Language Learning in Dyslexia

Artificial Grammar Learning (AGL) in adults with and without dyslexia

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Introduction

Dyslexia is a general term for a life-long condition where an individual has difficulties with word recognition, short term memory and verbal processing, despite adequate educational opportunities and a normal level of intelligence. It is a common learning difficulty which mainly affects an individual's ability in accurate spelling and reading.

The syntax is the set of grammatical rules which gives structure within any language and is composed of varied complexities. The ability to identify relationships between syntactic elements is essential for language learning, (for example subject-noun/verb agreement).

AGL framework manipulates a sets of rules to create sequences of varied difficulties. These sequences can be used to mimic natural language to assess human language learning abilities.

This study used artificial grammar with auditory made-up words to investigate how individuals with and without dyslexia learn the associations between made-up words in sequences that follow specific rules.

Adjacent and Non-adjacent grammar in natural language

XAB
We walked while ***they ran...***
She sang and ***I danced...***

AXB
She ***is*** always run***ning***
He got ***four*** pen***s***

Objectives

- To observe whether there are any differences in performance of learning adjacent and non-adjacent grammars in individuals with and without dyslexia.
- To investigate role of variability of the intervening middle X element in non-adjacent relationships learning.
- To use a generalisation task in the final testing run with new stimulus of made-up words to observe if the participants could generalise the rule.
- To use a natural language task to examine understanding of complex sentences in individuals with and without dyslexia.

References

1. Miller GA. (1958). Free recall of redundant strings of letters. *Journal of Experimental Psychology*.56(6):485.
2. Peterson RL and Pennington BF. (2012). Developmental dyslexia. *The Lancet*. 379 (9830)1997-2007.

Methods

Participants

13 native English speaking individuals, aged 18-32 (9 female and 4 male). The control group of non-dyslexics included 4 male and 5 female. The dyslexic group had 4 females. Aside from dyslexia, none had a history of hearing, speech, or language impairments. All the participants were given a series of language and cognitive tests to characterise their vocabulary, grammatical comprehension, verbal working memory, phonological processing and reading. This helped in discriminating the form of dyslexia.

Stimuli

AGL Task

The stimuli were randomly generated made-up words of the form consonant-vowel-consonant. 24 training strings and 24 testing strings were generated.
All 24 training sequences were grammatical, but of the 24 testing sequences, 12 were grammatical and 12 were ungrammatical.
The adjacent and non-adjacent rules used different X stimuli. The set size of the X varied from: low (X=6) – Run1, mid (X=12)- Run 2 and high (X=24) –Run 3 and 4.

Adjacent	
A_1	kiv
A_2	jub
B_1	rol
B_2	ber
X_1	bik
X_2	fop
X_3	hig
X_4	hok
X_5	jaz
X_6	jol
X_7	lin
X_8	los
X_9	lux
X_{10}	nop
X_{11}	nug
X_{12}	pab
X_{13}	pif
X_{14}	pux
X_{15}	rit
X_{16}	ruk
X_{17}	sil
X_{18}	sut
X_{19}	tem
X_{20}	tox
X_{21}	wez
X_{22}	yub
X_{23}	zan
X_{24}	zil

Table 1 showing all stimuli used in Adjacent grammars.

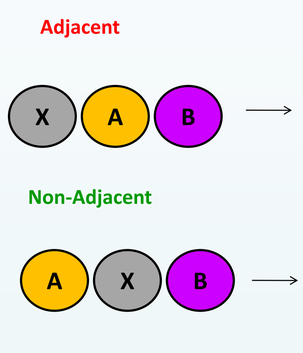

Figure 1- X preceded the A and B elements

Figure 2- X between the A and B elements

Non-Adjacent	
A_1	hix
A_2	zad
B_1	tef
B_2	pob
X_1	bek
X_2	biz
X_3	dil
X_4	fal
X_5	fip
X_6	gak
X_7	gol
X_8	heb
X_9	jat
X_{10}	kay
X_{11}	kug
X_{12}	lar
X_{13}	lod
X_{14}	lun
X_{15}	mep
X_{16}	mot
X_{17}	naj
X_{18}	raz
X_{19}	rik
X_{20}	ruj
X_{21}	sap
X_{22}	taz
X_{23}	vup
X_{24}	yun

Table 2 showing all stimuli used in Non-adjacent grammars.

Language Task

Sentence
It was the dentist who attacked the priest but not the dustman who tripped the grocer who the typist cuddled.

True/false Prompt
The typist cuddled the dustman

Procedure

Participants listened to different sequences of 3 made-up words in the exposure phase. Then they were played a mixture of sequences, half of which followed the rules, while the others that violated the rules in certain ways.
During this part the participants had to press keys C or M to respond, if they thought the sequence that they heard followed or broke the pattern.
Four testing runs were conducted, and these were separated by an exposure phase to give the participants a chance to familiarise themselves with the patterns by listening to the correct sequences again.
The final testing run used a new stimulus of made-up words to see if the participants could generalise the rule.

Results

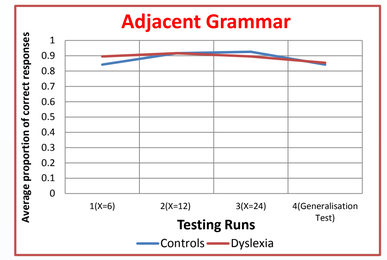

Figure 3- Average performance of dyslexics and controls across each Testing Run in Adjacent grammar.

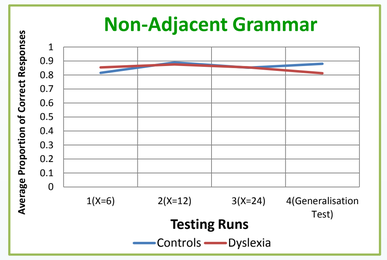

Figure 4- Average performance of dyslexics and controls across each Testing Run in Non-Adjacent grammar.

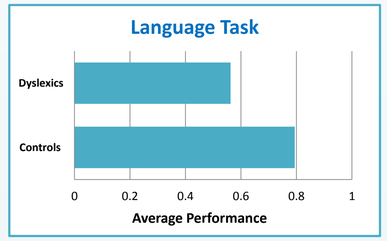

Figure 5- Average performance of dyslexics and controls in the language task.

Controls outperformed dyslexics in the language task as predicted

Conclusions

- All participants performed above chance in both adjacent and non-adjacent grammars and there was no significant difference in performance between dyslexic and control groups
- All participants were able to generalise the rule to new stimuli in Run 4
- Further research should explore language learning processes in individuals with dyslexia. This information can be used to develop targeted interventions in teaching approaches to help dyslexics achieve their full educational potential.

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