

## Health and Disability

# Prevalence of auditory hallucinations in Norwegian adolescents: Results from a population-based study

KRISTIINA KOMPUS,<sup>1,2</sup> ELSE-MARIE LØBERG,<sup>3,4</sup> MAJ-BRITT POSSERUD<sup>4,5,6</sup> and ASTRI JOHANSEN LUNDERVOLD<sup>1,5,6</sup>

<sup>1</sup>Department of Biological and Medical Psychology, University of Bergen, Norway

<sup>2</sup>NORMENT Center of Excellence, University of Oslo, Norway

<sup>3</sup>Department of Clinical Psychology, University of Bergen, Norway

<sup>4</sup>Division of Psychiatry, Haukeland University Hospital, Bergen, Norway

<sup>5</sup>Regional Centre for Child and Youth Mental Health and Child Welfare, Uni Health, Uni Research, Bergen, Norway

<sup>6</sup>K.G. Jebsen Centre for Research on Neuropsychiatric Disorders, University of Bergen, Bergen, Norway

Kompus, K., Løberg, E.-M., Posserud, M.-B. & Lundervold, A. J. (2015). Prevalence of auditory hallucinations in Norwegian adolescents: Results from a population-based study. *Scandinavian Journal of Psychology*, 56, 391–396.

Knowing the prevalence and characteristics of auditory verbal hallucinations (AVH) in adolescents is important for estimations of need for mental health care and assessment of psychosis risk. In this report we assess the prevalence of AVH in a population-based sample of 16–19 years old Norwegian adolescents ( $n = 9,646$ , 46.4% male) using two items assessing AVH (from the extended Launay-Slade Hallucination Scale). The prevalence of hearing a voice speaking thoughts aloud was 10.6%. The prevalence of being troubled by voices was 5.3%, showing that negative emotionality about AVH is less frequent than the experience of hearing voices. Female respondents had slightly increased risk for being troubled by voices than males (odds ratio = 1.3), while age did not modulate prevalence. This AVH prevalence is in line with earlier reports in smaller samples of adolescents and indicates that AVH are not uncommon in this period of life. Further longitudinal studies are needed to investigate the value of AVH in predicting psychiatric disorder.

**Key words:** Auditory hallucinations, adolescents

Kristiina Kompus, Department of Biological and Medical Psychology, Jonas Lies vei 91, University of Bergen, Norway. Tel: +4755586284; e-mail: Kristiina.Kompus@psybp.uib.no

## INTRODUCTION

People with auditory verbal hallucinations (AVH) hear voices that are not physically present. AVH may occur in the context of many neurological and psychiatric disorders, and are frequently encountered in patients with schizophrenia and other psychoses. However, AVH and voice-hearing may also occur without an accompanying psychotic disorder (Sommer, Daalman, Rietkerk *et al.*, 2010a), and lie on a continuum from psychotic hallucinations to normal perceptual experiences (see e.g., Larøi, 2012). In the present study these experiences are grouped together and termed AVH. The studies examining the prevalence of AVH in the general adult population have given varying estimates (Nuevo, Chatterji, Verdes, Naidoo, Arango & Ayuso-Mateos, 2012) with a median estimate of 4–5% (Van Os, Linscott, Myin-Germeys, Delespaul & Krabbendam, 2009). Since the experience of AVH may be considered a psychotic-like experience (PLE) (Van Os *et al.*, 2009) in addition to a marker for increased psychosis risk, the presence of AVH is of particular importance for the detection of schizophrenia-spectrum disorders. Correspondingly, most early detection services and assessments of ultra-high psychosis risk states aimed at young people include a focus on AVH. This stresses the need to know the prevalence of AVH in young people from the normal population by assessing voice hearing in a large, representative sample of adolescents. However, there have been few studies on the prevalence of AVH in adolescents (de Leede-Smith & Barkus, 2013) and the current estimates of AVH prevalence and outcome in children and adolescents vary. In a systematic review of 19 studies, Kelleher, Connor, Clarke, Devlin,

Harley and Cannon (2012a) reported a median prevalence of psychotic symptoms (predominantly assessed as hearing voices) to be 17% in general childhood samples (ages 9–12) and 7.5% in adolescent samples (ages 13–18).

Thus, developmental processes may influence the prevalence, as AVH appear to decrease throughout adolescence. Consistent with this view, Bartels-Velthuis, Van de Willige, Jenner, Van Os and Wiersma (2011) found that approximately two thirds of children reporting hearing voices at ages 7–8 did not report such experiences five years later. In contrast to the transient AVH, persistent AVH appear to increase the risk for depressed mood and general psychopathology in longitudinal studies (De Loore, Gunther, Drukker *et al.*, 2011), and AVH in later adolescence appears to have stronger association with psychiatric disorders compared to AVH in younger age groups (Kelleher, Keeley, Corcoran *et al.*, 2012b). Similarly, Rubio, Sanjuán, Flórez-Salamanca and Cuesta (2012) reported in a systematic review an increased prevalence of AVH in younger age. AVH were in most cases transient, whereas the persistence of AVH or transition to psychosis was suggested to be related to the severity of the hallucinatory experience (Rubio *et al.*, 2012).

In addition to age, there are other variables that may affect the frequency of reporting AVH. In clinical samples, rates of auditory hallucinations have been suggested to be higher in female patients (Rector & Seeman, 1992; Sharma, Dowd & Janicak, 1999), although there are many confounding variables which may account for apparent gender differences (e.g., sampling biases, comorbid depression, etc.). In general non-clinical populations, women have been found to have higher incidence of positive

psychotic symptoms (Maric, Krabbendam, Vollebergh, de Graaf & Van Os, 2003), and specifically auditory hallucinations (Shevlin, Murphy, Dorahy & Adamson, 2007; Tien, 1991). However, this difference may be mediated by depression (Tien, 1991). In young adults (age 18–24), a similar tendency for women reporting higher levels of hallucinations has been found (Scott, Welham, Martin *et al.*, 2008). It is not clear exactly when this tendency emerges due to few studies focusing on auditory hallucinations in adolescence. Kelleher *et al.* (2012b) report a trend for (nonspecified) psychotic symptoms being more prevalent among mid-adolescent boys than girls. By contrast, a slight (albeit non-significant) difference with girls reporting more hallucinations than boys has been reported (Dhossche, Ferdinand, Van der Ende, Hofstra & Verhulst, 2002). Although not specifically concentrating on hallucinations, Spauwen, Krabbendam, Lieb, Wittchen and Van Os (2003) report interaction for psychotic-like experiences (PLE) between sex and age for adolescents and young adults (age range 17–28 years), with higher PLE risk for males in younger age, but no gender difference in older age. In summary, it appears that the studies that specifically concentrate on hallucinations tend to show higher prevalence in women, whereas studies that examine non-specified PLE find higher prevalence in men; however, age should be taken into consideration when examining the gender differences. There are many relevant biological factors that may influence the differential expression of AVH between genders. Hormones, in particular estrogens, have been suggested as a factor which modulates the onset and symptomatology of psychotic disorders (Seeman, 1997). Also, the developmental trajectories of language networks in the brain, implicated in the neural basis of AVH (Catani, Craig, Forkel *et al.*, 2011), differ between adolescent boys and girls (Hirnstein, Westerhausen, Korsnes & Hugdahl, 2013). Childhood trauma has also been shown to increase the risk for having AVH in adult age (Daalman, Diederer, Derks, van Lutterveld, Kahn & Sommer, 2012; Janssen, Krabbendam, Bak *et al.*, 2004) and may also explain the higher rate of AVH in females as this is more often reported by females (Daalman *et al.*, 2012; Janssen *et al.*, 2004; Molnar, Berkman & Buka, 2001).

Taken together, there is a need for assessing the natural occurrence of AVH in large population-based samples of adolescents corresponding to typical high-risk age periods for psychosis. In this report we assess the prevalence of AVH in a population-based sample of 9,646 Norwegian adolescents aged 16 to 19 years. Further, we examined whether gender and age are related to self-reported AVH prevalence. As previous studies suggest that gender differences in AVH reporting exist, with a tendency for increased AVH in females, we hypothesized that girls would report more AVH. Also, we hypothesized that the prevalence of AVH would be influenced by age, with the lowest prevalence in the oldest age group.

Finally, socioeconomic variables have been suggested as possible modulatory variables on the expression of PLE (Saha, Scott, Varghese & McGrath, 2013; Scott, Chant, Andrews & McGrath, 2006). Correspondingly, we controlled the analyses with respect to the self-reported family economic status, maternal education, and migrant status (see also Bøe, Øverland, Lundervold & Hysing, 2012). However, we expected that due to the relatively homogeneous nature of Norwegian society the

socioeconomic variables would not have a significant effect in this sample.

## METHODS

### Sampling

The data stem from the fourth wave of the longitudinal *ung@hordaland*-survey (<http://www.unghordaland.no>), where all adolescents born between 1993 and 1995 living in the Hordaland county, Western Norway, were invited together with all students attending secondary education during spring 2012 (N = 19,121) to complete a web-based questionnaire on mental health and demographic background variables. Adolescents in secondary education received the invitation via e-mail and were allocated time (supervised by a teacher) during regular school hours to complete the questionnaire. Adolescents not in school received information by post. The study was approved by the Regional Committee for Medical and Health Research Ethics in Western Norway. The current study included the adolescents' self-reports on two items assessing AVH. Information about gender and year of birth were based on the personal identity number in the Norwegian National Population Register. The age of the participants was derived from information about date of birth and the date of completing the questionnaire, 11092 completed or partially completed the AVH items, yielding a participation rate of 58%. The main part of the sample was born between 1993 and 1995, representing the age group (16–19 years) focused on in the present study. A number of subjects (1,446) were removed (839 were not born within 1993–1995, 47 were missing personal identity numbers, 61 had unreliable answer profiles, 499 had missing reports on one or both of the AVH items), resulting in a total sample of 9,646 adolescents.

### Assessment of AVH

Presence of AVH was assessed with two items from the extended Launay-Slade Hallucinations Scale (LSHS-E) (Larøi, Marczewski & Van der Linden, 2004): (1) "I often hear a voice speaking my thoughts aloud;" (2) "I have been troubled by hearing voices in my head." LSHS-E is a self-report scale of hallucinatory experiences in non-clinical population. Factor analyses have found a four-factor structure, with one factor specific to AVH. The two AVH items used in the current study have shown strongest loading on the AVH factor (Larøi *et al.*, 2004; Vellante, Larøi, Cella, Raballo, Petretto & Preti, 2012). Responses are given on a 5-point scale (0 = "certainly does not apply to me," 1 = "possibly does not apply to me," 2 = "unsure," 3 = "possibly applies to me" and 4 = "certainly applies to me").

### Socioeconomic information

The participants indicated their parental education status for each parent, using six response options ("primary school," "secondary school," "vocational secondary school" "college or university, less than four years," "college or university, more than four years," "don't know"). The variable for each parent was re-coded into four categories ("primary," "secondary," "university," "don't know"). Family economic status was assessed by asking participants to estimate how their family economy is compared to most other families, using three response options ("approximately like most others;" "better;" "poorer"). Subjects reported their migration status by reporting whether they and their parents were born within Norway or outside of Norway; immigrant status was defined as both parents born outside of Norway. This information was included to investigate if the sample was representative of the population of Norwegian adolescents.

### Analysis

IBM SPSS Statistics, version 21.0.0.1 (IBM, Armonk, NY), was used to perform all analyses. The responses to the two LSHS items were

recoded into binary variables, with responses “3” and “4” coded as 1 (endorsement) and responses “0,” “1” and “2” coded as 0 (no endorsement). Each item was included in a logistic regression analysis as dependent variable. Gender, age (converted to z-score) and their interaction term were used as independent variables, entered in one block. To examine whether the results are independent of socioeconomic status, analyses were performed while controlling for the socioeconomic variables (family economic status, maternal education, immigrant status), which were entered in the first block, followed by the gender, age and their interaction in a separate block.

## RESULTS

### Demographic data

Of the 9,646 respondents in the analysis sample, 46.4% were male. Respondents' mean age was 17.4 yrs (SD 0.8 yrs), with no significant difference between male and female respondents. The majority of the respondents reported parents with high school or higher education, and family economy as comparable to other families. The percentage of immigrants in the sample was 5.9% (Table 1). These data indicate that the current sample was representative of general Norwegian adolescent population (Statistics Norway, 2014).

### AVH items

Item (1), sampling the experience of hearing a voice speaking thoughts aloud, was endorsed by 10.6% of the responders (see Table 2). The logistic regression analysis with gender and age and their interaction term indicated that neither age, gender nor their interaction were significantly associated with risk to hear a voice speaking thoughts aloud.

Item (2), sampling the experience of being troubled by voices, was endorsed by 5.3% of the responders (see Table 2). The logistic regression analysis with age, gender and their interaction term as predictors indicated slightly increased risk for being troubled by voices in female respondents (OR = 1.3; 95% CI = 1.02–1.5;  $p = 0.03$ ).

Table 1. Demographic data

N	9,646
Gender	
Male (%)	46.4
Female (%)	53.6
Age (SD), yrs	17.4 (0.8)
Immigrant (%)	5.9
Family economy (%)	
Same as others	67.4
Poorer than others	25.5
Better than others	7.1
Maternal education (%)	
Primary	7.8
Secondary	31.4
University	36.8
Paternal education	
Primary	7.9
Secondary	34.5
University	31.9

Note: For parental education, the percentage of “don't know” responses is omitted from the table.

Table 2. Responses to the items assessing AVH in the sample by gender

AVH item	Response (%)				
	Certainly does not apply	Possibly does not apply	Unsure	Possibly applies	Certainly applies
“I often hear a voice saying my thoughts aloud”					
Male	72.2	6.8	10.3	5.7	5.0
Female	70.2	7.2	12.1	6.5	4.1
“I have been troubled by hearing voices”					
Male	84.6	4.5	6.1	1.7	3.1
Female	81.9	5.2	7.1	3.0	2.8

We also examined whether the effects held when controlling for socioeconomic variables (household economy, maternal education, migration status). Repeating the logistic regression analyses while controlling for socioeconomic variables showed that the results did not change: for Item (1), there were no significant associations with age, gender nor their interaction; for Item (2), increased risk for female respondents remained significant (OR = 1.3; 95% CI = 1.03–1.6;  $p = 0.03$ ).

Finally, to examine possible bias, we also analyzed the endorsement of the AVH items among the excluded subjects. For the excluded subjects, the prevalence of endorsing item 1 was 10.9% and the prevalence of endorsing item 2 was 7.3%. The endorsement of item 2 is marginally higher among the excluded subjects than included subjects ( $\chi^2 = 5.97$ ;  $p = 0.02$ ).

## DISCUSSION

In a population-based sample of 9,646 Norwegian adolescents aged 16–19 years, 10.7% of the respondents endorsed hearing a voice speaking their thoughts aloud and 5.3% endorsed experiencing being troubled by voices. These findings roughly correspond to the prevalence reported in previous studies including smaller samples (Kelleher *et al.*, 2012b).

Contrary to our expectations and previous studies, we found no gender differences in the rate of youth reporting hearing a voice speak their thoughts aloud, but there was a small gender difference in being likely to report being troubled by the voices, with female responders reporting to be more frequently troubled by voices than males (OR = 1.3). Although the effect size is small, this finding deserves attention in further studies. The slightly increased risk for being troubled by voices for female respondents, with no difference in the overall report of hearing voices, suggests that the voices may be experienced as more distressing by young women than their male peers. Factor analyses of the LSHS have shown that while both of the items used in the present study load on an underlying “auditory hallucinations” factor (Larøi & Van Der Linden, 2005; Preti, Sisti, Rocchi *et al.*, 2014), the item addressing being troubled by the voices has also been found to load on a factor associated with psychopathology (Aleman, Nieuwenstein, Böcker & De Haan, 2001; Waters, Badcock & Maybery, 2003), and has been associated with higher degree of negative emotionality (Larøi & Van Der Linden, 2005). The persistence-impairment model suggested by Van Os *et al.* (2009) highlights environmental

stressors as crucial in the transition from non-clinical AVH to more clinically impairing and psychotic-like experiences (Van Os *et al.*, 2009). Females in this age group report higher levels of depression (Lundervold, Breivik, Posserud, Stormark & Hysing, 2013; Nolen-Hoeksema & Girgus, 1994; Welham, Scott, Williams *et al.*, 2009) indicating that they experience a higher stress level which could account for their having more stressful AVH. Also, depressive mood has also been shown to increase the risk of transition to psychosis in individuals with hallucinatory experiences (Krabbendam, Myin-Germeys, Hanssen *et al.*, 2005). Furthermore, childhood trauma and childhood sexual abuse is more often experienced by females (Janssen *et al.*, 2004; Molnar *et al.*, 2001) and is also one of the strongest risk factors for developing clinically impairing AVH and psychotic symptoms (Daalman *et al.*, 2012; de Leede-Smith & Barkus, 2013; Janssen *et al.*, 2004). The difference between genders was however small and the coding of symptoms in combination with different response style in the present study could also lead to a bias in results, as more females answered “unsure” to both item 1 and item 2. This could possibly also explain why we do not find a higher overall rate of AVH in females in the present study.

Contrary to our hypothesis, age was not related to either AVH item, suggesting that the age-related decline of AVH prevalence may have reached a stable plateau in this age group. Alternatively, this reflects the rather restricted age range of the sample. However, the exact trajectory of age-related changes in prevalence of different subtypes of PLE deserves a more detailed study. For instance, Scott *et al.* (2008) demonstrated that age-related decline of delusions continues from age 18 to 23, possibly related to ongoing maturation of the frontal lobes. As adolescence is a period of intense neuronal change coupled with large individual differences in puberty development and environmental exposure to stressors such as substance abuse, sexual experiences and psychosocial independence, chronological age may be a too crude measure not adequately reflecting individual development. Future studies should include a more detailed tracking of individuals experiencing AVH and factors affecting their development in adolescence to elucidate the mechanisms behind pathological vs. normative development of AVH.

An important question is to what extent the AVH prevalence in this study relates to other PLE as well as the psychosis risk in the adolescent population. Hallucinations (visual and auditory) consistently emerge as a distinct subtype of PLE. Other PLE dimensions have been labeled as persecutory ideas, bizarre experiences and magical thinking (Yung, Nelson, Baker, Buckby, Baksheev & Cosgrave, 2009), or delusions, paranoia, grandiosity and paranormal beliefs (Wigman, Van Winkel, Raaijmakers *et al.*, 2011a). The PLE subtypes show correlation with each other (Yung *et al.*, 2009). However, the subtypes have also a differential risk for distress and poor functioning, and hallucinations are among the subtypes with the strongest risk (Wigman *et al.*, 2011a; Yung *et al.*, 2009). Mackie, Castellanos-Ryan and Conrod (2011) found that distinct developmental trajectories can be identified in adolescent PLE, with “persistent” and “increasing” subclasses predicted by victimization and substance use. Wigman, Vollenbergh, Raaijmakers *et al.* (2011b) further demonstrated that within these trajectories, hallucinations and paranoia showed the strongest association with class

membership, with highest scores in the “persistent” group. Thus, it is reasonable to assume that adolescents reporting AVH in this sample may also experience other PLE and associated poor functioning. We do not know, however, to what extent the adolescents had a psychotic interpretation of the voices that they heard, even the young people endorsing that they had been troubled by their voices may still attribute these experiences to e.g., stress and mood. Thus, questions on how the young interpret and react to the voice hearing, both emotionally and behaviorally, would have aided the understanding of the results. However, the conversion to a psychiatric disorder and need for psychiatric care is probably mediated by environmental risk factors as well as factors such as coping style, cognitive biases and negative emotional affect (Johns, Kompus, Connell *et al.*, 2014).

A high participation rate and a representative sample were two main strengths of the present study. The current sample was representative of the Norwegian adolescent population as a whole, with relatively equal social positions and living standards among the participants. Most of the adolescents reported that their parents had high school or higher education. This is in accordance with national statistics for Norway, where over 80% of adults age 35–50 have high school or higher education (Statistics Norway, 2014). As shown by the control analyses, the inclusion of the socioeconomic variables did not affect the results, further indicating that the present sample was rather homogeneous.

Assessment of AVH using two brief self-report items was a limitation of the present study. It may also be questioned whether self-reports give valid information about AVH. While it is possible that self-reports may result in a slight over-estimation of PLE prevalence, the relationship between self-report and clinical interview estimates of AVH appears to be high. It has been demonstrated that a self-report questions on AVH have a positive predictive value of 71.4% (as well as a negative predictive value of 90.4%) for interview-verified AVH experiences in adolescent samples (Kelleher Harley, Murtagh & Cannon, 2011; see also Horwood, Salvi, Thomas *et al.*, 2008). Similar results have been reported in adult samples, e.g., in a study by Sommer *et al.* (2010a), where more than 60% of individuals who endorsed two AVH items from LSHS reported in a subsequent interview that they experienced AVH at least once a month.

It may be argued that item 1 represents a phenomenon of *gedankenlautwerden*, which could be a distinct subtype of hallucinatory experiences and not representative of a psychotic-like AVH. However, own-thought AVH are common in clinical samples (McCarthy-Jones, Trauer, Mackinnon, Sims, Thomas & Copolov, 2014). Further, Kelleher *et al.* (2011) found that among the clinically-validated adolescent AVH, the experience of hearing one’s thoughts loud was the most frequent qualitative type of AVH experience. Further, Sommer, Selten, Diederer and Blom (2010b) suggest that the audibility component, independent of content and appraisal, should be considered separately as an important perceptual component of AVHs and reflects the neural pathophysiology underlying AVH.

Finally, it is not possible in the current study to analyze the dimensions of AVH, such as frequency, content, locus, controllability and other characteristics. The content of AVH is relevant for predicting the clinical outcome of the AVH (McCarthy-Jones *et al.*, 2014) and deserves further study.

Previous studies from the Bergen Child Study have shown that there is a selection bias where non-responders have a slightly higher rate of mental health problems, but with low effect sizes and minimal effect on mean estimates (Stormark, Heiervang, Heimann, Lundervold & Gillberg, 2008). The population prevalence of AVH reported in the present study may thus rather be under than overestimated.

## CONCLUSION

The prevalence of self-reported AVH in a population based sample of Norwegian adolescents is 10.6%, close to the median prevalence found in earlier reports. Endorsing being troubled by voices is less common (5.3%), with adolescent girls being slightly more at risk for being troubled by voices than their male peers.

More research is needed to understand the nature of the AVH in young people and identifying features of AVH that may be useful in predicting persistence and need for psychiatric care. It is not yet clear, however, whether AVHs specifically increase the risk of schizophrenia- spectrum disorders, or whether they represent a non-specific indicator for vulnerability to psychiatric disorders (Dhossche *et al.*, 2002; Fisher, Caspi, Poulton *et al.*, 2013; Welham *et al.*, 2009). Findings from research on ultra-high psychosis risk groups have suggested inclusion of additional predictors of psychosis, e.g., negative symptoms, cognitive and social functioning, in addition to attenuated positive symptoms such as AVH (Fusar-Poli, Borgwardt, Bechdolf *et al.*, 2013).

The authors would like to thank Regional Centre for Child and Youth Mental Health and Child Welfare at Uni Research Health and the BCS project group for data collection and for making the data available for the present study. The authors would also like to thank the participants for their time and effort. K.K. was supported by European Research Council (ERC, Voice 249516) advanced grant to Professor Kenneth Hugdahl.

## REFERENCES

- Aleman, A., Nieuwenstein, M. R., Böcker, K. B. & De Haan, E. H. (2001). Multi-dimensionality of hallucinatory predisposition: Factor structure of the Launay-Slade Hallucination Scale in a normal sample. *Personality and Individual Differences*, *30*, 287–292.
- Bartels-Velthuis, A. A., Van de Willige, G., Jenner, J. A., Van Os, J. & Wiersma, D. (2011). Course of auditory vocal hallucinations in childhood: 5-year follow-up study. *The British Journal of Psychiatry*, *199*, 296–302.
- Bøe, T., Øverland, S., Lundervold, A. J. & Hysing, M. (2012). Socioeconomic status and children's mental health: results from the Bergen Child Study. *Social Psychiatry and Psychiatric Epidemiology*, *47*, 1557–1566.
- Catani, M., Craig, M. C., Forkel, S. J., Kanaan, R., Picchioni, M., Touloupoulou, T., *et al.* (2011). Altered integrity of perisylvian language pathways in schizophrenia: Relationship to auditory hallucinations. *Biological Psychiatry*, *70*, 1143–1150.
- Daalman, K., Dieren, K. M. J., Derks, E., van Lutterveld, R., Kahn, R. & Sommer, I. E. (2012). Childhood trauma and auditory verbal hallucinations. *Psychological Medicine*, *42*, 2475–2484.
- De Leede-Smith, S. & Barkus, E. (2013). A comprehensive review of auditory verbal hallucinations: lifetime prevalence, correlates and mechanisms in healthy and clinical individuals. *Frontiers in Human Neuroscience*, *7*, 367.
- De Loore, E., Gunther, N., Drukker, M., Feron, F., Sabbe, B., Deboutte, D., *et al.* (2011). Persistence and outcome of auditory hallucinations in adolescence: A longitudinal general population study of 1800 individuals. *Schizophrenia Research*, *127*, 252–256.
- Dhossche, D., Ferdinand, R., Van der Ende, J., Hofstra, M. & Verhulst, F. (2002). Diagnostic outcome of self-reported hallucinations in a community sample of adolescents. *Psychological Medicine*, *32*, 619–627.
- Fisher, H. L., Caspi, A., Poulton, R., Meier, M. H., Houts, R., Harrington, H., *et al.* (2013). Specificity of childhood psychotic symptoms for predicting schizophrenia by 38 years of age: A birth cohort study. *Psychological Medicine*, *43*, 2077–2086.
- Fusar-Poli, P., Borgwardt, S., Bechdolf, A., Addington, J., Riecher-Rössler, A., Schultze-Lutter, F., *et al.* (2013). The psychosis high-risk state: a comprehensive state-of-the-art review. *JAMA psychiatry*, *70*, 107–120.
- Hirnstein, M., Westerhausen, R., Korsnes, M. S. & Hugdahl, K. (2013). Sex differences in language asymmetry are age-dependent and small: A large-scale, consonant-vowel dichotic listening study with behavioral and fMRI data. *Cortex*, *49*, 1910–1921.
- Horwood, J., Salvi, G., Thomas, K., Duffy, L., Gunnell, D., Hollis, C., *et al.* (2008). IQ and non-clinical psychotic symptoms in 12-year-olds: Results from the ALSPAC birth cohort. *The British Journal of Psychiatry*, *193*, 185–191.
- Janssen, I., Krabbendam, L., Bak, M., Hanssen, M., Vollebergh, W., De Graaf, R., *et al.* (2004). Childhood abuse as a risk factor for psychotic experiences. *Acta Psychiatrica Scandinavica*, *109*, 38–45.
- Johns, L. C., Kompus, K., Connell, M., Humpston, C., Lincoln, T. M., Longden, E., *et al.* (2014). Auditory verbal hallucinations in persons with and without a need for care. *Schizophrenia bulletin*, *40*, S255–S264.
- Kelleher, I., Connor, D., Clarke, M. C., Devlin, N., Harley, M. & Cannon, M. (2012a). Prevalence of psychotic symptoms in childhood and adolescence: A systematic review and meta-analysis of population-based studies. *Psychological Medicine*, *42*, 1857–1863.
- Kelleher, I., Harley, M., Murtagh, A. & Cannon, M. (2011). Are screening instruments valid for psychotic-like experiences? A validation study of screening questions for psychotic-like experiences using in-depth clinical interview. *Schizophrenia Bulletin*, *37*, 362–369.
- Kelleher, I., Keeley, H., Corcoran, P., Lynch, F., Fitzpatrick, C., Devlin, N., *et al.* (2012b). Clinicopathological significance of psychotic experiences in non-psychotic young people: Evidence from four population-based studies. *The British Journal of Psychiatry*, *201*, 26–32.
- Krabbendam, L., Myin-Germeys, I., Hanssen, M., Graaf, R., Vollebergh, W., Bak, M., *et al.* (2005). Development of depressed mood predicts onset of psychotic disorder in individuals who report hallucinatory experiences. *British Journal of Clinical Psychology*, *44*, 113–125.
- Larøi, F. (2012). How do auditory verbal hallucinations in patients differ from those in non-patients? *Frontiers in Human Neuroscience*, *6*, 25.
- Larøi, F., Marczewski, P. & Van der Linden, M. (2004). Further evidence of the multi-dimensionality of hallucinatory predisposition: factor structure of a modified version of the Launay-Slade Hallucinations Scale in a normal sample. *European Psychiatry*, *19*, 15–20.
- Larøi, F. & Van Der Linden, M. (2005). Nonclinical participants' reports of hallucinatory experiences. *Canadian Journal of Behavioural Science/Revue canadienne des sciences du comportement*, *37*, 33–43.
- Lundervold, A. J., Breivik, K., Posserud, M.-B., Stormark, K. M. & Hysing, M. (2013). Symptoms of depression as reported by Norwegian adolescents on the Short Mood and Feelings Questionnaire. *Frontiers in Psychology*, *4*, 613.
- Mackie, C., Castellanos-Ryan, N. & Conrod, P. (2011). Developmental trajectories of psychotic-like experiences across adolescence: impact of victimization and substance use. *Psychological Medicine*, *41*, 47–58.
- Maric, N., Krabbendam, L., Vollebergh, W., de Graaf, R. & Van Os, J. (2003). Sex differences in symptoms of psychosis in a non-selected, general population sample. *Schizophrenia Research*, *63*, 89–95.
- McCarthy-Jones, S., Trauer, T., Mackinnon, A., Sims, E., Thomas, N. & Copolov, D. L. (2014). A new phenomenological survey of auditory hallucinations: Evidence for subtypes and implications for theory and practice. *Schizophrenia Bulletin*, *40*, 231–235.

- Molnar, B. E., Berkman, L. & Buka, S. L. (2001). Psychopathology, childhood sexual abuse and other childhood adversities: Relative links to subsequent suicidal behaviour in the US. *Psychological Medicine*, 31, 965–977.
- Nolen-Hoeksema, S. & Girgus, J. S. (1994). The emergence of gender differences in depression during adolescence. *Psychological Bulletin*, 115, 424–443.
- Nuevo, R., Chatterji, S., Verdes, E., Naidoo, N., Arango, C. & Ayuso-Mateos, J. L. (2012). The continuum of psychotic symptoms in the general population: A cross-national study. *Schizophrenia Bulletin*, 38, 475–485.
- Preti, A., Sisti, D., Rocchi, M. B. L., Siddi, S., Cella, M. & Masala, C., et al. (2014). Prevalence and dimensionality of hallucination-like experiences in young adults. *Comprehensive Psychiatry*, 55, 826–836.
- Rector, N. A. & Seeman, M. V. (1992). Auditory hallucinations in women and men. *Schizophrenia Research*, 7, 233–236.
- Rubio, J. M., Sanjuán, J., Flórez-Salamanca, L. & Cuesta, M. J. (2012). Examining the course of hallucinatory experiences in children and adolescents: a systematic review. *Schizophrenia Research*, 138, 248–254.
- Saha, S., Scott, J., Varghese, D. & McGrath, J. (2013). Socio-economic disadvantage and delusional-like experiences: A nationwide population-based study. *European Psychiatry*, 28, 59–63.
- Scott, J., Chant, D., Andrews, G. & McGrath, J. (2006). Psychotic-like experiences in the general community: The correlates of CIDI psychosis screen items in an Australian sample. *Psychological Medicine*, 36, 231–238.
- Scott, J., Welham, J., Martin, G., Bor, W., Najman, J., O'Callaghan, M., et al. (2008). Demographic correlates of psychotic-like experiences in young Australian adults. *Acta Psychiatrica Scandinavica*, 118, 230–237.
- Seeman, M. V. (1997). Psychopathology in women and men: Focus on female hormones. *American Journal of Psychiatry*, 154, 1641–1647.
- Sharma, R. P., Dowd, S. M. & Janicak, P. G. (1999). Hallucinations in the acute schizophrenic-type psychosis: Effects of gender and age of illness onset. *Schizophrenia Research*, 37, 91–95.
- Shevlin, M., Murphy, J., Dorahy, M. J. & Adamson, G. (2007). The distribution of positive psychosis-like symptoms in the population: A latent class analysis of the National Comorbidity Survey. *Schizophrenia Research*, 89, 101–109.
- Sommer, I. E., Daalman, K., Rietkerk, T., Diederer, K. M., Bakker, S., Wijkstra, J., et al. (2010a). Healthy individuals with auditory verbal hallucinations; who are they? Psychiatric assessments of a selected sample of 103 subjects. *Schizophrenia Bulletin*, 36, 633–641.
- Sommer, I. E., Seltzer, J.-P., Diederer, K. M. & Blom, J. D. (2010b). Dissecting auditory verbal hallucinations into two components: Audibility (Gedankenlautwerden) and alienation (thought insertion). *Psychopathology*, 43, 137–140.
- Spauwen, J., Krabbendam, L., Lieb, R., Wittchen, H.-U. & Van Os, J. (2003). Sex differences in psychosis: Normal or pathological? *Schizophrenia Research*, 62, 45–49.
- Statistics Norway (2014). Population's level of education, 1 October 2013. Retrieved 1 March 2015 from <http://www.ssb.no/en/utdanning/statistikker/utniv/aar/2014-06-19>.
- Stormark, K. M., Heiervang, E., Heimann, M., Lundervold, A. & Gillberg, C. (2008). Predicting nonresponse bias from teacher ratings of mental health problems in primary school children. *Journal of Abnormal Child Psychology*, 36, 411–419.
- Tien, A. Y. (1991). Distribution of hallucinations in the population. *Social Psychiatry and Psychiatric Epidemiology*, 26, 287–292.
- Van Os, J., Linscott, R. J., Myin-Germeys, I., Delespaul, P. & Krabbendam, L. (2009). A systematic review and meta-analysis of the psychosis continuum: Evidence for a psychosis proneness-persistence-impairment model of psychotic disorder. *Psychological Medicine*, 39, 179–195.
- Vellante, M., Laró, F., Cella, M., Raballo, A., Petretto, D. R. & Preti, A. (2012). Hallucination-like experiences in the nonclinical population. *The Journal of Nervous and Mental Disease*, 200, 310–315.
- Waters, F. A., Badcock, J. C. & Maybery, M. T. (2003). Revision of the factor structure of the Launay-Slade Hallucination Scale (LSHS-R). *Personality and Individual Differences*, 35, 1351–1357.
- Welham, J., Scott, J., Williams, G., Najman, J., Bor, W., O'Callaghan, M., et al. (2009). Emotional and behavioural antecedents of young adults who screen positive for non-affective psychosis: A 21-year birth cohort study. *Psychological Medicine*, 39, 625–634.
- Wigman, J., Van Winkel, R., Raaijmakers, Q., Ormel, J., Verhulst, F., Reijneveld, S., et al. (2011a). Evidence for a persistent, environment-dependent and deteriorating subtype of subclinical psychotic experiences: A 6-year longitudinal general population study. *Psychological Medicine*, 41, 2317–2329.
- Wigman, J. T., Vollebergh, W. A., Raaijmakers, Q. A., Iedema, J., Van Dorsselaer, S., Ormel, J., et al. (2011b). The structure of the extended psychosis phenotype in early adolescence – a cross-sample replication. *Schizophrenia Bulletin*, 37, 850–860.
- Yung, A. R., Nelson, B., Baker, K., Buckby, J. A., Baksheev, G. & Cosgrave, E. M. (2009). Psychotic-like experiences in a community sample of adolescents: Implications for the continuum model of psychosis and prediction of schizophrenia. *Australian and New Zealand Journal of Psychiatry*, 43, 118–128.

Received 7 July 2014, accepted 4 March 2015