Autism with Language Impairment vs. Specific Language Impairment: Different Declarative and Procedural Memory Profiles

Hanady Bani Hani & Aparna Nadig

McGill University School of Communication Sciences and Disorders, Centre for Research on Brain, Language and Music

BACKGROUND

✧ Some individuals with autism spectrum disorders (ASD) demonstrate the language profile of specific language impairment (SLI) (e.g., Leyfer et al., 2008), leading to an active debate as to whether language impairment has the same underlying cause in both cases.

✧ Memory systems have been hypothesized to contribute to the language impairment in both ASD (declarative impairment, Boucher et al., 2008; procedural impairment, Ullman, 2004), and SLI (procedural impairment, Ullman & Pierpont, 2005).

✧ Declarative and procedural memory are hypothesized to play key roles in typical language development. Specifically, declarative memory is implicated in binding conceptual, phonological and semantic representations of words, whereas procedural memory involves learning and storing regularities and rule-based information (Ellis,1994; Gupta, 2011; Ullman, 2004).

✧ The status of declarative and procedural memory processing in language-impaired children with ASD and children with SLI is still controversial. Moreover, no study has directly compared the two groups with respect to their performance on declarative and procedural memory tasks as well as vocabulary and phonology.

RESEARCH OBJECTIVE

To clarify whether language-impaired children with ASD (ASD+LI) exhibit similar or different memory and language profiles as those observed in children with SLI.

PARTICIPANTS

✧ Matched pairwise on dominant language (9 English, 5 French) and NVIQ (Leiter-3; Roid et al., 2013).

✧ Had a community diagnosis of either ASD or SLI and were involved in special school services for their condition

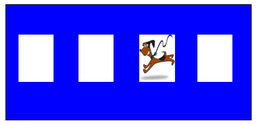
✧ Scored within the normal range on NVIQ

✧ Scored at least **1*SD*** below the mean (Kan & Windsor, 2010; Thordardottir et al., 2011;Tomblin & Zhang, 1999) on the Recalling Sentences subtest of the CELF-4 (Semel, Wiig, & Secord, 2003).

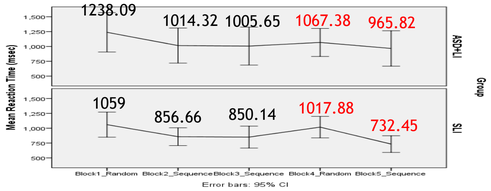
Characteristics	ASD+LI (n=14)	SLI (n=14)	
	M (SD) Range	M (SD) Range	p-value
CA (Y.M)	8 (1.24) 6 - 9	7.18 (1.19) 5 – 9	.09
NVIQ (Leiter-3)	102. 79 (9.7) 91-123	105.07 (7.8) 92-125	.50
CELF-4 Recalling Sentences	3.50 (2.03) 1-6	4.86 (2.21) 1-7	.10
Gender Female Male	3 11	4 10	.66

MEMORY MEASURES

1. Procedural memory



Serial Reaction Time task (SRT; Thomas & Nelson, 2001). Participants are instructed to press a button on a response box that corresponds to the location of a dog. Unbeknownst to the child, on some blocks of the experiment, the dog follows a repeating four-step-sequence and on others movement is random. Sequence learning is indicated by significantly faster reaction times in block 5 (sequence) in comparison to block 4 (random). This was measured by *a **sequence learning score*** (mean of block 4 – mean of block 5)/(mean of block 4 + mean of block 5). After the task we asked participants if they had noticed a pattern that helped them "catch the dog," providing a measure of explicit knowledge of the sequence.



- Groups showed similar ability to perform the task as indicated by the number of errors in blocks 4 and 5; U = 82, p = .47, r = -.14.
- The sequence learning score in the ASD+LI group (*Mdn* = 0.05) was significantly lower than in the SLI group (*Mdn* = .18); U = 52.5, p = .04, r = -0.4, **demonstrating a larger difference in response to sequence vs. random blocks in the SLI group than the ASD+LI group.**
- Within-group comparisons showed significantly faster responding in block 4 than 5 in the SLI group; T = 0, p < .001, r = .88, but not the ASD+LI group; T = 30, p = .17, r = .27, **indicating that the SLI group learned the sequence while the ASD+LI group did not.**
- Similar proportions of children with ASD+LI (5 of 14) and SLI (4 of 14) showed explicit knowledge of the sequence.

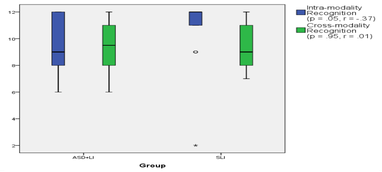
MEMORY MEASURES

2. Declarative memory

✧ ***Intra-modality recognition task*** (Bushnel & Baxt, 1999). The participant sees *six* novel objects, one by one. Then the participant is presented with these objects as well as *six* not-seen-before novel objects and is required to identify those seen before.

✧ ***Cross-modality recognition task*** (Bushnel & Baxt, 1999). The participant touches (without seeing) *six* novel objects, one by one, inside a box. Then the participant sees these objects as well as *six* not-touched-before novel objects and is required to identify those touched before.

Participants received a score out of 12 correct test items in each modality.



LANGUAGE MEASURES

Participants were tested in their dominant language using equivalent tests in English or French.

1. **Phonological awareness** *The Auditory Analysis Test* (Rosner & Simon, 1971) or Test d'Analyse Auditive en Français (Cormier et al., 1995). Participants were instructed to repeat a word. Then they were asked to repeat the word again, but to omit a particular phoneme or syllable.
2. **Articulation** *"Sounds-in-words" subtest* of the Goldman-Fristoe Test of Articulation-2 (Goldman & Fristoe, 2000) or Test de Dépistage Francophone de Phonologie (Rvachew, Brosseau-Lapré, & Paul, 2012).This test assesses articulation of particular phonemes using a picture naming task.
3. **Receptive vocabulary** *Peabody Picture Vocabulary Test-IV* (Dunn et al., 2007) or Les Échelle de Vocabulaire Image Peabody; Dunn, Thériault-Whalen, & Dunn, 1993). This is a standardized measure of lexical comprehension where the participant is asked to select a named item from an array of four pictures.
4. **Word learning** In this experimental task one of three novel objects was labeled by a speaker using gaze and pointing. Children were then asked to identify the target object among four distracters (brief delay). After approximately two hours of other activities children where asked to identify the target object among 9 distracters (longer delay). This procedure was repeated for two novel labels.

LANGUAGE MEASURES

Performance was similar between groups for all language measures.

Language measure	ASD+LI	SLI	
	Mdn	*Mdn*	p-value (*r*)
1. Phonological awareness	-.57	-1.12	.20 (*.25*)
2. Articulation	0	-.17	.83 (*-.04*)
3. Receptive vocabulary	84	91.5	.08 (*-.02*)
4. Word learning: - brief delay - longer delay	Similar proportions of children in each group mapped 0 labels, 1 label, or 2 labels		-.36 (*.1*)* -1.00 (*.31*)*

1. Z scores of the correct phoneme/syllable omissions calculated within each language.
2. Z scores of the percent of consonants correct calculated within each language.
3. Standard scores of correct identification of words.
4. Participants received a score out of 2 correct test items in each condition.

* Cramer's *V*

SUMMARY AND DISCUSSION

We found significantly worse declarative and procedural memory in ASD+LI than in SLI despite similar language skills, NVIQ, age and gender across groups. These findings add to the literature on distinct phenotypes of ASD+LI and SLI (Whitehouse et.al., 2008). If replicated, declarative and procedural learning could be used to differentiate SLI from ASD.

SUMMARY OF PROFILES

Memory		Language	
Procedural	**Declarative**	**Phonology**	**Vocabulary**
ASD impaired	**ASD impaired**	**ASD & SLI similar**	**ASD & SLI similar**

✧ The other study that tested visual procedural memory in ASD+LI (Gordon & Stark, 2007) reported intact, but slow, procedural learning on a 4-step-sequence after extensive training over six days. Our findings demonstrate impaired performance without such training.

✧ Our findings corroborate studies demonstrating intact procedural learning of 8-step sequences in SLI after adequate exposure to the pattern (Gabriel et al., 2013, 2011). However, several studies indicated impaired learning of a 10-step sequence in children with SLI compared to age-matched controls (for a review see Lum, 2014).

✧ Our findings corroborate studies that showed impaired visual recognition in ASD+LI in intra-modality tasks (Boucher et al., 2008; Dawson et al., 2001), but are at odds with those that found intact ability (Boucher & Lewis, 1992; Dawson et al., 1998). Though prior work appealed to lower intellectual abilities to explain impairment, we found impaired recognition even when NVIQ was controlled for.

✧ In line with our findings, intact visual recognition has generally been reported in SLI (Baird et al., 2010; Lum et al., 2012). In contrast, impaired visual recognition has been reported in cross-modality tasks (Müürsepp, et al., 2014). A difference in linguistic task demands, which were minimal in our study, may explain this discrepancy.