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Divided attention, selective attention and drawing: processing preferences in Williams syndrome are dependent on the task administered

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Abstract

The visuo-spatial abilities of individuals with Williams syndrome (WS) have consistently been shown to be generally weak. These poor visuo-spatial abilities have been ascribed to a local processing bias by some [R. Rossen, E.S. Klima, U. Bellugi, A. Bihrle, W. Jones, Interaction between language and cognition: evidence from Williams syndrome, in: J. Beitchman, N. Cohen, M. Konstantareas, R. Tannock (Eds.), Language, Learning and Behaviour disorders: Developmental, Behavioural and Clinical Perspectives, Cambridge University Press, New York, 1996, pp. 367–392] and conversely, to a global processing bias by others [Psychol. Sci. 10 (1999) 453]. In this study, two identification versions and one drawing version of the Navon hierarchical processing task, a non-verbal task, were employed to investigate this apparent contradiction. The two identification tasks were administered to 21 individuals with WS, 21 typically developing individuals, matched by non-verbal ability, and 21 adult participants matched to the WS group by mean chronological age (CA). The third, drawing task was administered to the WS group and the typically developing (TD) controls only. It was hypothesised that the WS group would show differential processing biases depending on the type of processing the task was measuring. Results from two identification versions of the Navon task measuring divided and selective attention showed that the WS group experienced equal interference from global to local as from local to global levels, and did not show an advantage of one level over another. This pattern of performance was broadly comparable to that of the control groups. The third task, a drawing version of the Navon task, revealed that individuals with WS were significantly better at drawing the local form in comparison to the global figure, whereas the typically developing control group did not show a bias towards either level. In summary, this study demonstrates that individuals with WS do not have a local or a global processing bias when asked to identify stimuli, but do show a local bias in their drawing abilities. This contrast may explain the apparently contrasting findings from previous studies.
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Keywords: Hierarchical processing; Local–global; Visuo-spatial perception; Drawing ability

1. Introduction

Individuals with Williams syndrome (WS) have poor visuo-spatial skills in relation to other cognitive abilities [1,4,6,7,9,12]. Based on previous research, it has been theorised that these individuals perceive the local and global aspects of visuo-spatial information in a manner that deviates from typical development. Local processing refers to the perception of the individual elements of an image, whilst attending to the image as a whole figure is referred to as global processing. In typical development, adults and older children process information at the global level faster than at the local level, thus global information is available before local information. This is known as the global precedence effect [15,16]. It has been suggested that individuals with WS do not show global precedence, but instead are biased towards processing the local elements of an image at the expense of the global form [2].

This proposal appears to be supported by observations of the nature of the errors made in visuo-spatial tasks. Individuals with WS show poor global organisation in the Block Design task [2] and similarly, their drawings consist of the individual details of the image [3,24], without being organised into a coherent global structure, thus apparently pointing towards a preference to perceive at the local level. However, Pani et al. [18] found that in a visual search task, 12 adults with WS were influenced by the grouping of the stimuli to the same extent as a typically developing (TD) control group matched by gender and chronological age

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(CA). This suggests that individuals with WS do exhibit global precedence in visual search.

The different interpretations of WS performance among the visuo-spatial tasks described above suggest that the processing biases observed in WS are dependent on the task administered. The performance of individuals with WS on a task that requires the participant to identify stimuli show a different pattern of processing to the performance observed on a visuo-spatial construction or drawing task. This difference in the task demands has not always been taken into account when interpreting results.

Task demands must also be accounted for within a task. A bias in local processing has been suggested to explain both an exceptionally poor level of performance on the Block Design task in WS, but to explain a superior level of performance on the same task in autism [26]. The local bias on this task is apparent when identifying component parts in individuals with autism, but, as discussed above, occurs at the stage of constructing the image in individuals with WS. In the present study, versions of the same task are employed in which identification, and image production through drawing are investigated separately. Patterns of performance can then be associated with the appropriate task demand, identification or production.

In addition to the problem of task demands, consensus has not been reached regarding the precise definition of 'local', 'global', and associated terms. Global precedence is considered by many to be a modern version of the Gestaltist claim of primacy of wholistic processing in perception, i.e. that global properties, rather than the component parts of that object, are the initial step for processing an object (e.g. [21,31]). As such, the terms wholistic and global processing are often used interchangeably. However, the term wholistic is also linked to the distinction between integrality and separability. In this sense, wholistic has a subtle but important different definition in which the properties of an object hold no weight in processing at all.

Solely the terms local and global will be employed for discussion in the present study. The use of local and global refers here to the notion that a visual scene can be viewed as a hierarchy of levels. The place that a visual property holds within the structure of a scene dictates it's globality, i.e. it is global to a property lower down the hierarchy, but local to a property at a higher hierarchical level. Three versions of the Navon task [15] are employed. This task has been chosen because it has two distinct hierarchical levels, global and local. Individuals are presented with hierarchical figures, which are letters, e.g. a number of letter Hs arranged to form a letter A. Letters at both hierarchical levels are equally recognisable and complex, and thus equally codable. Identification of one level does not provide any information about the identification of the other level, hence any differences in accuracy, or response time can be assumed to be accountable to hierarchical differences [15].

Four studies have investigated hierarchical processing in WS, typically employing the drawing version of the Navon task. Rossen et al. [23] and Birhle et al. [3] demonstrated that individuals with WS were more accurate at drawing the local elements of the images (small letters) in comparison to the global formation (larger letter). Bellugi et al. [2] report similar findings from their group of individuals with WS when asked to draw hierarchical figures of triangles made up of circles (a task taken from the Boston Diagnostic Aphasia Examination (BDAE) [8]). Accuracy was higher for their reproduction of the local forms than for the global whole.

The results of Stevens [28] are less in favour of a local bias in WS drawing than the three studies described above. Five out of 13 individuals with WS showed a local bias in a Navon drawing task. In a second experiment, the motor response was omitted, by asking participants to *describe* the stimuli. All individuals with WS were able to describe both local and global levels of the stimuli. Stevens suggests that the local bias present in the drawings of individuals with WS, is not related to the process of stimulus identification, but relates to difficulties in planning a motor response.

An individual's ability to identify a stimulus can also be directly investigated by employing a decision making task in which individuals have to indicate whether a particular letter is present at either the local or global level. Plaisted et al. [20] employed the Navon task with individuals with autism through two decision making tasks, one requiring selective attention and the other requiring divided attention. In the selective attention task the individual completed two conditions, in which they were asked either to respond to the large letter (global level), or to respond to the smaller letters (local level). Thus, participants only needed to focus on one level, local or global, in any one condition. In the divided attention task, the individual was asked to respond to a target letter, which could appear at the local level, the global level or at both levels. In this task participants were required to attend to both levels simultaneously in order to identify the target. Plaisted et al. [20] showed that the local bias typical of individuals with autism [11] was not present in the selective attention task, but was present in the divided attention task. The authors conclude that when primed to focus on a particular level, individuals with autism can process at the global level. The local bias in autism appears to be restricted to cases when individuals are unable to focus their attention on one level.

In typically developing adults, these tasks illustrate the global precedence effect. Global precedence does not become fully apparent until late childhood, and young children exhibit less of a bias towards processing at either global or local level [14]. In the selective attention task, global precedence is observed if targets at the global level are responded to faster than at the local level. In addition, when the target is at the local level, the letters at the global level should interfere with response time and accuracy. In the divided attention task, according to global precedence, targets at the global level should be detected more quickly and accurately than those at the local level. Similarly, response time should be faster, and accuracy greater in trials where the target is

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