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Involuntary Autobiographical Memory and Future Thought Predicting

Hallucination-Proneness

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Abstract

Involuntary (spontaneously arising) autobiographical memories and involuntary future thoughts are common in daily life, but their frequency and emotional intensity vary among individuals. Theories of hallucination in schizophrenia have hypothesized a key role for involuntary memories (Waters et al., 2006); however, this idea has been little examined. We report two studies, designed to address the role of involuntary mental events in relation to hallucination proneness. Both studies showed that the self-reported frequency of involuntary memories and future projections was a robust predictor of hallucination-proneness, even when controlling for measures of unwanted thoughts and rumination (Study 1) and measures of depression, dissociation, executive functions, imagery abilities and personality (Study 2). In Study 1, the emotional intensity of involuntary memories and future projections also predicted hallucination-proneness. The findings open a new avenue of research addressing the role of involuntary autobiographical memories and future projections in relation to hallucination and psychosis.

Key words: Involuntary autobiographical memory, Future projection, Hallucination, Psychosis continuum

Involuntary Autobiographical Memory and Future Thought Predicting Hallucination-

Proneness

Hallucinations are experiences that occur in the absence of a corresponding external

stimulation and which resemble veridical perceptions. About 70% of patients with

schizophrenia and 4% of the general population report such experiences (van Os, Linscott,

Myin-Germeys, Delespaul, & Krabbendam, 2009). However, we have a limited understanding

of the cognitive and neurological mechanisms involved in hallucinations.

A prominent group of theoretical models suggests that auditory hallucination results

from self-monitoring or self-recognition deficits, leading to inner speech not being recognized

as self-produced and instead being perceived as an autonomous, non-self voice (Jones &

Fernyhough, 2007; Bentall, 2003). Moreover, because of the well-established association

between abuse and auditory hallucinations (Bebbington et al., 2011), rumination or inner

dialogue concerning interaction with an abuser are thought to be the raw material for many

auditory hallucinations (Jones & Fernyhough, 2009). This is consistent with the

phenomenology of many auditory hallucinations being related to things spoken and heard at

the time of, or about, the original trauma (Hardy et al., 2005). Nonetheless, inner speech-

based models suffer from some limitations, as behavioral evidence for impaired monitoring of

inner speech in auditory hallucinations is limited and not specific to auditory hallucination.

For example, the majority of patients report being readily able to distinguish auditory

hallucinations from their own thoughts (Hoffman et al., 1999). Moreover, the phenomenology

of a large proportion of auditory hallucinations is difficult to reconcile with the inner speech

theory, as about 60% of patients also report non-verbal hallucinations (i.e., not voices), such

as environmental noises or animal sounds, on top of regular verbal hallucinations (Nayani &

David, 1996; Woods, Jones, Alderson-Day, Callard & Fernyhough, 2015).

Alternatively, Waters and colleagues (2006) suggested that auditory hallucination might result from non-inhibition, or unintentional activation, of memories of past events. Indeed, a majority of patients report that they know the identity of their voices, and about half agree with the idea that the contents of their voices could be reproduction of speech they had heard in the past (McCarthy-Jones et al., 2014), and memory has been thought to potentially mediate the relationship between trauma and hallucination (Steel, 2015; Jones & Steel, 2014; Hardy et al., 2005). Because of patients' deficit in binding contextual cues and self-monitoring default (Brébion et al., 2002; Frith, 2014), auditory hallucinations could come from pieces of decontextualized memories being unrecognized by the patient.

Consistent with this idea, we propose that involuntary autobiographical memories and episodic future projections may be central to auditory hallucination. Involuntary autobiographical memories are spontaneously arising memories of personal events (Berntsen, 1996, 2010) in distinction to voluntary autobiographical memories, which are strategically retrieved memories of personal events. The involuntary memories result from automatic and associative processes, with little involvement of cognitive control processes (Hall et al., 2014), and may thus be less easily recognized as self-generated (Johnson, Hashtroudi, & Stephen, 1993). Moreover, involuntary autobiographical memories are generally vivid and refer to specific events, encompassing personal details. They are often accompanied by a substantial emotional impact at the time of recall (Berntsen & Hall, 2004; del Palacio-Gonzalez et al., 2017).

Imagination of possible future events also occurs spontaneously (Berntsen & Jacobsen, 2008; Finnbogadóttir & Berntsen, 2011) and as frequently as involuntary memories of past events (Finnbogadottir & Berntsen, 2013). Indeed, remembering past events and imagining possible future events have been found to operate on the same underlying neurocognitive

structures (e.g., Addis, Wong, & Schacter, 2007; D'Argembeau & Van der Linden, 2004; Schacter et al., 2012). Therefore, they share many characteristics, with the important exception that future projections, by definition, are imagined events that are not yet been experienced. Besides, involuntary future oriented thoughts have been related to several mental disorders. Patients with panic- or social anxiety disorders show automatic and catastrophic imagery, preceding or accompanying the panic attack (Ottaviani & Beck, 1987). Relatedly, the anticipation of stressful events, through intrusive, repeated, disturbing imagined scenes, thoughts or images is strongly associated with post-traumatic stress disorders, and even predicted its later development in a study of Danish soldiers (Berntsen & Rubin, 2015). In affective disorder, flash-forwards to suicide are frequently reported and associated with a greater preoccupation than verbal thoughts about suicide (e.g., Hales, Deeprose, Goodwin & Holmes, 2011). Hence, because of the general similarities between involuntary future projections and involuntary autobiographical memories and because of the well-established role of spontaneous future thoughts in psychopathology, we assumed that not only involuntary memories of past events, but also involuntary imaginations of future events, would be related to hallucination processes.

We report two studies investigating the relationship between hallucination proneness and involuntary autobiographical memories and future projections, using a correlational design and controlling for a large range of other variables. Psychotic symptoms are present, not only in patients with schizophrenia, but in an attenuated form also among 5.2% of the general population (van Os et al., 2009). Focusing on psychotic-like symptoms in a non-clinical population allows an examination of cognitive mechanisms underlying psychotic symptoms in the absence of medication, hospitalization or other treatment effects, with less impact of illness-related variables, such as chronicity, comorbidity and lack of insight

(Mason, 2015). Jones and Steel (2012) observed that individuals with schizotypy traits were vulnerable to an increased frequency of non-distressing involuntary memories. Therefore, we hypothesized that frequency of involuntary autobiographical memories and imagined future events would be positively correlated to hallucination-proneness in the general population. Study 1 investigated this relationship when controlling for rumination and unwanted thought suppression, known as strongly related to hallucinatory phenomena (Jones & Fernyhough, 2009). Study 2 was undertaken to replicate and extend Study 1 by controlling for other potentially confounding factors; depressive and dissociative symptoms, personality traits, executive functioning and mental imagery abilities. Both studies were approved by the local ethics committee.

Study 1

Methods

Participants. Two hundred ninety-one participants were recruited through Amazon's Mechanical Turk. Participants under 18 or over 60 years of age, non-native English speakers, participants who did not correctly answers control questions (distributed all along the survey, to make sure the respondents actually read questions before answering), and those who did not fully complete the survey were excluded. There were 151 women and 140 men; mean age was 33.46 years ($SD = 9.13$) and mean number of years of schooling was (counted from the first year of elementary school) 14.97 ($SD = 1.91$). The large majority (96.2%) lived in the USA. For this study, each Mechanical Turk worker received USD $ 2.

Procedure and Materials. The study was conducted online using Qualtrics Survey® Software, which enables interactive questionnaires to be created and specific populations to be targeted. The key variables of interest were hallucination-proneness, involuntary autobiographical memories frequency and their emotional valence and intensity. These

variables were assessed through validated psychological and subclinical scales, which are detailed below. In addition, the following measures were included to control for potential shared variance with other factors: the voluntary memory control questions (see Berntsen, Rubin & Salgado, 2015), the Rumination Response Scale (RRS, Treynor, Gonzalez, & Nolen-Hoeksema, 2003) and thought suppression as assessed by the White Bear Suppression Inventory (WBSI, Wegner & Zanakos, 1994). The characteristics and properties of these scales are detailed in Supplemental Material available online (see Material Details 1).

The Launay-Slade Hallucination Scale, revised version (LSHS-R; Bentall & Slade, 1985). This 12-item scale assesses hallucination-proneness in the general population. Items are scored on a 5-point Likert Scale from 0 = *Certainly does not apply to me* to 4 = *Certainly applies to me*. For instance, items include references to auditory hallucinations ("In the past, I have often had the experience of hearing a person's voice and then found that no-one was there"; "I have been troubled by hearing voices in my head"), visual hallucinations ("On occasions, I have seen a person's face in front of me when no-one was in fact there") or vivid daydreaming ("Sometimes my thoughts seem as real as actual events in my life"; "In my daydreams I can hear the sound of a tune almost as clearly as if I were actually listening to it"). The internal consistency of this scale in the current study was high (Cronbach's α = .90).

Involuntary Autobiographical Memory Inventory (IAMI; Berntsen, Rubin, & Salgado, 2015). The IAMI assesses the frequency of involuntary autobiographical memories and involuntary future thoughts in daily life. Each item is rated as: 0 = *Never*; 1 = *Once a month or more*; 2 = *Once a week or more*; 3 = *Once a day or more*; 4 = *Once an hour or more*. The scale describes various daily life situations to evaluate the occurrence of involuntary autobiographical memories or future thoughts (e.g., "Listening to some music or songs bring memories of past events to mind – without me consciously trying to remember them"; "When

I am bored, imaginary future events come to my mind by themselves – without me consciously trying to evoke them". Mean scores are calculated for involuntary autobiographical memories (10 items), involuntary future thoughts (10 items) and total score (20 items). The internal consistencies of the entire scale, past sub-scale and future sub-scale in the current study were high (all Cronbach's α >=.91).

Emotional valence and emotional intensity of involuntary memories and future projections (Berntsen et al., 2015)**.** Four items were answered immediately after completing the IAMI, following these instructions "You have just answered a series of questions about how frequently past and future events come to your mind by themselves-without you trying to have them. The four questions were as follows: ''1. For the spontaneously arising memories of past events, in general how positive or negative were the memories?'' (From -2 extremely negative, to +2 extremely positive.) ''2. For the spontaneously arising memories of past events, in general how emotionally intense were the memories?'' (From 0 not at all intense, to 4 extremely intense). ''3. For the spontaneously arising imaginations of possible future events, in general how positive or negative were the imaginations?'' (to be rated on the same scale as the past directed valence question).''4. For the spontaneously arising imaginations of future events, in general how emotionally intense were the imaginations?'' (to be rated on the same scale as the past directed intensity question).

Results

Descriptive statistics and correlation analysis. For descriptive statistics and correlations, see Table S1 in the Supplemental Material available online. Significant positive correlations were found between hallucination-proneness (LSHS-R score) and involuntary memories characteristics (IAMI past and future subscales, IVM emotional intensity score), voluntary memories and future thoughts frequency, rumination (RRS score) and unwanted

thought suppression (WBSI score), ($rs > .48$; $ps > .001$). Both past and future IAMI subscales correlated with hallucination-proneness and were highly correlated with one another ($r = .82$; $p = .001$). Therefore, the total score of IAMI was considered in further analyses (significantly correlated with hallucination-proneness; $r = .64$; $p < .001$). Only the emotional valence of involuntary memories did not correlate with hallucination-proneness, ($r = -.04$; $p > .05$).

Regression analysis. A multiple regression analysis investigated whether involuntary memories characteristics predicted hallucination-proneness, when controlling for rumination, unwanted thought suppression and voluntary memories frequency (see Table 1). Demographic variables (age, sex and level of education), involuntary memories characteristics (frequency, emotional intensity and emotional valence), voluntary memories frequency, rumination and unwanted thought suppression were added as independent variables. The final model was significant, $F(9, 274) = 30,43$; $R^2 = .49$; $p < .001$ and accounted for 49% of hallucination-proneness variance. Higher IAMI score and higher emotional intensity of involuntary memories were significant predictors of hallucination-proneness when controlling for voluntary memories frequency, rumination and unwanted thought suppression. Demographic variables, emotional valence of involuntary memories, the frequency of voluntary memories and unwanted thought suppression were not significant.

Summary and Discussion

The main objective of Study 1 was to examine whether involuntary autobiographical memories and future thoughts were related to hallucination-proneness in the general population. The key finding of this study confirmed our hypothesis, showing that individuals experiencing frequent and emotionally intense involuntary autobiographical memories and imagined future events tended to experience more hallucination-like phenomena.

The regression analysis confirmed that both the frequency and emotional intensity of involuntary memories and future projections (but not emotional valence) were significant predictors of hallucination-proneness in the general population, even when controlling for rumination and unwanted thought suppression.

Rumination and unwanted thought suppression are not the only processes associated with hallucination-proneness. Executive dysfunction, and particularly intentional inhibition deficit, has been shown to be related to hallucinations in patients with schizophrenia (Badcock et al., 2005). Moreover, some authors posit that mental imagery impairment or imbalance between imagery and perception would lead to hallucination in psychosis (Aleman, de Haan, Böcker, Hijman, & Kahn, 2002). Clinical symptoms, such as dissociation (Varese, Barkus & Bentall, 2012) or depression (Freeman & Garety, 2003) are often associated with hallucinations, as well as some personality traits, in particular neuroticism (So, Begemann, Gong, & Sommer, 2016). Study 2 was undertaken to replicate and extend Study 1, when controlling for these variables.

Study 2

Methods

Participants. One hundred ninety-one participants were recruited through Amazon's Mechanical Turk. Exclusion criteria and compensation was the same as in Study 1.There were 91 women and 100 men; mean age was 33.98 years ($SD = 9.49$) and mean number of years of schooling (counted from the first year of elementary school) was 15.14 ($SD = 2.12$). The large majority of the participants (92.1%) lived in USA.

Procedure and Materials. Study 2 was also conducted online using the Qualtrics Survey® Software package. Similar to Study 1, it included the LSHS-R, IAMI and emotional valence and intensity of involuntary memories questions. In order to control for shared

variance with other factors, we also assessed depressive symptoms, dissociative symptoms, executive functioning, mental imagery and personality traits. We included the following measures (respectively): the Beck Depression Inventory-II (BDI-II, Beck, Steer, Ball & Ranieri, 1996), the Dissociative Experience Scale-II (DES-II, Carlson &Putnam, 1993), the Dysexecutive questionnaire (DEX, Wilson, Evans, Emslie, Alderman, & Burgess, 1998), two tests of verbal fluency (Salthouse, 1993), the questionnaire on mental imagery (Sheehan, 1967), and the Big Five Inventory (BFI, John & Srivasta, 1999). These additional measures are detailed in Supplemental Material (see Material Details 2).

Results

Descriptive statistics and correlation analyses. For descriptive statistics and correlations, see Table S2 in the Supplemental Material available online. Significant correlations were found between hallucination-proneness (LSHS-R score) and all the others variables measured in Study 2 (IAMI score, emotional intensity and valence of involuntary memories, depressive symptoms, dissociative symptoms, executive functioning), except for mental imagery ($rs > .19$; $ps < .01$). As in Study 1, both past and future IAMI subscales significantly correlated with hallucination-proneness ($rs > 0.51$; $ps < .001$) and correlated highly together ($r = 0.76$; $p < .001$, not shown in Table S2), hence the total score of IAMI was considered in further analyses.

Regression analysis. A single regression analysis was conducted to investigate the relationship between involuntary memory and hallucination-proneness, when controlling for clinical symptoms, cognitive processes and personality traits. Demographic variables (age, gender and educational level), involuntary memory and future thought characteristics (frequency, emotional intensity and emotional valence), depressive symptoms (BDI score), dissociative symptoms (DES-II score), executive functioning measures (DEX score and

verbal fluencies), and personality traits (BFI scores) were added as independent variables, and hallucination-proneness (LSHS score) as the dependent variable in the regression analysis. The regression model was significant, $F(18, 173) = 14,90$; $R^2 = .52$; $p < .001$. None of the demographic variables were significant predictors of hallucination-proneness (βs = <.06; ts < .96; ps >.34). Regarding memory measures, involuntary memory and future thought frequency (IAMI score) was a significant in the regression model, when controlling for all these variables. Finally, dissociative symptoms were the only other significant predictor of hallucination-proneness (see Table 2).

Summary and Discussion

Study 2 replicated and extended the findings from Study 1. The frequency of involuntary autobiographical memories and future imagined events remained a reliable predictor of hallucination-proneness even when controlling for measures of depression, dissociation, executive functions, imagery abilities and personality. In addition to involuntary autobiographical memories and future imagined events, only the measure of dissociation significantly predicted hallucination proneness, when controlling for other variables. These findings support the robustness of the relationship between hallucination-proneness and frequency of involuntary autobiographical memory and involuntary, imagined events.

General Discussion

We reported two studies indicating that the frequency of involuntary autobiographical memories and imagined future events were powerful predictors of hallucination-proneness in the general population. Involuntary autobiographical memories and involuntary future events were robustly related to hallucination proneness, even when controlling for a range of other factors known to be associated with psychopathology. Only dissociative symptoms, already associated to hallucinations in previous studies (Cole, Newman-Taylor, & Kennedy, 2016;

Perona-Garcelán et al., 2010; Varese et al., 2012) appeared as strongly related to hallucination proneness as involuntary autobiographical memory. Although voluntary autobiographical memories and future thoughts were associated with hallucination-proneness, only the involuntary part remained a strong predictor, when both types of recall were included in the regression analysis. This underscores the importance of spontaneous cognition in hallucinatory processes, consistent with studies on other types of spontaneous thought processes in schizophrenia (e.g., Elua, Keith & Kvavilashvili, 2012; Elua, Laws & Kvavilashvili, 2015).

The present findings agree with Waters' (2006) theory, but have further implications. Previous studies focused on the role of memories as possible precursors to hallucination (Jones & Steel, 2014; Hardy et al., 2005; Steel, 2015; Waters et al., 2006), whereas the present findings also suggest involuntary constructions of imagined future events as being central. This finding is consistent with an abundance of research showing that remembering the personal past and imagining the personal future are highly related mental processes that share a large common neural network and respond similarly to a range of behavioral manipulations (see Szpunar, 2010, for a review). Importantly, spontaneously arising images of future events are as frequent, specific and vivid as involuntary memories in daily life (Berntsen & Jacobsen, 2008; Finnbogadóttir & Berntsen, 2011, 2013) and earlier work has documented associations between intrusive flash-forwards and psychopathology (e.g., Hales et al., 2011; Berntsen & Rubin, 2015). By definition, imagined future events have not been experienced and thus might be even more prone to reality confusion for individuals with hallucination tendencies.

Study 1 also showed that the emotional intensity of involuntary memories was related to hallucination-proneness, and consistently predicted it, when controlling for rumination and

thought suppression. Interestingly, emotion regulation impairment, through depressive symptoms or anxiety, has been shown to be related to hallucination in schizophrenia (Badcock et al., 2011), playing both a causal and maintaining role in many cases of hallucination (Freeman & Garety, 2003). Recent findings showed that having involuntary autobiographical recollections is associated with more emotion regulation effort (e.g., suppression of emotion expression) in response to the memory compared with having voluntary recollections of autobiographical events (del Palacio-Gonzales et al., 2017). Hence, emotion regulation deficit could also play a key role in the relationship between involuntary autobiographical memories and hallucination-proneness.

Although the present set of studies do not clarify whether involuntary autobiographical memories are raw material for hallucinations, trigger them, or whether both processes are sustained by common underlying mechanisms, several potential explanations can be discussed. Contextual binding and mental imagery impairment in schizophrenia (Raffard, D'Argembeau, Bayard, Boulenger, & Van der Linden, 2010) could lead to incomplete mental representations of past and future events, less unique or distinct from others, and consequently difficult to identify (Nayani & David, 1996; Rubin & Umanath, 2015; Waters et al., 2006). Thus, event memories and imagined events lacking contextual information and popping up spontaneously in response to internal or external cues, could lead to incomplete mental representations of past or future events not recognized as self-generated. In addition, fundamental deficit in intentional inhibition would facilitate mental representations intruding into consciousness in a manner that is beyond the control of the sufferer (Badcock, Paulik & Maybery, 2011; Waters et al., 2006).

Limitations

Some limitations need to be acknowledged. First, we relied on self-report questionnaires, which may be affected by reporting bias. Second, the correlation analyses cannot demonstrate causal relations between variables. Experimental or experience-sampling studies, exploring how involuntary autobiographical memories and future oriented thoughts are related to psychotic symptoms, could provide stronger evidence in understanding the direction of the relationship found here.

Conclusion

We have demonstrated that the frequency of involuntary autobiographical memories and future projections robustly predicted hallucination-proneness in the general population, suggesting that involuntary autobiographical memories and future projections are central to hallucination. The present set of studies provide important novel insights to the understanding of hallucination and its cognitive correlates, but also calls for further investigation, in particular in patients with schizophrenia, to generalize results to the whole psychosis continuum.

Authorship

D.B. and M.A. developed and designed the study. Data collection was performed by M.A. Data analysis and interpretation were performed by M.A. under the supervision of D.B. and F.B. M.A. drafted the paper, and D.B. and F.B. provided critical revisions. All authors approved the final version of the paper for submission.

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Table 1

Multiple Regression Analyses Predicting Hallucination-Proneness from Involuntary Memories Variables Controlling for Other Variables (Rumination and Thought Suppression)

	Hallucination-Proneness		
Predictors	β	*t*	*p*-value
Demographic variables	<0.07	<1.68	>0.09
IAMI – *mean score*	0.33	4.79	<0.001
IVM Emotional Intensity	0.14	2.87	0.04
IVM Emotional Valence	0.04	0.95	0.34
VM – *mean score*	0.02	0.37	0.71
WBSI	0.12	1.91	0.06
RRS	0.23	3.31	0.001
Total R^2	0.49***		

Note. $N = 291$. IAMI = Involuntary Autobiographical Memory Inventory; IVM = Involuntary Memories and future thoughts; VM = Voluntary Memories and future thoughts; WBSI = White Bear Suppression Inventory; RRS = Rumination Response Scale
[a]Demographic variables include gender, age and years of education
*p<.05; **p<.01; ***p<.001

Table 2

Multiple Regression Analyses Predicting Hallucination-Proneness from Involuntary Memories Variables Controlling for Clinical Symptoms (Depression and Dissociation), Cognitive Processes (Executive Dysfunction and Mental Imagery) and Personality Traits

Predictors	Hallucination-Proneness		
	β	t	p-value
Demographic variables	<0.06	<0.96	>0.34
IAMI – *mean score*	0.19	2.44	0.02
IVM Emotional Intensity	0.07	1.04	0.30
IVM Emotional Valence	-0.01	-0.20	0.84
BDI	0.11	1.38	0.17
DES-II	0.23	2.51	0.01
DEX – *total score*	0.16	1.79	0.08
VF (S words)	-0.05	-0.74	0.46
VF (ay words)	-0.10	-1.62	0.11
Mental Imagery	-0.07	-1.16	0.25
BFI – Extraversion	0.08	1.24	0.22
BFI – Agreeableness	-0.06	-0.98	0.33
BFI – Conscientiousness	-0.06	-0.77	0.44
BFI – Neuroticism	0.13	1.48	0.14
BFI – Openness	0.07	1.16	0.24
Total R^2	0.52***		

Note. N = 191. IAMI = Involuntary Autobiographical Memory Inventory; IVM = Involuntary Memories and future thoughts; BDI = Beck Depression Inventory; DES-II = Dissociative Experiences Scale-II; DEX = Dysexecutive Questionnaire; VF = Verbal Fluency; BFI = Big Five Inventory
[a]Demographic variables include gender, age and years of education; *p<.05; **p<.01; ***p<.001