

Sentence Production in Adults with Dyslexia

Lori J. P. Altmann, Linda J. Lombardino, & Jordan Ginsburg
Communication Sciences and Disorders, University of Florida

ABSTRACT

Little is known about language production deficits that may accompany developmental dyslexia. It has been documented that children with dyslexia have impaired fluency on tests like Rapid Automatic Naming and also may have deficits in grammatical knowledge. However, it is not known whether these deficits affect sentence level production, nor whether these difficulties continue to be a problem into adulthood. Altmann, Lombardino and Puranik (in press) reported that fluency and grammaticality were both impaired in elementary and middle school children with dyslexia, but that older individuals with dyslexia only showed deficits in fluency on an offline task. The current study compared the performance of adults (age 16 to 28) with dyslexia to that of normal adult readers on an online version of the same task to determine 1) whether the earlier finding of impaired sentence production fluency in this group was replicated, and 2) whether grammatical sentence production is indeed preserved in adults with dyslexia.

METHODS

Participants

- 18 Adults with developmental dyslexia (DD): age 16-50 ($M = 19.88$, $SD = 3.09$)
- 27 Adults with normal reading (NR): age 28-30 ($M = 20.25$, $SD = 1.82$)

Evaluation

Individuals with a previous or suspected diagnosis of developmental dyslexia (DD) completed a 2 hour evaluation to confirm this diagnosis. Tasks used in the evaluation included:

- From the WRMT: word ID, word attack and passage comprehension.
 - Individuals scoring below 80% on passage comprehension were excluded, based on the likelihood of a language disorder in addition to dyslexia
- From the WRAT-3: spelling
- From the CTOPP: elision, blending words, memory for digits, nonword repetition, rapid digit naming, and rapid letter naming.
- From the TOWRE: phonemic decoding efficiency and sight word efficiency

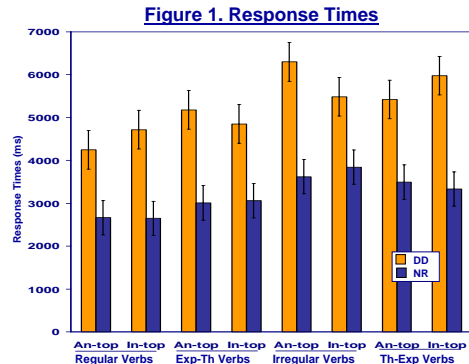
Procedure

- Participants produced sentences that included 3 stimulus words. Stimuli were centered vertically and horizontally on a computer screen.
- Each trial consisted of: a Ready screen ("Ready? Push the space bar"), a fixation star (500 ms), a stimulus set, then the Ready screen.
- Stimuli disappeared as soon as a response was detected.

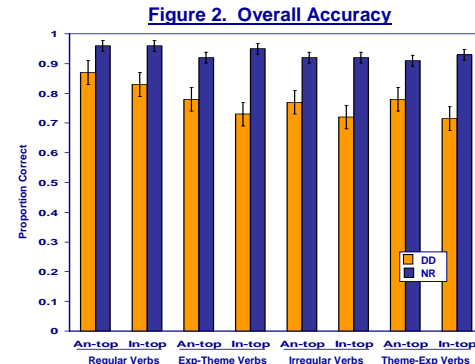
Materials

- 64 sets of 3 words, each set included 2 nouns and a verb.
- 2 nouns differing in animacy:
 - Animate nouns referred to professions (doctor, butler, farmer).
 - Inanimate nouns were chosen to be plausible objects of particular verbs.
- Stimuli either had the animate (Top-AN) or inanimate (Top-IN) noun on top of the array.
- The verb was always in the center of the array
- Stimuli included past participles of 4 types of verb:
 - Regular agent-patient (e.g., *stirred, kicked*)
 - Experiencer-Theme (Exp-Th) (e.g., *loved, despised*)
 - Irregular agent-patient (e.g., *shaken, thrown*).
 - Regular Theme-Experiencer (Th-Exp) (e.g., *confused, bored*).

RESULTS

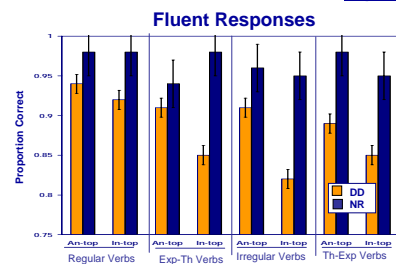


- Main effect of Group, $F(1,39) = 85.704$, $p < .0001$, $\eta^2 = .75$
- DD ($M = 5274$, $SD = 2381$) > NR ($M = 3211$, $SD = 1285$)
- Main effect of Verb type, $F(3,39) = 18.278$, $p < .001$, $\eta^2 = .58$
 - Regular < Exp-Theme < (Irregular = Theme-Exp Verbs)
- Significant Verb type x Noun Order x Group Interaction
 - $F(3, 123) = 3.524$, $p < .02$, $\eta^2 = .08$
 - DD group was disproportionately slow in Irregular + An-top and Theme-Exp + In-top



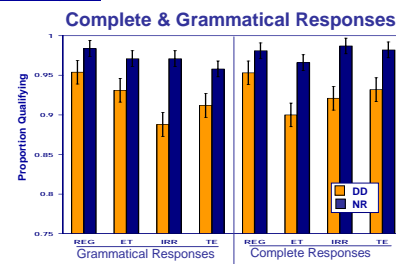
- Main Effect of Group, $F(1,43) = 20.904$, $p < .001$, $\eta^2 = .33$
- DD ($M = .78$, $SD = .14$) < NR ($M = .93$, $SD = .06$)
- Main Effect of Verb type, $F(3,41) = 2.872$, $p < .05$, $\eta^2 = .17$
 - Regular > (Exp-Theme = Irregular = Theme-Exp)
- Noun Order by Group interaction, $F(1,39) = 7.132$, $p < .02$, $\eta^2 = .20$
 - DD: An-top ($M = .82$, $SD = .12$), In-top ($M = .76$, $SD = .17$)
 - NR: An-top ($M = .92$, $SD = .07$), In-top ($M = .93$, $SD = .06$)

Figure 3 Error Subtypes



Fluent Responses

- Main effect of Group, $F(1,43) = 10.15$, $p < .005$, $\eta^2 = .20$
- DD ($M = .89$, $SD = .10$) < NR ($M = .96$, $SD = .03$)
- Significant Noun Order x Group Interaction,
 - $F(1,43) = 12.832$, $p < .002$, $\eta^2 = .23$
 - DD: An-top ($M = .92$, $SD = .10$) > In-top ($M = .86$, $SD = .12$)
 - NR: An-top ($M = .96$, $SD = .05$) = In-top ($M = .96$, $SD = .04$)



Grammatical responses

- Main effects of Group, $F(1,43) = 6.911$, $p < .02$, $\eta^2 = .14$
- DD ($M = .92$, $SD = .08$) < NR ($M = .97$, $SD = .03$)
- Main effects of Verb type, $F(3,41) = 3.501$, $p < .02$, $\eta^2 = .20$
 - REG = Exp-Theme, Regular > (Irregular = Theme-Exp)

Complete Responses

- Main effects of Group, $F(1,43) = 19.625$, $p < .001$, $\eta^2 = .31$
- DD ($M = .93$, $SD = .05$) < NR ($M = .98$, $SD = .02$)

CONCLUSIONS

Answer to questions posed in abstract

1) Were previous findings of impaired sentence production fluency in adults with dyslexia replicated?

- YES. Adults with dyslexia were less fluent in sentence production, at least in this experimental task, than normal readers.

2) Were previous findings of preserved grammatical sentence production in adults with dyslexia replicated?

- NO. In this timed task, adults with dyslexia produced significantly fewer grammatical responses than normal readers.

Group differences between DD and NR

- Individuals with DD were slower to produce sentences than NR
- Individuals with DD were less accurate than NR at producing sentences
 - DD produced significantly fewer fluent responses than NR
 - DD produced significantly fewer grammatical responses than NR
 - DD produced significantly fewer complete responses than NR

Underlying Deficits

Underlying deficits in phonological encoding may lead to phonological representations that are difficult to activate and manipulate

- This would slow response times and impede the production of fluent speech.

Impaired phonological representations could also disrupt the normal acquisition and mastery of grammatical knowledge

- Impaired phonological representations could obscure morphological regularities across words and across usages of the same word.
 - Leading to slowed acquisition of morphology, as found in Altmann et al. (in press), without an underlying morphological deficit

- Impaired phonological representations could interfere with the ability to hold words in memory, impairing short term memory and interfering with the acquisition of verb argument structures.

- Learning the argument structure of verbs requires tracking the animacy and thematic roles of the nouns around the verb, and storing this information for later use.
 - If phonological representations require extra memory resources, or cannot be retained in memory, the acquisition of low frequency, unusual verb constructions could be slowed
- Previously, we found significant impairments in younger DD subjects in Theme-Exp verbs and, more severely, in Irregular past participles—neither of which can be used in the canonical English sentence form (Animate N – Verb – Inanimate N)
- We believe Irregular past participle use was particularly impaired because it requires associating the presence of a single sound, the morpheme (-en), with very distinct sentence structures (had eaten, was eaten by)

Take-Home Message

Underlying deficits in phonological encoding throughout life can have pervasive effects on language use in adults with dyslexia, without having to posit additional language impairments in this population.

Altmann LJP, Lombardino LJ, Puranik C (in press). Sentence Production in Students with Dyslexia. *International Journal of Language and Communication Disorders*.

We would like to acknowledge the help of SueAnn Eidson and Becky Wisehart in completing the Evaluations, as well as the members of the UF Language over the Lifespan Lab for data management. This study was partially funded by an AARC grant to Lori Altmann. Presented at ASHA, Nov. 16, 2007, Boston, MA. Contact information: laltmann@ufl.edu

