These indicated significant relationships between the number of hallucinations and delusions ( $n = 82$ ,  $r = 0.37$ ,  $p<0.001$  CI 0.15 to 0.54) distress (DASS total  $n = 82$   $r = 0.44$ ,  $p<0.001$  CI 0.24 to 0.60; Stress  $n = 82$   $r = 0.37$ ,  $p<0.001$  CI 0.16 to 0.55; Anxiety  $n = 82$   $r = 0.26$ ,  $p<0.001$  CI 0.15 to 0.54 and Depression  $n = 82$   $r = 0.34$ ,  $p = 0.002$  CI 0.12 to 0.52) but not with perceived functioning ( $n = 82$ ,  $r=-0.12$   $p = 0.28$  CI  $-0.34$  to 0.10).

#### 4. Discussion

The prevalence and nature of hallucinations in people with auditory hallucinations and first episode psychosis was examined. Hallucinations across sensory modalities were common, with visual hallucinations (52%) and tactile hallucinations (52%) reported often, consistent with reports of other similar groups (Badcock et al., 2021; Isaacson et al., 2022; Toh et al., 2019). Experiencing two or three or more modalities of

hallucinations was the norm (78%), whereas a single sensory experience was less common (22%). Using the definition of [Toh et al. \(2022\)](#) the majority of hallucinations were classified as multimodal rather than multisensory. When the experiences were happening at the same time (simultaneous) then auditory hallucinations in combination with visual (or auditory, visual and tactile) were particularly common experiences. The presence of a greater number of hallucinations was associated with higher levels of delusional ideation and high levels of distress, but not reduced functioning.

To our knowledge, the work is the first to systematically establish the prevalence of and nature of the relationships between hallucinations across sensory modalities in people with psychosis. Steps were taken to ensure the experiences reported were hallucinations rather than illusions and hallucinations were considered within a conceptual framework of temporal and origin relatedness. Previous work has indicated that hallucinations are often co-occurring ([Lim et al., 2016](#)) but the nature of the relatedness has not been properly explored, and not specifically whether the experiences are serial or simultaneous in nature. The high rate of reporting of simultaneous experiences (always in the context of other serial experiences) was not known before.

It is important to note the work has some limitations. An obvious one is that the interview used to elicit and categorise the hallucinations is not validated. Steps were taken to ensure experiences met the definition of a hallucination, and codings were discussed in depth, and reviewed to ensure agreement. Also, whilst we endeavoured to systematically apply the framework ([Toh et al., 2022b](#)) suggested to understand multisensory and multimodal experiences, there were challenges in doing this. For instance, when asked about the relatedness of the experience a broad range of causal explanations were offered that did not always reveal thematic, content or personal relatedness. Establishing the relatedness of some experiences can be difficult as a consequence of the very nature of psychosis as well as the high rates of adversity experienced by people with psychosis. Two hallucinations may be thematically related such as seeing a vision of a man, and smelling burning in that they may relate to experiences of abuse in childhood. However, the person may report them as unrelated as the person has not yet linked the hallucinations with the abuse experiences. Making sense of these relationships is an important focus of therapies that target trauma in the context of psychosis ([McCartney et al., 2019](#); [Varese et al., 2021](#)). Given the importance of adversity in psychosis, and in relation to multisensory/multimodal it is a limitation that we did not also ask about adversity and dissociation.

We had assumed that where people report more than one sensory experience that multisensory or multimodal experiences would lead to higher levels of conviction and distress than unimodal experiences ([Dudley et al., 2018](#); [Ferryhough, 2019](#)). Distress and conviction scores were reviewed but it was not possible to distinguish multisensory/multimodal experiences on this basis. All the participants were in the trial as they wanted help with distressing auditory hallucinations. The scores for the combinations of multisensory and multimodal hallucinations were therefore high as they nearly always included auditory experiences, and so there was a reverse halo effect (or horn effect) where all the other experiences were affected by the high distress associated with auditory hallucinations.

Our focus was on a restricted number of domains in keeping with the recommendations of [Toh et al., 2022b](#) but Blom identifies a large number of sensory domains for people to report unusual experiences within ([Blom, 2010](#)). There is a risk we imposed a framework that missed the full range of people's experiences. Another limitation is that we did not explicitly consider the impact of medication or different diagnoses on the reporting of multisensory or multimodal hallucinations. Our sample was quite small and we had no specific hypotheses regarding these variables but future research may wish to consider the possible impact of these on reporting of hallucinatory experiences.

In terms of theoretical implications, it is evident that this group have a rich experience of hallucinations across domains that are often co-

occurring. The factors that lead to this difference are not well understood but it does imply that the development of psychosis is associated with the breakdown of the boundary between internal and external events, and that the confusion can lead to greater sensory experiences. The reality monitoring framework holds that judgements made about whether an event was real or imagined is based on lots of different kinds of information, including vividness, perceptual detail, etc. ([Johnson and Raye, 1981](#)). Therefore, an experience that co-occurs in multiple modalities weighs the judgement towards the event being real, being a further reason why multimodal hallucinations might be more impactful. Where people report more modalities, then it could increase the risk of more delusional ideation which is consistent with our findings. Given the high rates of multisensory and multimodal hallucinations it is hard to distinguish if these represent discrete, or common pathways.

For people in the EIP service, treatment focusses primarily on understanding and managing auditory hallucinations and delusional thinking. In the current sample only 22% just reported auditory hallucinations. 78% reported additional hallucinations for which we have no proven treatments to offer. Moreover, the most common combination is of visual and auditory experiences, but our treatments address only auditory experiences, leaving a gap between what we offer and what people are reporting. Given the importance of multisensory and multimodal hallucinations as experiences in themselves but also in delusional ideation then models, treatments and outcome measures need to better account for the range of experiences reported. [Figs. 1, 2 and 4](#)

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#### Data availability

Owing to the sensitive nature of the questions asked in this study, participants were assured raw data would remain confidential and would not be shared widely. Summary and anonymised data would be available on the basis of written reasonable request. A copy of the multimodal hallucination is available on request. *Data not routinely available / The data that has been used is confidential.*

#### CRediT authorship contribution statement

**Robert Dudley:** Conceptualization, Formal analysis, Writing – original draft, Visualization. **Florence Watson:** Data curation. **Lucy O'Grady:** Data curation. **Charlotte Aynsworth:** Visualization, Data curation. **Guy Dodgson:** Visualization. **Stephanie Common:** Visualization. **Ben-Alderson Day:** Visualization. **Charles Ferryhough:** Visualization.

#### Declaration of Competing Interest

RD receives payment for workshops in treating hallucinations and GD, SC, CA and RD declare they are involved in running treatment studies investigating psychological therapies for psychosis. All other authors declare no competing interest.

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## References

- Badcock, J.C., Brand, R., Thomas, N., Hayward, M., Paulik, G., 2021a. Multimodal versus unimodal auditory hallucinations in clinical practice: clinical characteristics and treatment outcomes. *Psychiatry Res.* 297 <https://doi.org/10.1016/j.psychres.2021.113754>.
- Blom, J., 2010. *A Dictionary of Hallucinations*. Springer.
- Chesterman, L., Boast, N., 1994. Multi-modal hallucinations. *Psychopathology* 273–280.
- David, A.S., 2004. *Voices in the brain: the cognitive Neuropsychiatry of Auditory Verbal Hallucinations*. Psychology Press.
- Dodgson, G., Aynsworth, C., Mitrenga, K.J., Gibbs, C., Patton, V., Fernyhough, C., Dudley, R., Ewels, C., Leach, L., Alderson-Day, B., Common, S., 2021. Managing unusual sensory experiences: a feasibility trial in an at risk mental states for psychosis group. *Psychol. Psychother. Theory Res. Pr.* 94 (3) <https://doi.org/10.1111/papt.12323>.
- Dudley, R., Aynsworth, C., Cheetham, R., McCarthy-Jones, S., Collerton, D., 2018. Prevalence and characteristics of multi-modal hallucinations in people with psychosis who experience visual hallucinations. *Psychiatry Res.* 269 <https://doi.org/10.1016/j.psychres.2018.08.032>.
- Dudley, R., Aynsworth, C., Mosimann, U., Taylor, J.-P., Smailes, D., Collerton, D., McCarthy-Jones, S., Urwyler, P., 2019. A comparison of visual hallucinations across disorders. *Psychiatry Res.* 272 <https://doi.org/10.1016/j.psychres.2018.12.052>.
- Dudley, R., Dodgson, G., Common, S., O'Grady, L., Watson, F., Gibbs, C., Arnott, B., Fernyhough, C., Alderson-Day, B., Ogundimu, E., Kharatikoopaei, E., Patton, V., Aynsworth, C., 2022a. Managing unusual sensory experiences in people with first-episode psychosis (MUSE FEP): a study protocol for a single-blind parallel-group randomised controlled feasibility trial. *BMJ Open* 12 (5). <https://doi.org/10.1136/bmjopen-2022-061827>.
- Fernyhough, C., 2016. *The Voices Within: The History and Science of How we Talk to Ourselves*. Basic Books.
- Fernyhough, C., 2019. Modality-general and modality-specific processes in hallucinations. *Psychol. Med.* 49 (16), 2639–2645. <https://doi.org/10.1017/S0033291719002496>. Cambridge University Press.
- Girgis, R.R., Feng, X., Brucato, G., Sigmon, H.C., Lieberman, J.A., Provenzano, F., 2021. The neurobiology of auditory and visual perceptual abnormalities in a clinical high-risk for psychosis cohort: a pilot morphometric magnetic resonance imaging study. *J. Psychiatr.* Res. 142, 240–242. <https://doi.org/10.1016/j.jpsychires.2021.08.009>.
- Graham, G., Dean, J., Mosimann, U.P., Colbourn, C., Dudley, R., Clarke, M., Collerton, D., 2011. Specific attentional impairments and complex visual hallucinations in eye disease. *Int. J. Geriatr. Psychiatry* 26 (3). <https://doi.org/10.1002/gps.2522>.
- Haddock, G., McCarron, J., Tarrier, N., Faragher, E.B., 1999. Scales to measure dimensions of hallucinations and delusions: the psychotic symptom rating scales (PSYRATS). *Psychol. Med.* 29 (4), 879–889. <https://doi.org/10.1017/S0033291799008661>.
- Isaacson, M., Hazell, C.M., Cape, J., Hickson, E., Islam, F., Gill, A., Simon, K., Patel, R., Souray, J., Raune, D., 2022. The cognitive-phenomenological assessment of delusions and hallucinations at the early intervention in psychosis service stage: the results of a quality improvement project. *Early Interv. Psychiatry*. <https://doi.org/10.1111/eip.13283>.
- Johnson, M., Raye, C., 1981. Reality Monitoring. *Psychol. Rev.* 88 (a), 67–85.
- Lim, A., Hoek, H.W., Deen, M.L., Blom, J.D., Bruggeman, R., Cahn, W., de Haan, L., Kahn, R.S., Meijer, C.J., Myin-Germeys, I., van Os, J., Wiersma, D., 2016. Prevalence and classification of hallucinations in multiple sensory modalities in schizophrenia spectrum disorders. *Schizophr. Res.* 176 (2–3), 493–499. <https://doi.org/10.1016/j.schres.2016.06.010>.
- Lovibond, P.F., Lovibond, S.H., 1995. The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behav Res Ther.* 33 (3), 335–343.
- Maier, B., 1974. Delusional thinking and perceptual disorder. *J. Individ Psychol.* 30 (1), 98–113.
- Makin, S.M., Redman, J., Mosimann, U.P., Dudley, R., Clarke, M.P., Colbourn, C., Collerton, D., 2013. Complex visual hallucinations and attentional performance in eye disease and dementia: a test of the perception and attention deficit model. *Int. J. Geriatr. Psychiatry* 28 (12). <https://doi.org/10.1002/gps.3947>.
- McCarthy-Jones, S., Smailes, D., Corvin, A., Gill, M., Morris, D.W., Dinan, T.G., Murphy, K.C., Anthony O'Neill, F., Waddington, J.L., Australian Schizophrenia Research Bank, Donohoe, G., Dudley, R., 2017b. Occurrence and co-occurrence of hallucinations by modality in schizophrenia-spectrum disorders. *Psychiatry Res.* 252 <https://doi.org/10.1016/j.psychres.2017.01.102>.
- McCarthy-Jones, S., Thomas, N., Dodgson, G., Fernyhough, C., Brotherhood, E., Wilson, G., Dudley, R., 2014. What have we learnt about the ability of cognitive behavioural therapy to help with voice-hearing? Psychological Approaches to Understanding and Treating Auditory Hallucinations: From Theory to Therapy <https://doi.org/10.4324/9781315753829>.
- McCartney, L., Douglas, M., Varese, F., Turkington, D., Morrison, A.P., Dudley, R., 2019. Cognitive behavioural therapy for psychosis targeting trauma, voices and dissociation: a case report. *Cogn. Behav. Ther.* <https://doi.org/10.1017/S1754470x19000035>.
- Montagnese, M., Leptourgos, P., Fernyhough, C., Waters, F., Larøi, F., Jardri, R., McCarthy-Jones, S., Thomas, N., Dudley, R., Taylor, J.P., Collerton, D., Urwyler, P., 2021. A review of multimodal hallucinations: categorization, assessment, theoretical perspectives, and clinical recommendations. *Schizophr Bull.* 47 (1), 237–248. <https://doi.org/10.1093/schbul/sbaa101>. NLM (Medline).
- Neil, S.T., Kilbride, M., Pitt, L., Nothard, S., Welford, M., Sellwood, W., Morrison, A.P., 2009. The questionnaire about the process of recovery (QPR): a measurement tool developed in collaboration with service users. *Psychosis* 1 (2), 145–155. <https://doi.org/10.1080/17522430902913450>.
- Niles, H.F., Walsh, B.C., Woods, S.W., Powers, A.R., 2019. Does hallucination perceptual modality impact psychosis risk? *Acta Psychiatr. Scand.* 140 (4), 360–370. <https://doi.org/10.1111/acps.13078>.
- Office for National Statistics, 2018. Population of England and Wales: by Ethnicity. Office for National Statistics. Gov.uk. <https://www.ethnicity-facts-figures.service.gov.uk/uk-population-by-ethnicity/national-and-regional-populations/population-of-england-and-wales/latest>. Accessed 14 September 2022.
- Oorschot, M., Lataster, T., Thewissen, V., Bentall, R., Delespaul, P., Myin-Germeys, I., 2012. Temporal dynamics of visual and auditory hallucinations in psychosis. *Schizophr. Res.* 140 (1–3), 77–82. <https://doi.org/10.1016/j.schres.2012.06.010>.
- Parr, T., Benrimoh, D.A., Vincent, P., Friston, K.J., 2018. Precision and False Perceptual Inference. *Front. Integr. Neurosci.* 12 <https://doi.org/10.3389/fnint.2018.00039>.
- Thomson, C., Wilson, R., Collerton, D., Freeston, M., Dudley, R., 2017. Cognitive behavioural therapy for visual hallucinations: an investigation using a single-case experimental design. *Cogn. Behav. Ther.* 10 <https://doi.org/10.1017/S1754470x17000174>.
- Toh, W.L., Bere, M., Rossell, S.L., 2022b. Distinguishing multimodal versus multisensory hallucinations in psychosis: key definitions and a way forward. *Aust. N. Z. J. Psychiatry* 56 (5), 445–450. <https://doi.org/10.1177/00048674211031455>.
- Toh, W.L., McCarthy-Jones, S., Copolov, D., Rossell, S.L., 2019. Have we overlooked the significance of multinodal hallucinations in schizophrenia? *Psychiatry Res.* 279, 358–360. <https://doi.org/10.1016/j.psychres.2019.06.018>.
- Toh, W.L., Moseley, P., Fernyhough, C., 2022a. Hearing voices as a feature of typical and psychopathological experience. *Nat. Rev. Psychol.* 1 (2), 72–86. <https://doi.org/10.1038/s44159-021-00013-z>.
- Turner, D.T., Burger, S., Smit, F., Valmaggia, L.R., van der Gaag, M., 2020. What constitutes sufficient evidence for case formulation-driven CBT for psychosis? Cumulative meta-analysis of the effect on hallucinations and delusions. *Schizophr Bull.* 46 (5), 1072–1085. <https://doi.org/10.1093/schbul/sbaa045>.
- Varese, F., Douglas, M., Dudley, R., Bowe, S., Christodoulides, T., Common, S., Grace, T., Lumley, V., McCartney, L., Pace, S., Reeves, T., Morrison, A.P., Turkington, D., 2021. Targeting dissociation using cognitive behavioural therapy in voice hearers with psychosis and a history of interpersonal trauma: a case series. *Psychol. Psychother. Theory Res. Pr.* 94 (2) <https://doi.org/10.1111/papt.12304>.
- Waters, F., Woods, A., Fernyhough, C., 2014. Report on the 2nd international consortium on hallucination research: evolving directions and top-10 “hot spots” in hallucination research. *Schizophr Bull.* 40 (1), 24–27. <https://doi.org/10.1093/schbul/sbt167>.
- Wilson, R., Collerton, D., Freeston, M., Christodoulides, T., Dudley, R., 2016. Is seeing believing? The process of change during cognitive-behavioural therapy for distressing visual hallucinations. *Clin. Psychol. Psychother.* 23 (4) <https://doi.org/10.1002/cpp.1962>.