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Research report

Familiarity and recollection in Williams syndrome

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ABSTRACT

Interest is being shown in a componential analysis of performance on declarative memory tasks that distinguishes two different kinds of access to stored memories, recollection and familiarity. From a developmental perspective, it has been hypothesized that recollection emerges later and shows more developmental changes than familiarity. Nevertheless, the contribution of recollection and familiarity to the recognition performance of individuals with intellectual disabilities (ID) has been rarely examined. The present study was aimed at investigating the qualitative profile of declarative long-term memory in a group of individuals with Williams syndrome (WS). We compared 13 individuals with WS and 13 mental-age-matched typically developing children in two different experimental paradigms to assess the contribution of familiarity and recollection to recognition performance. We adopted a modified version of the process dissociation procedure and a task dissociation procedure, both of which are suited to individuals with ID. Results of both experimental paradigms demonstrated reduced recollection and spared familiarity in the declarative memory performances of individuals with WS. These results provide direct evidence of a dissociation between recollection and familiarity in a neurodevelopmental disorder and are discussed in relation to alternative approaches for explaining abnormal cognition in individuals with ID.

1. Introduction

Currently, componential analyses of performance on declarative memory tasks are carried out to distinguish between two different kinds of access to stored memories: recollection and familiarity. According to several theorists (Mandler, 1980; Tulving, 1985; Yonelinas, 2002), recollection involves mentally reliving the specific episode during which an item was encountered; it permits remembering the spatial-temporal context in which the event occurred and other associated information. Conversely, familiarity entails the feeling of having previously encountered the stimulus target without the retrieval of other details, that is, contextual or associated information.

An ongoing debate in the literature concerns whether recollection and familiarity are the expression of different memory processes mediated by distinct neural circuits (dual-process models; i.e., Aggleton and Brown, 1999; Yonelinas et al., 2007) or whether they reflect access to memory traces of different strength in a unitary declarative memory system

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(unitary-strength models; e.g., Manns et al., 2003; Wixted and Squire, 2004; Squire et al., 2007). Based on a review of animal studies and a meta-analysis of published data on amnesic patients, Aggleton and Shaw (1996) proposed that in the context of the mesial temporal lobe the hippocampus is decisive for recollection but not necessary for item familiarity. Instead, item familiarity depends on the integrity of the perirhinal cortex within the parahippocampal gyrus. Consistent with this hypothesis, several neuropsychological studies have provided evidence that amnesic patients with selective hippocampal damage have a more severe deficit of recollection than familiarity (Aggleton and Shaw, 1996; Mayes et al., 1995; Turriziani et al., 2004, 2008; Vann et al., 2009). Many lesion studies in animals (Easton and Eacott, 2010; Eichenbaum, 2000; Farovik et al., 2008) and functional neuroimaging investigations in healthy humans (e.g., Montaldi et al., 2006; Yonelinas et al., 2005; for a review see Skinner and Fernandes, 2007) have also confirmed the differential recruitment of the hippocampus and the perirhinal cortex by recollection and familiarity processes, respectively. Nevertheless, neuropsychological and functional neuroimaging evidence has also been provided supporting the alternative unitary-strength models. In particular, studies from the Squire's laboratory have demonstrated comparable reduction of recollection and familiarity processes in amnesic patients with damage restricted to the hippocampal formation (Manns et al., 2003; Wixted and Squire, 2004). Moreover, functional activity in the medial temporal lobe was found to predict subjects' confidence ratings on both single-item or source recognition judgments, thus suggesting a lack of specialization in the medial temporal lobe, with the hippocampus and parahippocampal cortices cooperating in the functioning of both recollection and familiarity components of recognition (Kirwan et al., 2008; Shrager et al., 2008; Wais et al., 2010).

From a developmental perspective, the hypothesis that recollection emerges later and shows more developmental changes than familiarity has theoretical foundations. First, the subjective experience of recollection may not be present until a certain age. For example, Perner and Ruffman (1995) argued that young children cannot experience subjective remembering, differentiated from knowing, that events happened to them, until they can fully appreciate that what they know originates from personal experience. From this standpoint, recollection emerges from an earlier state of undifferentiated familiarity. In fact, a number of studies conducted to investigate the development of recognition memory from a dual-process perspective and using a variety of experimental paradigms (e.g., Anooshian, 1999; Billingsley et al., 2002; Brainerd et al., 2004; Holliday, 2003; Holliday and Hayes, 2000, 2001) documented age-related increases in recollection and stable familiarity. Specifically, recollection continues to develop during childhood and adolescence; by contrast, familiarity may be substantially stable during the same lifespan period, even though it undergoes some developmental change (Brainerd et al., 2004).

The present study was aimed at investigating the relative contribution of recollection and familiarity processes to the performance on recognition memory tests of individuals with intellectual disabilities (ID). Because of the difficulty of experimental procedures typically used to compute familiarity and recollection estimates, we choose to focus on a particular group of individuals with ID, people with Williams syndrome (WS), that can reach a global level of mental-age maturation of at least 6 years, a mental age sufficiently high to ensure that they understand the relatively complex instructions of these experimental tasks. WS is a neurodevelopmental disorder characterized by a deletion on chromosome 7q11.23 (Korenberg et al., 2000); prevalence is 1 in 7500 (Strømme et al., 2002). In WS, the phenotype includes infantile hypercalcemia, delays in growth and psychomotor development, characteristic facial dysmorphism, malformation of the cardiovascular system, and mild to moderate ID (Arnold et al., 1985; Bellugi et al., 1990; Udwin and Yule, 1991). The qualitative profile of the cognitive impairment in these individuals is characterized by relatively weaker and stronger areas of performance. Indeed, many authors have noted that aspects of language development, narrative skills, and auditory short-term memory are relatively proficient, whereas visual-spatial processing ability, counting, planning, and implicit learning are more severely impaired (Atkinson et al., 2001; Bellugi et al., 2000; Mervis et al., 2000; Vicari et al., 2001, 2007). This irregular cognitive profile is also found in individual cognitive domains, including long-term memory. For example, the declarative long-term memory of individuals with WS is particularly impaired on verbal and visuo-spatial tasks (Udwin and Yule, 1991; Vicari et al., 1996) but relatively preserved on visual-object tasks (Vicari et al., 2005).

Until now, only few studies have investigated the contribution of recollection and familiarity to the memory performance of individuals with ID. Most of the evidence in this regard comes from studies that provided indirect estimates of recollection and familiarity by contrasting performance on tests of recognition (which involve both recollection and familiarity processes) and free recall (which involves recollection processes only). Inconsistent results might be at least partially due to variable etiology of ID in individuals participating in different studies and discrepant criteria used to match individuals with ID to typically developing (TD) children who served as controls. Indeed, Jarrold et al. (2007) reported a more severe deficit on tests of free recall than recognition in individuals with WS or down syndrome (DS) compared to chronological-age standardization. In the WS group, the impairment in free recall for both verbal and visual stimuli was still present when performance was compared to verbal mental-age standardization but it only involved visual material when performance was compared to non-verbal mental-age standardization; in these same individuals recognition was only reduced for visual material under verbal mental-age standardization. Preservation of verbal free recall in individuals with WS when compared to non-verbal mental-age-matched controls was also reported by Brock et al. (2006). In contrast, in Jarrold et al. (2007) individuals with DS showed impaired free recall for visual material irrespective of modality of mental-age standardization, but they showed no evidence of impaired performance on recognition tests. Other studies also found different patterns of results depending on the etiology of ID. Indeed, in two studies which compared individuals with ID with mental-age-matched TD children based on the performance on a global intelligence scale (Stanford-Binet or Wechsler intelligence scale), Vicari (2001)