

Egocentric and Allocentric Navigation Strategies in Williams Syndrome

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Introduction

- Individuals with Williams syndrome (WS) often present with difficulties on both small and large-scale tasks requiring an understanding of spatial relationships (Nardini et al., 2008; Farran et al., 2010).
- In typical development (TD), young children and adults predominantly use an egocentric navigation strategy (body-centred), but between 5-10 years of age become more able to use an allocentric strategy (external or object-centred) (Bullens et al., 2010).
- In TD, egocentric strategies are associated with dorsal stream activation (e.g. Committeri et al., 2004), and allocentric strategies with hippocampal activity (e.g. King et al., 2002). Both of these regions are known to be atypical in WS (Atkinson et al., 1997; Meyer-Lindenberg et al., 2005).

Do difficulties in understanding spatial relationships in WS lead to the use of atypical navigation strategies in a large-scale environment?

Method: Participants

TD children aged 5-10 years (total N=64), and participants with WS (N=17).

Table 1: Mean age and cognitive abilities in each group

	CA: yrs; mths	BPVS ¹	RCPM ¹
	Mean (SD)		
5 yrs (N=16)	5;7 (0;4)	78.9 (13.5)	19.4 (3.9)
6 yrs (N=15)	6;8 (0;3)	91.3 (14.3)	24.3 (4.9)
8 yrs (N=17)	8;3 (0;4)	112.4 (15.8)	28.0 (5.0)
10 yrs (N=16)	10;1 (0;4)	130.8 (15.2)	30.4 (3.1)
WS (N=17)	21;10 (8;5)	123.7 (22.4)	16.8 (3.3)

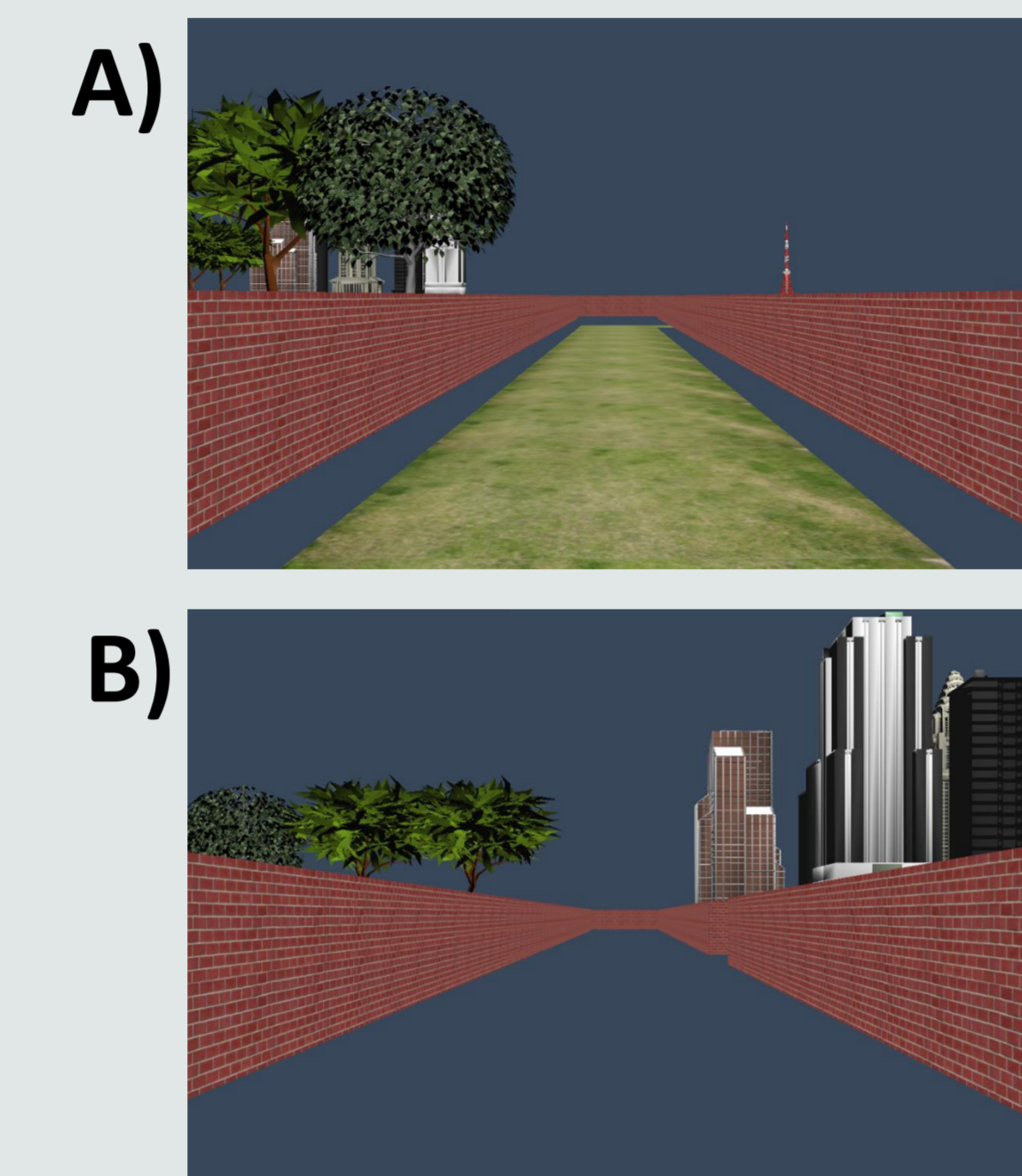
¹ Verbal and non-verbal cognitive abilities were assessed using the British Picture Vocabulary Scales (BPVS-III) and Ravens Coloured Progressive Matrices (RCPM), respectively.

BPVS = 5 and 6 year-olds < 8, 10 and WS groups ($p < .01$)

RCPM = 5 year-olds and WS < 6, 8 and 10 year-olds ($p < .01$)

Method: Design and Procedure

A virtual environment cross-maze (based on the star-maze task, [Bullens et al., 2010]) was used to examine navigation strategies in each group.



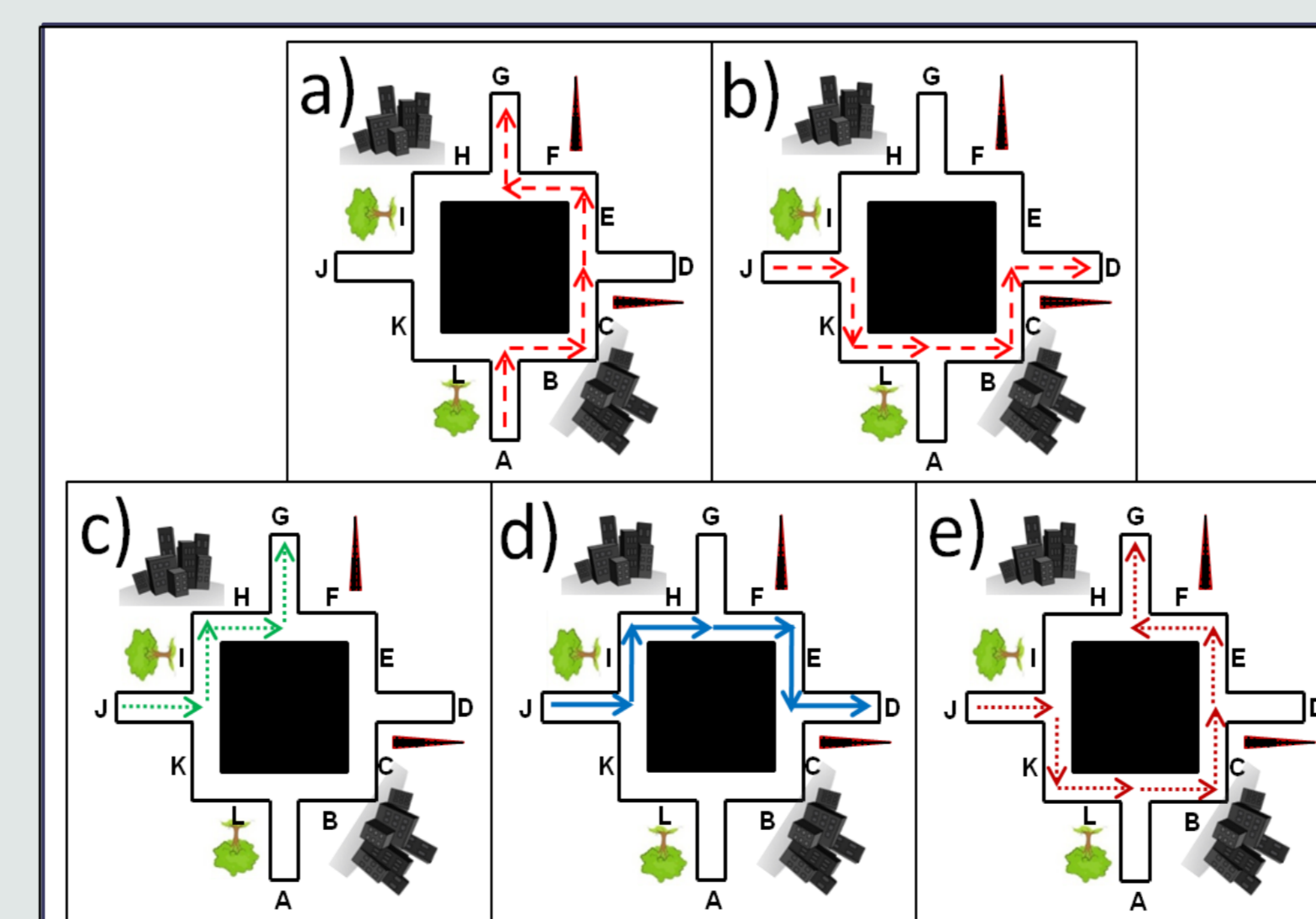
- Participants learn route to 'hidden exit' following grass path (A)
- Practice trials without grass (B) to reach criterion (2 correct trials)
- Twelve test trials (eight 'normal' trials interspersed with four 'spontaneous strategy' trials)
- 'Spontaneous strategy trials' (4 trials) - starting from a different place in the cross-maze (unknowingly).
- Participants then learn route to new 'hidden exit' and given the 'Enforced Allocentric trials' - (3 trials x 2 starting places [total = 6 trials]). These trials require the use of an allocentric strategy to succeed (finding the shortest route).
- Cognitive Map Test** - asked to choose correct layout of maze from choice of 6. This examines the development of an understanding of the spatial layout of the environment, a test of allocentric knowledge.

Results

Number of trials taken to reach criterion: 10 year-olds < 5 and 6 year-olds and WS groups ($p < .05$ for all).

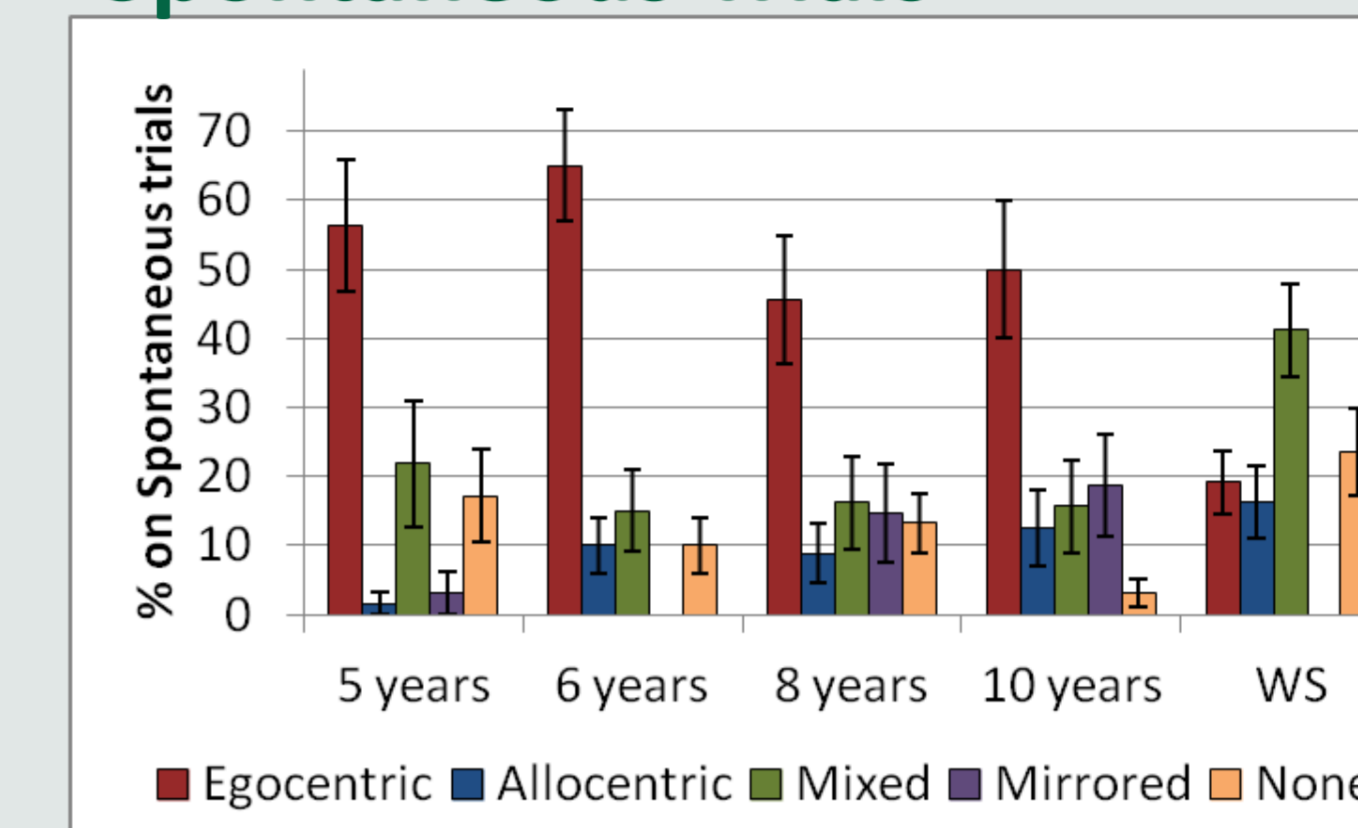
Four different strategies observed (b, c, d, and e):

- Route taken on learning trials
- Sequential Egocentric** (uses same body-based series of turns)
- Allocentric** (uses layout and landmark knowledge to make short-cut)
- Mirrored egocentric** (uses layout but not landmarks)
- Mixed strategy** (starts using egocentric, then uses distal landmarks)



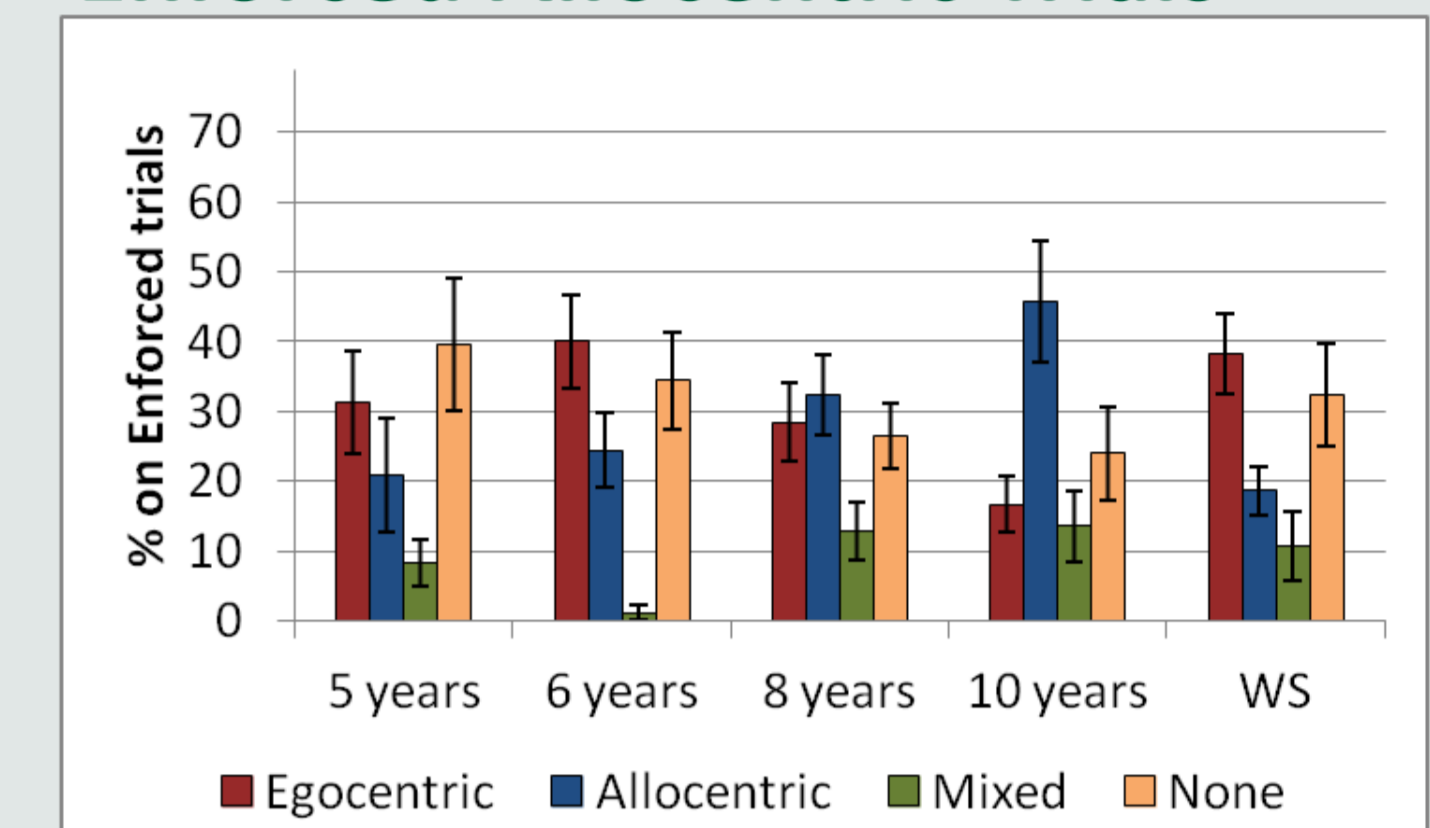
Percentage of each strategy type used across groups:

Spontaneous Trials



- All TD groups used an **egocentric** strategy > any other strategy
- WS group used an **egocentric** strategy < than all TD groups
- WS group used a **mixed** strategy > than all TD groups

Enforced Allocentric Trials



- Allocentric score:** (Ego = 0 points, Mixed = 1 point, Allo = 2 points)
 - Spontaneous trials allocentric score: WS > 5 and 6 yr-olds
 - Enforced trials allocentric score: 10 yrs > 5 and 6 yrs and WS
 - ↑ in allocentric score for 8 and 10 yrs (spontaneous to enforced)
 - ↓ in allocentric score for WS (spontaneous to enforced)
- Cognitive Map Test:** Correct layout chosen significantly more often than chance only in 8 and 10 year-olds groups

Conclusions

- TD children predominantly use a sequential egocentric strategy to navigate, becoming increasingly more able to use an allocentric strategy when necessary between 8 and 10 years
- Individuals with WS predominantly rely on landmarks to navigate, but are unable to develop an understanding of the relationships between landmarks and are therefore unable to use an allocentric strategy when it is required to make short-cuts
- The WS group demonstrated an atypical pattern of performance both on spontaneous strategy trials and enforced allocentric trials, suggesting difficulties in the use of both egocentric and allocentric spatial representations
- Atypical presentation of egocentric and allocentric spatial encoding in WS may be related to known cortical abnormalities in Dorsal stream (Atkinson et al., 1997) and Hippocampal regions (Meyer-Lindenberg et al., 2005) in this disorder.