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ORIGINAL ARTICLE

Corsi Blocks Task Complexity Effects in People with Intellectual Disabilities

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ABSTRACT

The Corsi blocks task, a widely used measure of spatial short-term memory, has been used for some investigations of people with intellectual disabilities (ID) of unknown etiology, but evidence of its efficacy is mixed. To clarify those mixed results, this study examined the effects of the path configuration complexity in the Corsi blocks task on people with ID of unknown etiology. This study also examined the interaction of the path configuration complexity and recall directions.

Participants were 12 people with ID of unknown etiology (4 female, 8 male; mean CA = 33.82 yr, SD = 8.69, range 21–46 yr). Forward and backward versions of the Corsi blocks task were administered. Participants received simple sequences involving short distances between blocks without path crossings or complex sequences involving long distances between blocks with one path crossing.

Results demonstrated that complex sequences were more difficult to recall than simple sequences. No difference in performance was found between recall directions. Furthermore, results exhibited interaction of the complexity of the path configurations and recall directions. Especially in the backward version of the Corsi blocks task, the path configuration complexity affected performance in people with ID.

Results imply that spatial processing involved in the backward version of the Corsi blocks task might play a key role in the results. Future research with more sophisticated design must be conducted to clarify this matter.

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Ⅰ. Introduction

The Corsi blocks task (Corsi, 1972), a widely used measure of spatial short-term memory, was developed originally as a non-verbal counterpart to the verbal short-term memory span task (Milner, 1971). The original materials comprise nine identical irregularly distributed blocks that are permanently fixed on a board. The experimenter taps a sequence of blocks. Immediately thereafter, the participant must tap the same blocks in their order of presentation. The number of blocks tapped by the examiner increases gradually until recall is regarded as no longer correct. The task has variations in display characteristics and test administration (Berch, Krikorian & Huha, 1998). It can assess backward as well as forward recall. Since its development, numerous variations of the Corsi blocks task have been used to assess spatial short-term memory in adults and children with typical and atypical development (e.g. Oi, Ikeda, Okuzumi et al., 2014).

Some investigations of spatial short-term memory in people with intellectual disabilities (ID) of unknown etiology have been conducted using the Corsi blocks task. Several reports have described that people with ID have mental-age appropriate performance on the task (Henry & Winfield, 2010; Jarrold & Baddeley, 1997; Jarrold, Baddeley & Hewes, 1999; Schuchardt, Gebhardt & Mäehler, 2010). For example, Henry & Winfield (2010) investigated children with mild to moderate ID, comparing typically developing children matched for mental age. Results show no significant difference among these groups. However, several studies have found poorer performance on the task by people with ID (Bayliss, Jarrold, Baddeley et al., 2005; Numminen, Service & Ruoppila, 2002; Van der Molen, Van Luit, Jongmans et al., 2009). In contrast, some evidence shows that people with ID have superior performance on the task to that of people of the same mental age (Henry & MacLean, 2002; Rosenquist, Conners & Roskos-Ewoldsen, 2003). Therefore, evidence is mixed on how well people with ID of unknown etiology perform on the Corsi blocks task in comparison with those of the same mental age, or whether their spatial short-term memory is in line with mental age. Methodological variations among studies might account for some inconsistency of results, but no full explanation is available at present (Henry, 2012).

This inconsistency might have several causes (e.g. severity of ID, method of assessing intellectual ability), but here we specifically examine the Corsi blocks task characteristics. Performance on the Corsi blocks task was assumed to depend on sequence length, as with other serial memory tasks. Nevertheless, early research (Smirni, Villardita & Zappalá, 1983) has demonstrated that task performance depends not only on the sequence length but also on characteristics of the path formed by the blocks tapped by the examiner. In recent years, it was demonstrated that task performance decreases as the spatial length of path and the number of path crossings increases (Orsini, Pasquadibisceglie, Picone et al., 2001; Orsini, Simonetta & Marmorato, 2004; Parmentier,

Elford & Maybery, 2005). Therefore, the path configuration complexity should be considered when using the Corsi blocks task. Some studies of ID have investigated this matter. For people with ID of unknown etiology, Schuchardt, Gebhardt & Mäehler (2010) included two variations of the Corsi blocks task: simple sequences involving short distances between blocks without path crossings, and complex sequences involving long distances between block with path crossings. Nevertheless, they neither reported the task details nor presented a discussion of the results of the two variations.

This study was therefore conducted to examine how the path configuration complexity in the Corsi blocks task affects performance in people with ID of unknown etiology. Few studies of ID described in the relevant literature have included the backward version of the Corsi blocks task. For that reason, this study also examined the interaction of the complexity of the path configurations and recall directions.

Ⅱ. Method

Participants

Participants were 12 people with ID of unknown etiology (4 female, 8 male; mean CA = 33.82 yr, SD = 8.69, range 21–46 yr). They were recruited from a residential care facility in Japan. For some participants, IQ and MA were assessed through administration of the Tanaka–Binet intelligence scale, which is a standardized and widely used intelligence test in Japan that has been validated sufficiently against the Wechsler Scale (mean IQ = 38.23, SD = 13.06, range 19–52; mean MA = 76.29 months, SD = 24.25, range 44–101 months). Criteria for selection were: (1) IQ under 70, (2) absence of sensory deficits, (3) ability to follow test instructions, (4) particular ability to perform backward recall.

Additionally, 12 healthy adults (4 female, 8 male; mean CA = 22.83 years, SD = 1.11, range 21–24 yr) participated in this study. They were recruited from Tokyo Gakugei University to serve as a reference group.

Informed consent was obtained from each participant or from a guardian of each participant before the assessment session. Ethical approval for this study was obtained from the Research Ethics Board at Tokyo Gakugei University.

Materials

The Corsi blocks task used for this study consisted of nine white blocks (25 × 25 × 25 mm) that had been fixed on a white board (255 × 205 mm). The blocks were numbered 1–9 on the examiner's side. Figure 1 presents block placement, which is based on that used by Kessels, van Zandvoort, Postma et al. (2000).

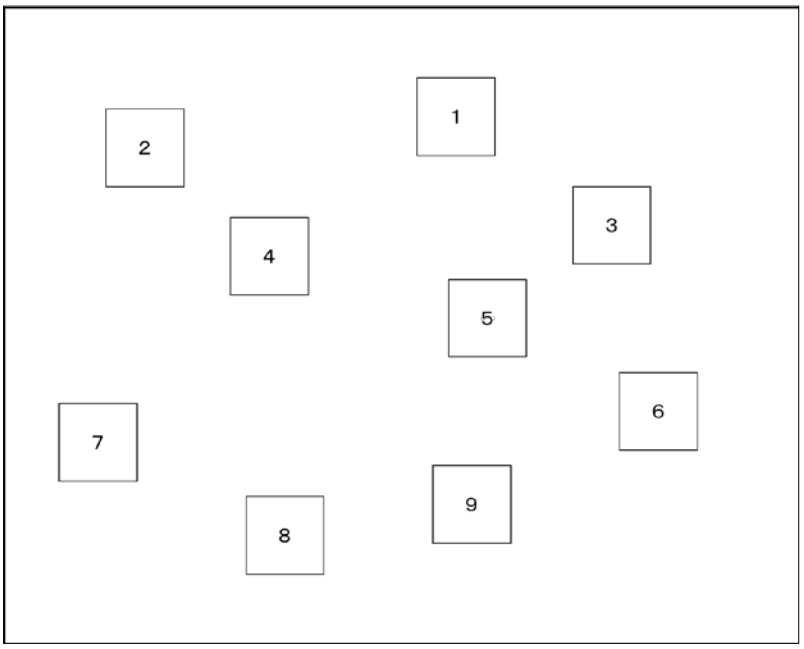
Procedure

Each participant was seated in front of the examiner and was administered the Corsi blocks task. The examiner tapped the blocks with his index finger at a rate of one block

per second. Immediately after the examiner finished tapping, the participant had to tap the same blocks in the correct order. Two trials were given per block sequence of the same length. The length of the sequences increased gradually from two to eight until two successive trials of the same length were incorrect. The participant was administered forward recall and backward recall in this order.

Two block sequence variations that differed in complexity were prepared for each recall direction (see Table 1). *Simple* sequences involved short distances between blocks without path crossings, whereas *complex* sequences involved long distances between block with one path crossing. Half of the participants in each group were presented the simple sequences; the other half were presented the complex sequences.

For each participant, a total score was calculated as the number of correctly recalled sequences until the test stopped for each recall direction.



<Figure1> Corsi blocks task used for this study viewed from an aerial perspective and from the examiner's viewpoint. This block placement is based on that reported by Kessels et al. (2000) with little modification because of the smaller sized blocks used for the present study.

<Table1> Block sequences

	Simple		Complex	
Length	Forward	Backward	Forward	Backward
2	4 1	6 9	4 6	6 4
	8 9	3 1	8 3	3 8
3	9 5 3	7 4 2	9 1 2	7 3 9
	7 4 1	3 5 9	7 3 8	3 6 4
4	9 6 5 1	9 8 4 1	9 2 5 8	9 7 3 8
	6 3 5 4	1 5 4 2	6 2 9 3	1 6 8 3
5	3 5 4 8 7	2 4 1 3 6	3 8 4 1 9	2 7 1 4 9
	1 2 7 8 5	4 7 8 5 3	1 4 6 3 9	4 6 8 7 3
6	5 9 8 7 4 1	8 9 6 5 1 4	5 9 3 2 8 1	8 6 4 3 1 5
	6 9 5 4 2 7	6 3 1 2 4 9	6 8 3 4 1 5	6 8 4 1 3 9
7	7 8 9 5 4 1 3	4 7 8 5 1 3 6	7 2 9 6 3 1 8	4 3 5 6 8 7 1
	9 6 5 3 1 4 8	5 9 8 7 2 4 1	9 6 3 5 2 1 8	5 2 7 4 8 9 1
8	8 4 2 1 3 6 9 5	1 5 6 9 8 7 4 2	8 6 3 5 1 4 2 9	1 3 9 8 7 2 4 6
	5 1 4 2 7 8 9 6	3 1 5 4 7 8 9 6	5 7 8 9 6 1 2 3	3 1 6 4 2 7 9 5

Ⅲ. Results

Table 2 presents the means and standard deviations for the total scores. For the healthy adult group (reference group), statistical analysis was not used because of ceiling effects. Therefore, statistical analysis described below was done for the ID group alone.

A 2 (complexity) × 2 (recall direction) mixed analysis of variance was conducted for total scores. The analysis found a significant main effect for complexity ($F_{1, 10} = 6.48$, $p < .05$; partial $\eta^2 = 0.39$) and for interaction of complexity and recall direction ($F_{1, 10} = 6.31$, $p < .05$; partial $\eta^2 = 0.39$) but not a main effect for recall direction ($F_{1, 10} = 0.20$, *ns*; partial $\eta^2 = 0.02$). Contrasts conducted within each recall direction revealed that the total score on complex sequences was significantly lower than on simple sequences for backward recall ($p < .05$). Neither the difference between simple and complex sequences within forward recall nor the difference between recall directions within complex sequences was found to be significant ($p = .11$; $p = .06$).

<Table 2> Means and standard deviations for total score

	Simple				Complex			
	Forward		Backward		Forward		Backward	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
ID group	7.0	3.2	8.2	4.1	4.5	1.4	2.8	1.8
Reference group	13.3	1.2	13.2	0.8	11.7	2.1	11.8	1.7

Ⅳ. Discussion

This study assessed effects of the path configuration complexity in the Corsi blocks task on people with ID of unknown etiology. Furthermore, this study examined the interaction of the path configuration complexity and recall directions.

Results demonstrated that complex sequences with long spatial length of paths with one crossing were more difficult to recall than simple sequences having short spatial length of the paths without a crossing. This difficulty is in line with earlier findings (Maehler & Schuchardt, 2009; Schuchardt et al., 2010). Furthermore, no difference was found in performance between recall directions, which agrees with earlier findings obtained from healthy adults (Kessels, van den Berg, Ruis et al., 2008; Vandierendonck & Szmalec, 2004; Wilde & Strauss, 2002).

Results also showed interaction of the complexity of the path configurations and recall directions. Especially in the backward version of the Corsi blocks task, the path configuration complexity affected performance in people with ID. These effects were not observed for the healthy adults, although the task used for this study simply might not have detected such effects. Although reasons for the effects of complexity for backward recall remain unclear, possible spatial processing involved in the backward version of the Corsi blocks task (Mammarella & Cornoldi, 2005) might play a key role.

This study had some methodological problems including the small sample size and the lack of a control group matched for MA. Therefore, this study cannot produce a meaningful conclusion. In addition, the path configuration complexity was treated as a between-participant factor. These methodological problems might create apparent differences between simple and complex sequences, and render differences between forward recall and recall directions in complex sequences as not significant. Future research must be undertaken on this matter using studies with more sophisticated design.

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