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Implicit and explicit olfactory memory in people with and without Down syndrome

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ABSTRACT

This study examined differences in implicit and explicit memory performance between people with Down syndrome (DS), their siblings, children matched on mental age, and university undergraduates, using olfactory stimuli. The DS and mental-age matched participants were also compared on two tasks of executive function. The data revealed implicit memory for olfactory stimuli. Further, people with DS performed similarly to each control group on the implicit memory task, but performed significantly poorer than all control groups on the explicit memory task. Impairment to executive functioning was identified as a possible cause of this deficit in explicit memory as people with DS performed more poorly than the mental-age matched controls on both tasks of executive function.

1. Introduction

The present study explores the dissociation between implicit and explicit memory in people with Down syndrome (DS) using olfactory stimuli. Previous research reveals that people with DS display comparable implicit memory abilities, yet have relatively poor explicit memory abilities, when compared to mental-age matched typically developing controls (Carlesimo, Marotta, & Vicari, 1997; Vicari, Bellucci, & Carlesimo, 2000) and those with developmental delays of other aetiology (Carlesimo et al., 1997; Vicari, 2001). These investigations utilised visual and verbal stimuli, which may confound the results as they tap various physical and cognitive impairments observed in people with DS. Pennington, Moon, Edgin, Stedron, and Nadel (2003) proposed that memory studies of people with DS should only involve "non-verbal, non-visual and non-motor" tasks. Research reveals that olfaction is intact in people with DS through to young adulthood (McKeown et al., 1996). Consequently, olfactory stimuli may be a more suitable modality for examining implicit and explicit memory function in DS. Based on Degel and Koster's (1999) experimental design, the authors have developed a purpose-designed task of implicit and explicit odour memory to investigate whether people with DS perform similarly to all control groups on the implicit memory task, but show impaired performance on the explicit memory task.

The DS literature hypothesises that impairment in executive functioning may underlie the deficit observed in explicit memory in people with DS. Previous investigations, however, have not directly examined the link between tasks of executive function and explicit memory performance in people with DS. Further, prior research has not reliably observed impairment in executive functioning in people with DS (Chapman & Hesketh, 2000). The present study compares the performance of

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people with DS and mental-age matched controls of typical development on two tasks of executive function. It also explores whether performance on these tasks of executive function predict explicit, but not implicit, memory performance.

2. Materials and methods

2.1. Participants

Fifteen persons with DS between 8 and 20 years old (7 males), 11 of their siblings (6 males), 17 mental-age matched children (8 males), and 21 undergraduate students (9 males) with mean chronological ages of 14.8 (S.D. 3.7), 14.6 (S.D. 4.7), 5.7 (S.D. 1.3) and 20.8 (S.D. 3.8) years, respectively, participated in the study. The undergraduate participants were significantly older than all other participants (DS: $p < 0.001$; sibling: $p < 0.001$; mental-age matched: $p < 0.001$), the mental-age matched group was significantly younger than all other participants (undergraduate: $p < 0.001$; sibling: $p < 0.001$; DS: $p < 0.001$), and the DS and sibling groups did not significantly differ in age ($p = 0.869$). The experimental groups did not significantly differ in gender composition. Mental-age for the DS participants was determined by administering the Wechsler Abbreviated Scale of Intelligence (WASI). The DS participants attained an average Full Scale IQ score of 55.93 (S.D. 6.18) on the WASI.

2.2. Neuropsychological battery

Testing was conducted in a single session at the participants' homes, childcare centre, schools, or university research room. All participants were requested to indicate whether they were suffering from a cold or any other deficiency to their sense of smell prior to testing.

2.2.1. The 'Where's Wally?' odour task (WWOT)

The WWOT tested implicit and explicit memory for odours, and was administered to all participants. Its design was based on Degel and Koster's (1999) implicit odour memory study. The current study utilised pictures from 'Where's Wally?', a book of illustrations that contain hidden characters and objects that readers are requested to find (Handford, 1997). It is intended for children of all ages, requires no reading or knowledge for its execution, and no verbal responses. In the inspection phase, participants were presented with three pictures for a period of 4 min each. Each picture was an A3 size, laminated, colour photocopy of illustrations from the book. The three pictures selected were chosen based on the absence of olfactory clues in the illustrations and the generality of their topics. For each picture, participants were asked to find various characters and objects – a task that was unrelated to, and distracted the participant from, its underlying purpose. On each of the three presented pictures were two white adhesive labels, measuring 39 mm × 76 mm, with a number indicating the picture's order of presentation. They were positioned in the bottom left hand and top right hand corner of each picture. The labels of each picture were scented with a given odour, which was wiped onto the label using a cotton bud. The odours were not visible on the labels and the pilot study established that the concentration was sufficient to detect the odour if one's attention was drawn to it, but not sufficiently strong as to alert the participant to its presence – that is, it was incidental. At the conclusion of each testing session the labels were removed and the laminated pictures scrubbed to eradicate odour traces. Participants were not informed of the odours. The three pictures in the inspection phase were presented to participants in a random order.

After an interval in which participants completed an unrelated task the DS and mental-age matched groups were administered the 'animal' reverse categorisation task (see below), whereas the undergraduate and sibling groups completed an unrelated mirror-drawing task, participants were administered the WWOT implicit memory test phase. They were provided with six, A3 size, laminated 'Where's Wally?' pictures in a random order. Three of the pictures were unscented copies of those presented in the inspection phase and the others were previously unseen illustrations from the same book. The researcher told participants that "the author of 'Where's Wally?' wants to make a 'scratch 'n' sniff' version of the book using nice perfumes and needs your help to decide which perfumes go well with which pictures". For each picture, participants were provided with six odours by the researcher, the three presented on the three pictures in the inspection phase, and three not previously smelt. They were presented individually and in a random order at 30 s intervals. The participant was asked for each presented odour "how well does this perfume fit with this picture?" The participants responded non-verbally by pointing to their answer on a five point scale, which used pictures rather than words. The scale used pictures of 'thumbs up' or 'thumbs down' to measure participants' judgements, where two 'thumbs down' signified that the odour did not fit the picture at all, one 'thumb down' indicated that the odour fitted moderately poorly with the picture, 'thumb up and thumb down' signified that the odour did not go well but did not go badly with the picture, one 'thumb up' indicated that the odour fitted moderately well with the picture, and two 'thumbs up' meant that the odour fitted very well with the picture. The picture that the participant pointed to was scored on a scale of 1–5, with 1 being 'very poor fit' and 5 being 'very good fit'. This phase of the experiment also served as the incidental inspection phase of the explicit odour memory task. The six odours that were being judged across the six pictures became the target odours for the explicit memory task.

After another interval in which participants completed an unrelated task DS and mental-age matched groups were administered the 'hand' reverse categorisation task (see below), and the undergraduate and sibling groups were administered an unrelated mirror-drawing task, participants were administered the test phase of the explicit memory task.