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Prevalence of multisensory hallucinations in people at risk of transition to psychosis

Robert Dudley^{*,a,b}, Sophie Denton^c, Jennifer Mathewson^c, Sairah Pervez^c,
Charlotte Aynsworth^a, Guy Dodgson^a, Nicola Barclay^c

^a Early Intervention in Psychosis services, Cumbria, Northumberland, Tyne and Wear NHS Foundation Trust, St. Nicholas Hospital, Jubilee Road, Gosforth, Newcastle Upon Tyne, NE3 3XT, United Kingdom

^b Department of Psychology, University of York, York, YO10 5DD UK

^c At Risk Mental State Services, Cumbria, Northumberland, Tyne and Wear NHS Foundation Trust, Gosforth, Newcastle Upon Tyne, NE3 3XT, UK.

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ABSTRACT

Hallucinations can occur in single or multiple sensory modalities. Greater attention has been paid to single sensory experiences with a comparative neglect of hallucinations that occur across two or more sensory modalities (multisensory hallucinations). This study explored how common these experiences were in people at risk of transition to psychosis ($n=105$) and considered whether a greater number of hallucinatory experiences increased delusional ideation and reduced functioning, both of which are associated with a greater risk of transition to psychosis. Participants reported a range of unusual sensory experiences, with two or three being common. However, when a strict definition of hallucinations was applied, in which the experience has the quality of a real perception and in which the person believes them to be real experiences, then multisensory experiences were rare and when reported, single sensory hallucinations in the auditory domain were most common. The number of unusual sensory experiences or hallucinations was not significantly associated with greater delusional ideation or poorer functioning. Theoretical and clinical implications are discussed.

1. Introduction

Hallucinations are the experience of seeing, hearing, feeling, smelling or tasting something that is not actually there. They are different to misperceptions or misidentifications of actual objects, and occur in full consciousness and not at the borders of sleep, for example (Waters et al., 2014). They are a key feature of psychosis where auditory (AH) and visual hallucinations (VH) (60-70% and 27% respectively (McCarthy-Jones et al., 2017; Ayalde et al., 2022)) are common, whilst tactile (9.3-19.3% TH) and olfactory hallucinations (5.8-9.6% OH) are rarer (McCarthy-Jones et al., 2017).

Hallucinations in a number of modalities are also reported across the psychosis spectrum indicating hallucinations can be experienced in the absence of distress, and even experienced positively. A sample of over 10,000 people recruited from the general population reported high rates of AH (29.5%), VH (21.5%), TH (19.9%), and OH (17.3%) in the last month (Linszen et al., 2022). For a substantial number however, these experiences were distressing and disruptive. Of those reporting hallucinations, 47.6% reported experiences in two or more modalities. The

more recent the hallucinations, the greater the association with delusional ideation. It should be noted that the authors acknowledge they used a broad definition of what constitutes a hallucination. Other studies using stricter definitions in community samples reported lower rates of OH (4.2% (Wehling et al., 2021)) or VH (5% (Aynsworth et al., 2022)) in the last month.

Given how common hallucinations are in the non-clinical population (Linszen et al., 2022) it is evident it is not the presence of hallucinations per se that leads to distress and the transition to psychosis. Rather transition is linked with changes in cognitive appraisals, presence of subclinical symptoms (e.g. anxiety, depression), delusional ideation, reduced functioning and sub-clinical negative symptoms. In terms of the specific role of hallucinatory experiences in transition, a study in a clinically high-risk group indicated that no specific domain of sub-clinical hallucinations predicted transition to psychosis, but verbal rather than non-verbal auditory experiences did, as well the presence of delusional ideation (Niles et al., 2019). Another study indicated that AH were associated with transition, but VH were protective (Lehembre-Shiah et al., 2017). This contrasts with the situation in people with

* Corresponding author at: Department of Psychology, University of York, York, YO10 5DD, United Kingdom
E-mail address: rob.dudley@york.ac.uk (R. Dudley).

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psychosis where VH are less common than AH, but their presence is associated with a significantly worse global severity of illness and lower global functioning (Mueser et al., 1990). Given that in people with psychosis experiences like VH are a marker for distress, disability and poor functioning there is a need to consider how common these and other non-auditory experiences are across the continuum of psychosis and whether these experiences are an important clinical marker.

Knowing more about the frequency and nature of these experiences is important theoretically and clinically. In terms of theory, whilst many factors may cause hallucinations, at some level they represent a confusion between internal and external events or real and imagined events (Johnson & Raye, 1981; Bentall, Baker & Havers, 1991). Greater confusion between imagined and real experiences could increase the number of modalities in which hallucinations are experienced and help explain the transition to psychosis. Moreover, more unusual sensory experiences like this could drive a search for meaning and lead to the development of delusional explanations for these unusual experiences (Maher, 1974).

In terms of clinical implications, existing psychological treatments for people in ARMS services focus mainly on auditory experiences (Dodgson et al., 2021; Morrison et al., 2012) and so risk being less than optimally matched to the actual experience of people at risk of transition, and may lack the powerful beneficial impact that a treatment that fully met the presenting needs of the service users could have.

So, an important first step is to systematically examine the prevalence of hallucinations across the various sensory domains in people at risk of developing psychosis. In light of this information, the number of modalities could be explored as factor in the transition to psychosis.

The current work was undertaken in an At Risk Mental State (ARMS) service which supports people presenting with psychosis like symptoms, but not at the frequency or level of distress that would bring them into a first episode service. The present study examines i) the frequency of different hallucinations in the last twelve months reported by people in ARMS service, ii) whether people report hallucinations in one single modality (unimodal hallucinations) or report more than one modality of hallucination (multisensory hallucinations); iii) and if so, asks what is the most common combination of multisensory hallucinations?

In the ARMS service the rate of transition has been very low (3/105 accepted cases) meaning it is not feasible to examine if hallucinations are associated with a transition to psychosis. Instead, it is possible to consider if the number of hallucinations is associated with other factors associated with transition. Hence, it is predicted that when people report more hallucinations these are associated with greater delusional ideation, and poorer functioning which have previously been associated with a greater risk of transition (Niles et al., 2019).

2. Methods

2.1. Participants

Participants included all individuals accepted into the At-Risk Mental State service from service launch (September 2020-May 2022, $n = 105$). 59% ($n = 62$) were female and 41% ($n = 43$) were male. The mean age was 18.56 years ($sd = 3.10$). 75% were white British, with white other (7%) and Asian (7%) being the next most common ethnicities. This is broadly representative of the local population (Office of National Statistics, 2021). 27% ($n = 28$) of individuals were not in education, employment or training (NEET) at the time of their referral into the ARMS service, 11% were employed, and the rest in school (30%), college (10%) or University (20%). As noted, at the time of the service evaluation only three people had made the transition to psychosis, limiting the ability to find any factors predicting transition.

2.2. Procedure

Participants were assessed on a standardised measure, the

Comprehensive Assessment of At-Risk Mental States (CAARMS) which asks about a range of sensory experiences including auditory, visual and other hallucinatory experiences in the last 12 months. All CAARMS assessments were carried out by 2 assessors (clinical psychologists, psychological therapists, assistant psychologists and care co-ordinators) trained in the use of the CAARMS. In most cases assessment was undertaken within two weeks of referral to the service. Demographic information was collected as part of routine assessment. Following each assessment, CAARMS were scored within a multi-disciplinary team to determine whether individuals should be accepted into the ARMS service. Individuals could be referred to another service such as an Early Intervention in Psychosis service if their symptoms and functioning met the threshold for this, or a Community Mental Health Treatment team if psychosis was not the predominant need. If symptoms were not problematic enough, they may be referred to an Improving Access to Psychological Therapies Service, or their General Practitioner.

2.3. Measures

The Comprehensive Assessment of At-Risk Mental States (CAARMS; (Yung et al., 2005)) is a clinician administered, semi-structured interview that assesses attenuated psychotic and psychotic symptoms. The perceptual abnormality section assesses hallucinatory like experience in five sensory modalities. Global rating scale scores for perceptual abnormalities in each sensory domain were recorded. Where individuals had multiple perceptual experiences in one sensory domain (e.g., two auditory experiences), the experience with the highest global rating scale score was recorded, regardless of whether the frequency score was within the at-risk mental state range. This was to maintain a focus on the quality and intensity of perceptual experiences present within the ARMS population.

After global rating scale scores had been recorded in each sensory domain for all participants, perceptual abnormalities in each domain were marked as being present if the global rating scale score was 3 or above (in line with ARMS criteria for the intensity of perceptual abnormalities). Where global rating scale scores were less than 3, experiences in each domain were marked as not present. Where scores were not clearly identified the presence of an experience was marked as unknown.

Given the interest in the presence of unusual sensory experiences (USE) and the development of more distinct hallucinations, the perceptual abnormality scale was used to distinguish the two. A global rating of 3 is where the unusual sensory experience is described as moderate and as puzzling, but one that the person is able to dismiss, and is not particularly distressing. The scale describes these unusual experiences as vivid distortions, illusions, and sensations like indistinct murmuring. An USE was categorised if a person scored a 3 and above. A score of 5 or 6, is considered severe and described as a true hallucination, such as hearing voices, or feeling something touching the body, that seems to be real, can be questioned with effort, and may be distressing.

Current functioning was also recorded, as well as global rating scale scores for unusual thought content (UTC) which assesses unusual experiences and thoughts (not related to persecutory ideation) and asks about explanations for unusual experiences. Scores on the non-bizarre ideation (NBI) scale were also recorded which assesses paranoid thinking as well beliefs about guilt, grandiosity, and somatic ideas. As with perceptual experiences, if individuals had more than one experience of UTC or NBI, the experience with the highest global rating scale score was recorded.

2.4. Data analytic strategy

Missing data was not replaced and is reported on an analysis-by-analysis basis. The first three questions of the study were descriptive and data is reported in terms of frequencies of both USE and

hallucinations. For the specific consideration of whether the presence of a greater number of hallucinations was associated with greater level of delusional ideation and poorer functioning, correlations of the number of USE and the unusual thought content (UTC) and non-bizarre ideation (NBI), and current functioning on the CAARMS was undertaken. It was repeated with the number of true hallucinations. Data was checked for normality and analysed using SPSS v28 (IBM). Given there were six correlations a Bonferroni correction was applied ($p < 0.008$) and confidence intervals were reported. No sample size estimation was undertaken as this was part of an ongoing service evaluation, but a sample of 82 is sufficient for an effect size of 0.3 for a two tailed correlation with alpha at 0.05 and beta at 0.8 (Gpower, Faul et al., 2009)

2.5. Ethical considerations and information governance

The data from the CAARMS was collected as part of the routine service data collection. In accordance with the UK Policy Framework for Health and Social Care Research (2017), NHS Research Ethics Committee approval was not required. The study was registered with an NHS Research and Development team in 2020. Participants gave informed consent to completing the CAARMS as part of service entry assessment. The authors have abided by the Ethical Principals of Psychologists and Code of Conduct as set out by the HCPC and BPS.

3. Results

The first area of interest was the range of experiences reported by people in the ARMS service in the last 12 months. Table 1 shows the number of people that reported experiences in each individual sensory domain. As can be seen in the table in some instances data was not reported for some individuals and % score are calculated based on the data available. As expected, unusual sensory experiences were common, 93% (88/95) of all individuals reporting auditory experiences, and 68% (61/90) reporting visual experiences with other modalities being less common.

When the stricter criterion of a score of 5 or more is applied the prevalence is reduced markedly, with 45% (43/95) reporting AH and 12% (11/90) reporting VH with much less of a difference between VH and other modalities.

The second question was whether unimodal experiences/hallucinations were more common than multisensory ones. For a proportion of individuals in this sample ($n = 27, 26\%$), datasets were incomplete. For those that had complete datasets ($n=78$) only two participants reported having no multisensory experiences (see Table 2). 33% reported unimodal experiences, with 65% reporting multisensory experiences with 2 (35%) or 3 (24%) sensory modalities being most common. When the stricter definition was applied none (49%) or one hallucination modality (38%) was most common. Multisensory hallucinations were rare (13%).

Combinations of sensory experiences were analysed for the sample

Table 1
Number of individuals in which unusual sensory experiences were present (a score of 3-6 on the CAARMS global rating scale), not present (a score of 0-2) or where the presence of an experience was unknown for each sensory domain and below is where the experience meets criteria for a true hallucination (a score of 5 or 6).

Unusual sensory experience	Auditory (%)	Visual (%)	Tactile (%)	Olfactory (%)	Gustatory (%)
Yes	88 (93)	61 (68)	23 (25)	10 (10)	2 (1)
No	7 (7)	29 (32)	68 (75)	88 (90)	99 (99)
Unknown	10	15	14	7	4
True hallucinations					
Yes	43 (45)	11 (12)	9 (10)	4 (4)	1 (1)
No	52 (55)	79 (88)	82 (90)	94 (96)	100 (99)
Unknown	10	15	14	7	4

Table 2
Frequencies and percentages of individuals with experiences in each possible number of sensory domains.

Number of modalities of unusual sensory experiences	Frequency (n=78)	Percentage
0	2	3
1	26	33
2	27	35
3	19	24
4	3	4
5	1	1

Number of modalities of true hallucinations	Frequency (n=78)	Percentage
0	38	49
1	30	38
2	9	12
3	1	1
4	0	0
5	0	0

($n = 78$). USE in the auditory domain only ($n = 23, 29\%$) were common, but so too were experiences in both the auditory and visual domain ($n = 24, 31\%$), followed by auditory, visual and tactile experiences ($n = 16, 21\%$). Visual experiences on their own were rare (4%) and were much more common in combination with other USE (46 of the participants or 59% reported visions in combination with other experiences). Fig. 1 shows frequencies of all different combinations of sensory experiences reported.

Once again, when the stricter criterion of a score of 5 or more was applied the findings in relation to prevalence of multisensory experiences changed and are shown in Fig. 2. Most participants did not have true hallucinations ($n = 38/78 48.7\%$) which would be consistent with them being in the ARMS group. However, where the experience seemed to meet criteria for a true hallucination 24 (30.1%) had AH only and only 11 (13%) had some combination of multisensory experiences.

Finally, the relationship between the number of unusual sensory experiences ($n = 78, M = 1.97 sd = 0.98$) was examined in relation to delusional ideation (UTC, $n = 98 M = 3.47 sd = 1.78$; NBI $n = 97, M = 2.88 sd = 1.35$) and functioning (SOFA's $M = 48.54 sd = 7.39$). All the variables except functioning demonstrated acceptable kurtosis and skew and parametric correlations were reported except for functioning which used non-parametric correlation. These indicated no significant relationship between number of USE and UTC ($n = 76, r = .03, p = .77, CI -.19$ to $.26$), NBI ($n = 78, r = .19, p = .10, CI -.04$ to $.39$) or current functioning ($n = 63,$

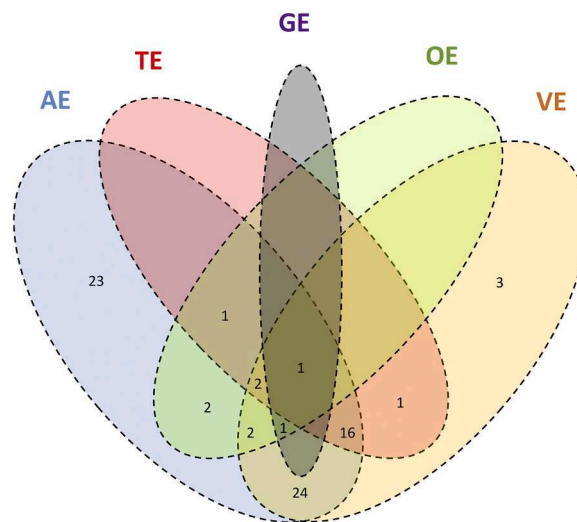


Fig. 1. Combinations of unusual sensory experiences AE Auditory Experiences, TE Tactile Experiences, GE Gustatory Experiences, OE Olfactory Experiences, VE Visual Experiences

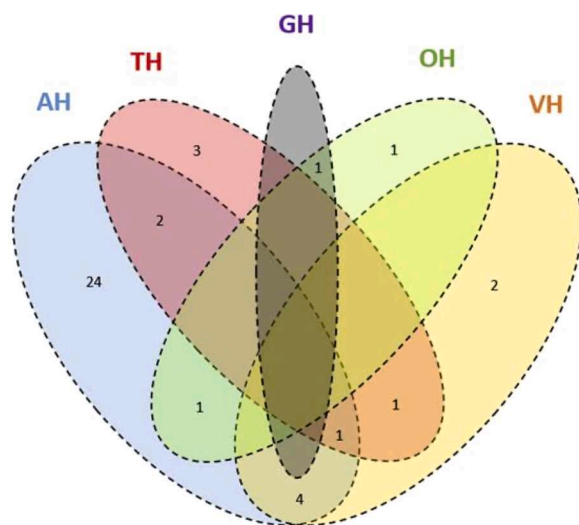


Fig. 2. Combinations of true hallucination experiences AH Auditory Hallucinations, TH Tactile Hallucinations, GH Gustatory Hallucinations, OH Olfactory Hallucinations, VH Visual Hallucinations

$r=.06$, $p=.62$, CI $-.19$ to $.31$). The analysis was repeated with the true hallucinations ($n=77$ $M=0.66$ $sd=0.74$) revealing a similar pattern in relation to UTC ($n=75$, $r=.07$, $p=.56$ CI $-.16$ to $.29$) and current functioning ($n=62$, $r=-.06$, $p=.62$, CI $-.32$ to $.20$). The analysis for non-bizarre ideation was significant (NBI $n=77$, $r=.25$ $p=.03$, CI $.03$ to $.45$) but not once the correction for multiple comparisons was applied. Hence, the number of modalities of hallucination was not associated with delusional ideation or functioning, and so seem unlikely to be factors in the transition to full psychosis.

4. Discussion

The prevalence and nature of unusual sensory experiences and hallucinations in people at risk of developing psychosis was examined. USE were common, with auditory experiences being reported more often than those in other sensory modalities. Applying a strict definition of a true hallucination, it was the case that half the people did not have hallucinations, or if they did AH were most frequent. As with people with psychosis, AH were more common than VH which were similar to the rate of TH and more common than OH and GH. Unlike people with psychosis, unimodal hallucinatory experiences were more common than multisensory hallucinations (Dudley et al., 2023). Like in psychosis, people in the ARMS service reported AH and VH as the most common combination of multisensory experience. The presence of a greater number of USE or hallucinations was not associated with delusional ideation and/or poor functioning.

The work is the first to report on the prevalence of unimodal/multisensory USE and hallucinations in people with ARMS. The application of definitions of USE/hallucinations helped to overcome some of the challenges of assessment of the presence of hallucinations, where single items on self-report or brief interviews may lack the specificity required to distinguish illusions, and non-distressing experiences from the more frank, puzzling, seemingly real and often upsetting experiences of hallucination (Aynsworth et al., 2017).

However, the work has some obvious limitations. The sample size was modest, and the very low rate of transition meant it was not possible to examine these experiences as predictors of transition to psychosis. Another limitation arising from the use of the CAARMS is that we were unable to explore the relationship and nature of the experiences. For instance, we lacked information as to whether hallucinations occurred at the same or different times, or whether they were perceived to originate from the same source (Toh et al., 2022). Future research needs to

systematically ask about these features using either validated measures that capture the occurrence of hallucination like experiences (Linszen et al. 2022) or appropriate semi structured interviews that try to better explore the nature of the relationship between these experiences and whether they occur at the same or different times for example (Dudley et al. 2023). Also, we were unable to reliably differentiate verbal and non-verbal AH meaning we were not able to explore how this may have contributed to transition or presence of delusions and impaired functioning (Niles et al., 2019). However, the point of the service evaluation was to better understand the needs of those presenting to services and to identify if sensory experiences across domains were an important issue for people.

Knowing whether hallucinations are unimodal, or multisensory may have important theoretical implications (Montagnese et al., 2021). It is evident that the ARMS group have a rich range of USE, but true hallucinations are not that frequent, and where they are reported they are usually unimodal. People with psychosis report more hallucinations across more domains (Dudley et al., 2023) and these are more often multisensory and are associated with greater negative affect, and delusional ideation. 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 experiences, and more delusional ideation and it is not the presence of hallucinations alone that leads to psychosis (Waters et al., 2018). Linszen et al., (2022) found more hallucinations were associated with more delusional ideation in a non-clinical group, but this was not the case with the ARMS group (though see Niles et al., 2019). Rather they seem to be more like those of Toh and colleagues who asked non-clinical voice hearers ($n=33$) about other sensory experiences they experienced and they reported VH (50%), TH (24%) and OH (29%) at least once a week. However, these experiences had little association with delusions (Toh et al., 2020).

For many people in the ARMS service, treatment focussed primarily on understanding and managing auditory hallucinations (Dodgson et al., 2021) would be appropriate. However, for the small number reporting multisensory experiences these may be important to directly address (Collerton & Dudley, 2004; Toyohara et al., 2021), though there is a lack of evidence-based treatment for dealing with these other presenting issues (Thomson et al., 2017; Wilson et al., 2016).

CRedit authorship contribution statement

RD had overall responsibility for the study and drafted the first draft of the write up. RD, CA, NB, GD contributed to the study design. SD, SP, JM coordinated the data collation. All authors read and approved the final submission.

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. *Data not available / The data that has been used is confidential.*

Declaration of Competing Interest

RD receives payment for workshops in treating hallucinations and GD, 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

- Ayalde, J., Wearne, D., Hood, S., Waters, F., 2022. Visual hallucinations in psychiatry – what aren't we seeing? *Australas. Psychiatry* 30 (1), 113–115. <https://doi.org/10.1177/10398562211038909>.
- Aynsworth, C., Collerton, D., Dudley, R., 2017. Measures of visual hallucinations: review and recommendations. *Clin. Psychol. Rev.* 57, 64–182.
- Aynsworth, C., Rolinson, J., Pervez, M., Collerton, D., Dudley, R., 2022. What is the frequency and nature of visual hallucinations in non-clinical participants? *Psychol. Psychother.: Theory Res. Pract.* <https://doi.org/10.1111/papt.12440>.
- Bentall, R.P., Baker, G.A., Havers, S., 1991. Reality monitoring and psychotic hallucinations. *Br. J. Clin. Psychol.* 30, 213–222. <https://doi.org/10.1111/j.2044-8260.1991.tb00939.x>.
- Collerton, D., Dudley, R., 2004. A cognitive behavioural framework for the treatment of distressing visual hallucinations in older people. *Behav. Cogn. Psychother.* 32 (4), 443–455. <https://doi.org/10.1017/S1352465804001626>.
- 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. Pract.* 94 (3) <https://doi.org/10.1111/papt.12323>.
- Dudley, R., Watson, F., O'Grady, L., Aynsworth, C., Dodgson, G., Common, S., Day, B.A., Fernyhough, C., 2023. Prevalence and nature of multi-sensory and multi-modal hallucinations in people with first episode psychosis. *Psychiatry Res.* 319 <https://doi.org/10.1016/j.psychres.2022.114988>.
- Faul, F., Erdfelder, E., Buchner, A., Lang, A.G., 2009. Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses. *Behav. Res. Methods.* 41 (4), 1149–1160. <https://doi.org/10.3758/BRM.41.4.1149>. NovPMID: 19897823.
- Johnson, M., Raye, C., 1981. Reality monitoring. *Psychol. Rev.* 88 (a), 67–85.
- Lehembre-Shiah, E., Leong, W., Brucato, G., Abi-Dargham, A., Lieberman, J.A., Horga, G., Girgis, R.R., 2017. Distinct relationships between visual and auditory perceptual abnormalities and conversion to psychosis in a clinical high-risk population. *JAMA Psychiatry* 74 (1), 104–106. <https://doi.org/10.1001/jamapsychiatry.2016.3055>.
- Linszen, M.M.J., de Boer, J.N., Schutte, M.J.L., Begemann, M.J.H., de Vries, J., Koops, S., Blom, R.E., Bohlken, M.M., Heringa, S.M., Blom, J.D., Sommer, I.E.C., 2022. Occurrence and phenomenology of hallucinations in the general population: A large online survey. *Schizophrenia* 8 (1). <https://doi.org/10.1038/s41537-022-00229-9>.
- Maher, B., 1974. Delusional thinking and perceptual disorder. *J. Individ. Psychol.* 30 (1), 98–113.
- 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., 2017. 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>.
- 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) <https://doi.org/10.1093/schbul/sbaa101>.
- Morrison, A.P., French, P., Stewart, S.L.K., Birchwood, M., Fowler, D., Gumley, A.I., Jones, P.B., Bentall, R.P., Lewis, S.W., Murray, G.K., Patterson, P., Brunet, K., Conroy, J., Parker, S., Reilly, T., Byrne, R., Davies, L.M., Dunn, G., 2012. Early detection and intervention evaluation for people at risk of psychosis: multisite randomised controlled trial. *BMJ* 344 (7852). <https://doi.org/10.1136/bmj.e2233>.
- Mueser, K.T., Bellack, A.S., Brady, E.U., 1990. Hallucinations in schizophrenia. *Acta Psychiatr. Scand* 82, 26–29. <https://doi.org/10.1111/j.1600-0447.1990.tb01350.x>.
- 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 of National Statistics <https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/populationandhouseholdestimatesenglandandwalescensus> 2021.
- 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. *Cognit. Behav. Therap.* 10 <https://doi.org/10.1017/S1754470X17000174>.
- Toh, W.L., Bere, M., Rossell, S.L., 2022. 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., Thomas, N., Robertson, M., Rossell, S.L., 2020. Characteristics of non-clinical hallucinations: a mixed-methods analysis of auditory, visual, tactile and olfactory hallucinations in a primary voice-hearing cohort. *Psychiatry Res.* 289 <https://doi.org/10.1016/j.psychres.2020.112987>.
- Toyohara, N., Fujita, J., Okumura, Y., Suda, A., Hattori, S., Saigusa, Y., Aoyama, K., Asanuma, K., Takahashi, Y., Arai, T., Hishimoto, A., 2021. Association between suicidal behaviors and auditory and visual hallucinations in Japanese adolescent psychiatric outpatients at first visit: a cross-sectional study. *Child Adolesc Ment Health.* <https://doi.org/10.1111/camh.12504>.
- Waters, F., Collerton, D., Ffytche, D.H., Jardri, R., Pins, D., Dudley, R., Blom, J.D., Mosimann, U.P., Eperjesi, F., Ford, S., Larøi, F., 2014. Visual hallucinations in the psychosis spectrum and comparative information from neurodegenerative disorders and eye disease. *Schizophr. Bull.* 40 (SUPPL. 4) <https://doi.org/10.1093/schbul/sbu036>.
- Waters, F., Blom, J.D., Jardri, R., Hugdahl, K., Sommer, I.E.C., 2018. Auditory hallucinations, not necessarily a hallmark of psychotic disorder. *Psychol. Med.* 48 (4), 529–536. <https://doi.org/10.1017/S0033291717002203>.
- Wehling, E., Bless, J.J., Hirnstein, M., Kråkvik, B., Vedul-Kjelsås, E., Hugdahl, K., Kalhovde, A.M., Larøi, F., 2021. Olfactory hallucinations in a population-based sample. *Psychiatry Res.* 304 <https://doi.org/10.1016/j.psychres.2021.114117>.
- 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>.
- Yung, A.R., Yuen, P., McGorry, P.D., Phillips, L.J., Kelly, D., Dell'olio, M., Francey, S.M., Cosgrave, E.M., Killackey, E., Stanford, C., Godfrey, K., Buckley, J., 2005. Mapping the onset of psychosis: the comprehensive assessment of at-risk mental states. *Aust. N. Z. J. Psychiatry* 39.