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## Modality effect on contextual integration in people with Williams syndrome



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### ABSTRACT

In this study meaningful social stimuli were used as probes in a task requiring the judgment of semantic appropriateness to investigate contextual integration ability to test the ability of people with Williams syndrome (WS) to integrate information, as opposed to the use of meaningless syllables in audiovisual studies (the McGurk effect). Participants were presented with background auditory primes followed by targets that were either congruent or incongruent with the prime. Two modes of target were presented: a visual target (AV task) or an auditory target (AA task). Participants were asked to respond yes to contextually appropriate pairs and no to those that were contextually inappropriate. The congruency effect was measured as an index of successful central coherence. Similar to normally developing controls, people with WS showed shorter response latencies and greater accuracy in recognizing congruent pairs compared with incongruent pairs. Their performance did not differ from that of controls matched by mental age, but was inferior to that of controls matched by chronological age. The results revealed generalized contextual integration for auditory primes in both tasks, consistent with previous studies using visual presentation of social-related stimuli in people with WS (Hsu, 2013a, 2013c). Further demonstration of the presence of a modality effect on contextual coherence implies that cross-modal learning may be advantageous compared with unimodal learning.

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## 1. Introduction

Weak central coherence has been well documented in people with autism since Professor Uta Frith's book *Autism: Explaining the Enigma* appeared in 1989. Weak central coherence refers to a deficit in the ability to combine parts into a whole when processing information or integrating contexts, including in the verbal and nonverbal domains. However, whether the cognitive style of global ignorance and local concentration (Happé & Frith, 2006) is syndrome-general or syndrome-specific has received little attention by those researching developmental disabilities. A series of studies on people with Williams syndrome (WS) lends support to weak central coherence being syndrome-general (conceptual integration: Hsu, Karmiloff-Smith, Tzeng, Chin, & Wang, 2007; proposition integration: Hsu & Tzeng, 2011; contextual integration using pictures: Hsu, 2013a; verbal causal coherence: Hsu, 2013b; cross-modal contextual integration: Hsu, 2013c), revealing delayed or deviant central coherence processing. By employing socially meaningful stimuli instead of abstract geometric blocks or patterns, the results of nonverbal studies using presentations of visual primes challenged the

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traditional view that the visuospatial construction ability of people with WS is completely impaired. To ensure systematic investigation, the integration of information with auditory primes was studied using bimodal and unimodal presentations to people with WS.

People with WS have a deficiency in chromosome 7q11.23 with, on average, 15–22 genes missing (Korenberg et al., 2000). The incidence is 1 in 7500 live births (Strømme, Bjørnstad & Ramstad, 2002). People with WS are reported to have an uneven cognitive profile with relatively good language ability but relatively poor visuospatial construction skills (Bellugi, Lichtenberger, Jones, Lai, & George, 2000). Deficient visuospatial ability was previously documented in block design, pattern construction and visual motor integration tests (Bellugi et al., 2000; Atkinson et al., 1997). However, recent studies have challenged the traditional view of a completely impaired visuospatial ability in people with WS. Hsu (2013a) reported non-deviant but delayed contextual integration in people with WS when socially related pictures were used. Participants were required to judge whether pairs of pictures, a preceding background prime and a target, were congruent in terms of semantic appropriateness. By using pictures showing concrete and meaningful stimuli, the information-processing ability to integrate parts into a whole was successfully elicited as delayed in people with WS compared with their mental-age matches. A follow-up study using a bimodal presentation of visual background primes and auditory targets to people with WS was conducted (Hsu, 2013c). The instructions given to participants were the same as for the unimodal study: press the *yes* button to indicate contextual appropriateness between background and target (e.g., a sports store followed by a pair of sports shoes) and press the *no* button for contextual inappropriateness (e.g., a sports store followed by a pair of high heels). The results revealed a delayed performance when visual primes were used, similar to that shown in the unimodal study, with faster responses to visual targets compared with auditory targets, indicating a modality effect on contextual coherence in visually primed contexts.

A study investigating audiovisual integration using the McGurk effect paradigm with meaningless syllables was conducted on people with WS by Böhning, Campbell, and Karmiloff-Smith (2001). Participants were required to report syllables displayed on a screen (vision alone condition), syllables heard without being seen (audition alone condition), or syllables shown on the screen and heard (audiovisual condition). Those participants with WS showed reduced accuracy of identification in the vision alone but not in the audition alone condition compared with normally developing controls. Moreover, the congruent effect in people with WS was lower than in normally developing controls. When comparing congruent audiovisual responses with correct auditory reports in different places of articulation (five tokens: /b/, /v/, /θ/, /d/, /g/) between groups, a significant interaction was observed. The results suggested that congruent visual images generally benefitted audiovisual perception in the normally developing controls but had a restricted influence (bilabial token only: /b/) on the participants with WS. This finding confirms a reduced visual influence on auditory perception in people with WS. Further comparisons between older WS individuals and younger controls revealed no differences in audiovisual perception, suggesting that those with WS did not completely fail to integrate information.

To investigate whether people with WS demonstrated a contextual effect on partial and full integration with less concrete but still socially meaningful auditory stimuli as probes, the current study reversed the modality and used auditory background primes followed by either visual targets (bimodal study) or auditory targets (unimodal study). Based on the results of previous studies on auditory or verbal short-term memory, it was predicted that people with WS would show non-deviant but delayed contextual integration in auditory contexts. These previous WS studies addressed unique hyperacusis auditory sensitivity in people with WS toward medium to high frequencies in pure-tone audiogram testing, and a dysfunction of the outer cochlear hair cells in distortion-product otoacoustic emissions testing (Gothelf, Farber, Raveh, Apter, & Attias, 2006), a verbal short-term memory revealing normal-like proficiency in non-word repetition and impaired phonological awareness performance (Majerus, Barisnikov, Vuillemin, Poncet, & van der Linden, 2003), and a normal-like cross-modal ability to integrate social stimuli through demonstrating the facilitation of musical affect on social stimuli (faces) compared with non-social objects (Järvinen-Pasley et al., 2010). By using socially meaningful auditory primes as contexts for priming bimodal visual or unimodal auditory targets in a task requiring the judgment of semantic appropriateness, we expected that a non-defective cross-modal processing of social-related auditory stimuli would be observed in people with WS. Hence, a generalization of contextual integration ability regarding visual and auditory presentation modalities could be achieved in people with WS. A minor goal was to investigate whether the modality effect of the better recognition of visual than auditory targets was valid in people with WS.

## 2. Method

### 2.1. Participants

Eighteen participants with WS (5 females, 13 males) were recruited with a mean chronological age (CA) of 19.57 years (SD = 4.65, range = 13.08–29.05) and a mean mental age (MA) of 9.42 years (SD = 2.58, range = 6.04–14.08). All of the participants were diagnosed as having missing genes on chromosome 7q11.23 in hospital at an early age or at school age. Two groups of normally developing controls were individually matched to the WS participants according to gender and CA ( $n = 18$ , 5 females/13 males, mean age = 19.95, SD = 4.69, range = 13.09–30.01) and according to gender and MA ( $n = 18$ , 5 females/13 males, mean age = 9.25, SD = 2.56, range = 5.11–14.03). The average CA between the WS group and the CA-matched controls was not significantly different ( $t(17) = 1.22$ ,  $p = .24$ ), and neither was the average MA between the relevant groups ( $t(17) = -1.20$ ,  $p = .25$ ). The CA-matched controls were significantly older than the MA-matched controls

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