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Categorical perception of familiarity: Evidence for a hyper-familiarity in schizophrenia

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ABSTRACT

Familiarity is a crucial aspect of recognition that may be perturbed in schizophrenia patients (SZP) and may lead to delusional disorders. However, there are no existing guidelines on how to assess and treat familiarity disorders in schizophrenia. Some experimental studies have investigated familiarity processing in SZP but have produced inconsistent results, which are likely a result of methodological issues. Moreover, these studies only assessed whether familiarity processing is preserved or impaired in SZP, but not the tendency of SZP to consider unfamiliar stimuli to be familiar. By using a familiarity continuum task based on the existence of the categorical perception effect, the objective of this study was to determine whether SZP present hyper- or hypo-familiarity.

To this purpose, 15 SZP and 15 healthy subjects (HS) were presented with facial stimuli, which consisted of picture morphs of unfamiliar faces and faces that were personally familiar to the participants. The percentage of the familiar face contained in the morph ranged from 5 to 95%. The participants were asked to press a button when they felt familiar with the face that was presented.

The main results revealed a higher percentage of familiarity responses for SZP compared with HS from the stimuli with low levels of familiarity in the morph and a lower familiarity threshold, suggesting a hyper-familiarity disorder in SZP. Moreover, the intensity of this "hyper-familiarity" was correlated with positive symptoms. This finding clearly suggests the need for a more systematic integration of an assessment of familiarity processing in schizophrenia symptoms assessments.

1. Introduction

Familiarity processing is a crucial aspect of recognition because it provides the experience that an item has been previously encountered (Yonelinas, 2001; Daselaar et al., 2006; Song et al., 2011). This ability is notably essential to establish appropriate social interactions (Antonius et al., 2013). Indeed, familiarity disorders have been described as a failure of affective judgment capable of strongly impacting social interactions (Ameller et al., 2015). They are notably present in some delusional disorders, such as Capgras syndrome (Capgras and Reboul-Lachaux, 1923) in which patients hold a delusion that an impostor has replaced a friend, spouse, parent, or other close family member, or in Fregoli syndrome (Courbon and Fail, 1927) which is the delusional belief that one or more familiar persons, usually persecutors following the patient, repeatedly change their appearances (Klein and Hirachan, 2014). While in Capgras syndrome, the patients display a loss of familiarity; in Fregoli syndrome they display "hyper-familiarity" (Klein and Hirachan, 2014). In schizophrenia, the existence of a familiarity disorder appears to place patients at risk for maladaptive behaviors and their medico-legal consequences, as suggested by links with violence and homicides (Bourget and Whitehurst, 2004; Carabellese et al., 2014). However, there are no existing guidelines on how to assess and treat familiarity disorders in schizophrenia (Klein and Hirachan, 2014). This is most likely because the nature of these impairments remains unaddressed by the commonly used experimental tasks. Thus, further experimental investigations are needed to better understand familiarity

Abbreviations: SZP, schizophrenia patients; HS, healthy subjects.

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processing in schizophrenia and may ultimately contribute to an improvement in the therapeutic care of those patients.

Recognition is supported by two kinds of memory, recollection and familiarity, that depend on distinct processes and different systems of brain structures (Yonelinas, 2001; Yonelinas et al., 2010). Until now, familiarity processing in SZP has primarily been examined using paradigms that estimate the relative contributions of familiarity (i.e., the feeling that a stimulus has been encountered before) and recollection (i.e., the retrieval of details associated with the initial exposure) during recognition tasks (Yonelinas et al., 2010). These paradigms are performed in two steps: 1) an encoding phase and 2) a test phase. Recognition is considered to be based on recollection if participants are able to recollect some specific aspects of the encoding conditions present when the stimulus was encountered.

Nevertheless, the studies that have employed these paradigms have produced inconsistent results. Indeed, a recent review that focused on familiarity and recollection suggested that recollection is consistently reduced in SZP, but the conclusions with regards to familiarity processing were less clear (Libby et al., 2013). Of the 19 identified studies that compared SZP with healthy controls, 7 reported that familiarity was reduced in SZP, 7 reported that familiarity was preserved, and 5 showed an increased reliance on familiarity processes, i.e., an increased proportion of items that were recognized based on familiarity in the absence of recollection for SZP compared with healthy subjects (HS) (Libby et al., 2013). Because familiarity is described as an automatic form of memory, one might assume that it should be preserved in SZP. Additionally, previous studies (Marie et al., 2001; Antonius et al., 2013) have demonstrated intact familiarity preference processing in SZP, suggesting that the feeling of familiarity is not impaired in SZP. Nevertheless, other studies shown that SZP suffer from a deficit in familiarity processing (Martin et al., 2005; Guillaume et al., 2007; Weiss et al., 2008). To explain this deficit, Weiss et al. (2008) postulated that SZP may present familiarity impairment because of an absence of rapid "novelty signal".

Beyond these inconsistencies, those studies had several methodological limitations. On the one hand, there are well-known difficulties with accurately distinguishing familiarity from recollection. Notably, it has been shown that source recognition may be supported by familiarity when the item and its context are unitized during encoding, which occurs when the contextual information is encoded as a feature of the item (Diana et al., 2008; Montaldi and Mayes, 2010; Migo et al., 2012). On the other hand, the use of an encoding phase to create familiar stimuli may be problematic because SZP are known to exhibit deficits in learning (Danion et al., 1999; Boyer et al., 2007). Moreover, a potential limitation of these methods is that they are procedurally complex and that the instructions for these tasks are most likely difficult to understand for patients with cognitive deficits (Ragland et al., 2012).

Those methodological limitations can be overcome by using (1) simple categorization tasks through which the ability of participants to detect familiar stimuli among unfamiliar stimuli can be easily measured and (2) stimuli that are familiar to the participant and therefore do not require an initial encoding or familiarization task (Maddock et al., 2001; Qin et al., 2012). A range of studies has assessed face processing in SZP from categorization tasks based on familiar stimuli but only a few have systematically assessed familiarity processing per se (Darke et al., 2013; Joshua and Rossell, 2009). Moreover, several methodological limitations may still be noted. First, some of these studies have used faces of famous people as familiar stimuli (Pomarol-Clotet et al., 2010), which were generally iconic pictures of celebrities (such as Che Guevara or Marilyn Monroe); these iconic pictures may promote recollection processes (Ramon et al., 2011) and can be unknown to some participants (Trinkler et al., 2009), particularly those who may have a restricted general knowledge. Second, to assess whether familiarity processing is preserved or impaired in SZP, those studies were focused on the analysis of correct responses. However, an analysis of errors can also be very instructive: a high number of omissions can be associated with a "hypo-familiarity" disorder, i.e., an inability to detect familiar stimuli (or alternatively, with the tendency of SZP to not answer in favor of familiarity when they feel uncertain); a high number of false alarms can be considered to reveal a "hyper-familiarity" disorder, i.e., considering unfamiliar stimuli to be familiar (or alternatively, with the tendency of SZP to answer in favor of familiarity when they feel uncertain). In several studies that examined face recognition in SZP by comparing the rates of correct responses between SZP and HS, we observed that a frequent type of error made by SZP is a false alarm, suggesting a possible "hyper-familiarity" disorder (Irani et al., 2006; Caharel et al., 2007).

In the current study, we aimed to assess familiarity disorders in SZP by creating an original paradigm that was particularly suited to studying familiarity processing in SZP. Considering the previous reports, we decided to use a categorization task that was based on stimuli that were familiar for the participant. To avoid methodological issues linked to the use of pictures of celebrities, we chose to use personally familiar stimuli for each of the participants. Additionally, to test whether there is a hypo- or a hyper-familiarity disorder in SZP, we decided to use a familiarity continuum task. This type of task is based on the existence of the categorical perception effect, which occurs when the perception of differences between categories is enhanced at the expense of our perception of incremental changes in the stimulus within a category (Pollak and Kistler, 2002). This categorical perception effect can be evidenced using an imaging-morphing procedure which consists of creating stimuli that vary along continua between discrete categories: (Kiffel et al., 2005; Angeli et al., 2008; Armann and Bülthoff, 2012). Referring to studies on categorical perception, we chose to use an identification task in which participants had to press a button when they felt familiar with the face that was presented. We created facial stimuli specific to each participant by morphing photographs of faces from persons that were unknown and personally familiar to them. Thus, the use of personally familiar stimuli allowed the specific study of familiarity without the involvement of recollection because (1) the participants were naïve with regard to the familiar persons' faces that were presented and (2) no original pictures were displayed (the least familiar picture involved a 5% level of familiarity, and the most familiar one involved a 95% level of familiarity). Since facial stimuli were never seen by the participants before the task, we expected that participants could not "recollect" the stimulus and that stimulus recognition was only based on familiarity.

Two types of analyses were performed on the collected data. First, the individual percentage of "familiarity" responses were compared between groups. Second, based on the strategy used by Pollak and Kistler (2002) and D'Hondt et al. (2015), we fit separate psychometric function models for the familiarity continuum to the data from each individual participant, providing us with estimates of category boundaries and slope, which we used to compare familiarity processing between SZP and healthy controls. On the one hand, the categorical boundary corresponds to the level of the continuum where the probability of responding either that a face is familiar or unfamiliar is equal to 50%. Here, we use the term "familiarity threshold" to refer to this categorical boundary. We therefore hypothesized that SZP would demonstrate a shift in the familiarity threshold compared to HS. On the other hand, the slope of the logistic function allows us to estimate the abruptness of the response change (Kee et al., 2006).