Frequency and neighborhood effects on lexical retrieval in children who stutter

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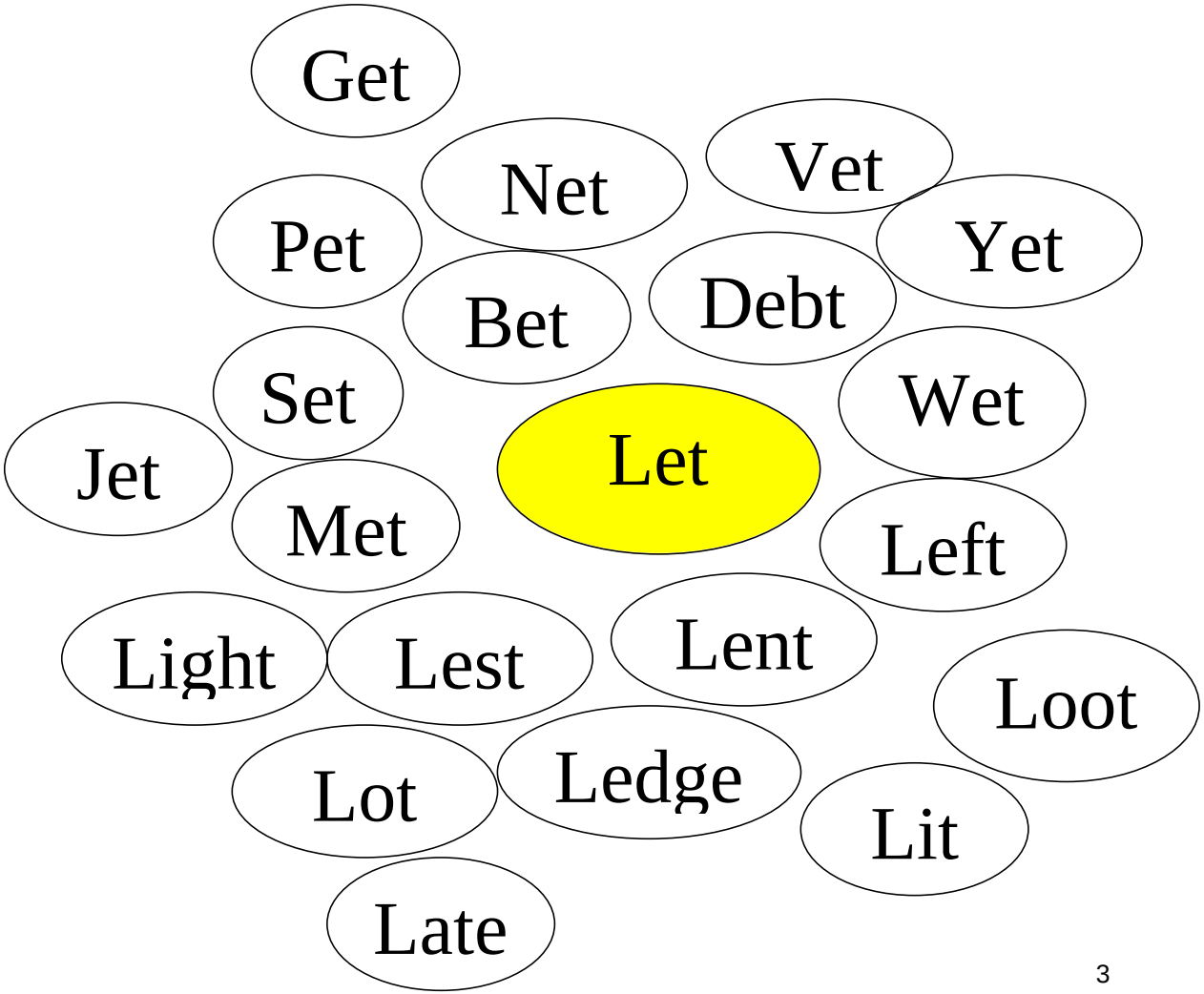
What we know about lexical processing in PWS

- **Lexical factors such as word frequency affect stuttering and fluency**
  - Danzger & Halpern, 1973; Hubbard & Prins, 1994; Palen & Peterson, 1982; Ronson, 1976; Soderberg, 1966
- **Linguistic/lexical processing is poorer in PWS**
  - e.g., Arnold, Conture, & Ohde, 2005; Byrd & Cooper, 1989; Murray & Reed, 1977; Silverman & Bernstein Ratner, 2002; Westby, 1974.
- **Lexical decision times are slower in PWS**
  - Hand & Haynes, 1983; Prins, Main and Wampler,1997; Rastatter & Dell, 1987
- **PWS show atypical priming**
  - Burger & Wijnen, 1998; Burger & Wijnen, 1999; Pellowski & Conture, 2005)

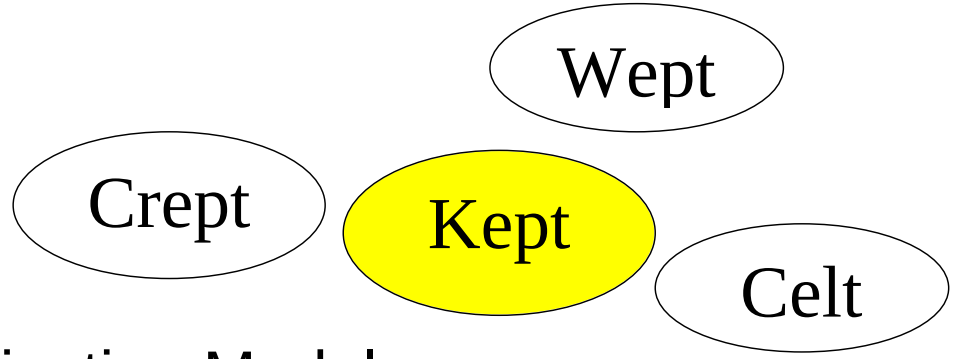
Our interest: Lexical neighborhoods

- **Some words are phonologically similar to many words**
  - **E.g., *Let* is similar to *bet*, *less*, *lent* and *light*, among others**



Lexical neighborhoods (cont.)

- **Other words are similar to few words**
  - **E.g., *kept* is similar only to three English words (*crept*, *Celt* and *wept*).**



- The Neighborhood Activation Model (Luce & Pisoni, 1998) suggests that words that sound similar are stored together in neighborhoods, and this can affect lexical access.

- For example, when attempting to access the word *let,* the speaker might experience competition from the other similar words.

Neighborhood factors in PWS

- There have only been three prior studies of neighborhood effects in PWS:
  - **Both children who do and do not stutter are faster and more accurate at naming words with few neighbors**
    - **Arnold, Conture & Ohde, 2005**
  - **Stuttered words were more likely to be low frequency and have low neighborhood frequency than fluently produced words.**
    - **Anderson & Linton, 2004**
  - **Adults who stutter perform similarly to typically fluent adults, except for accuracy of naming**
    - **Newman & Bernstein Ratner (2006)**

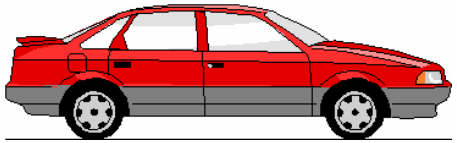
Prior Study (Newman & Bernstein Ratner, 2006)

- We examined how three lexical factors affected speech production in 25 AWS and 25 fluent speakers:
  - **the word's frequency of occurrence,**
  - **the number of other words to which it is phonetically similar (its neighborhood density),**
  - **and the average frequency of those neighbors**

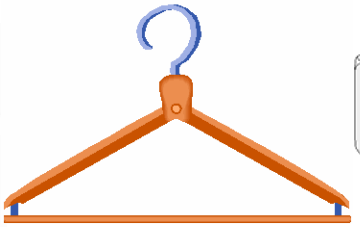
Stimuli (for adults & children)

- Stimuli were pictures of 107 common nouns & verbs
- These could be divided into 6 subsets . . .
  - Words high vs. low in **word frequency**
  - Words high vs. low in **neighborhood density**
  - Words high vs. low in **average frequency of neighbors**
    - This can be thought of as a measure of the frequency with which the sound pattern in general is encountered.

- Examples of **high frequency**:

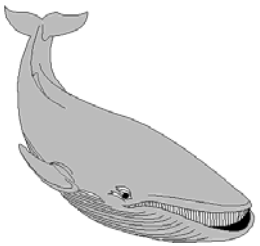


- And **low frequency**:

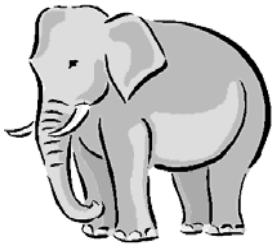


Examples: Words that have…

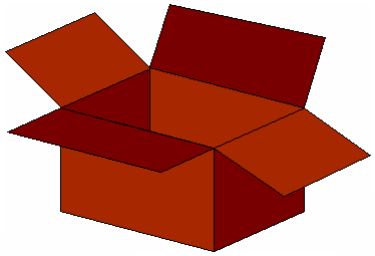
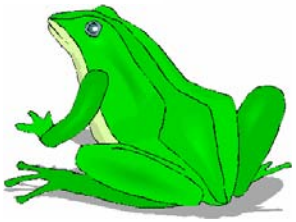
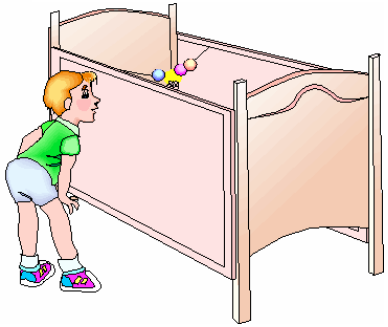
- Dense neighborhoods:



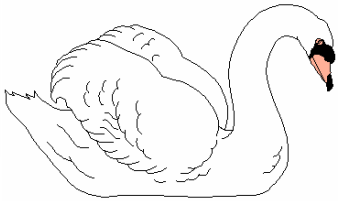
- High neighborhood frequency



- Sparse neighborhoods:

- Low neighborhood frequency



Stimuli

- **For frequency, 2 lists of 20 words each, with average log frequency of 0.85 vs. 2.68.**
- **For neighborhood, 2 lists of 22 words each, with 5.18 neighbors vs. 22.9 neighbors**
- **For neighborhood frequency, 2 lists of 22 words each, with average log neighborhood frequencies of 0.87 vs. 2.00**
- **All lists were matched for**
  - **Distribution of onset phonemes**
  - **Average number of syllables & phonemes per word**
  - **Other two lexical factors**

Method

- **All words were presented to the participants in a combined fashion, in random order.**
  - **Half participants were tested on nouns first, half on verbs first.**
- **For the nouns, participants were told to name the item they saw on the screen, using a single-word answer.**
- **For the verbs, participants were told to identify what the person or people in the picture were doing, again using a single-word answer.**

Results, Overall Analyses, Adults

- **Significant accuracy difference between groups**
  - **AWS responded correctly 94.3% of the time,**
  - **AWDNS responded correctly 97.6% of the time**
  - ***t*(24)=3.89, *p*<.001**

- **No significant difference in overall RTs, although tendency for AWS to be slower**
  - **AWS: 1.19 seconds per word; AWDNS: 1.04 sec, *t*(24)=1.75, *p*>.10**

- **This accuracy difference suggests that AWS were having difficulty accessing the words, not simply difficulty in producing them.**

Results, Word Frequency

- **Overall effect: slower reaction times & more errors to low-frequency words** ***(RTs 1.099 vs 1.037 sec, F(1,24)=18.11 p<.0005; errors*** **5.60% vs. 2.53%, *F*(1,24)=14.05, *p*=.001**
- **Significant interaction between word frequency and group on RTs, with AWS showing a larger effect of word frequency than AWDNS** ***(F(1,24)=4.6 p=.04)***
  - **For AWS, RTs were 1.187 and 1.094 sec**
  - **For AWDNS, RTs were 1.011 and .979 sec.**
- **No interaction on accuracy** ***(F(1,24)=1.77 p>.19)*** **although the thrend is in the same direction**
  - **for AWS, error rates were 7.75% vs. 3.43 %**
  - **For AWDNS, error rates were 3.44 vs. 1.63%**

- This suggests that AWS appear to be relatively disadvantaged in accessing low frequency words.

Results, Word Frequency, Stuttering

- As has been reported in previous studies *(e.g., Hubbard & Prins, 1994; Soderberg, 1966),* AWS were more likely to stutter on low frequency words than on high frequency words.
  - **They averaged 2.5 episodes of stuttering on the low-frequency words, but only 1.5 episodes on the high-frequency words, a significant difference ($t(24)=3.11$, $p<.005$, 2=.29).**
- **However, no other factors affected fluency in AWS.**

Results, Neighborhood Density

- **RTs showed no effect of group *(F(1,24)=1.96, p>.10,),* or of neighborhood *(F <1),* and no interaction *(F (1,24) = 2.92 p >.1).***
- **Neighborhoods *did* influence accuracy.**
  - **More errors on words from sparse (6%) than dense (3.3%), *F(1,24)=7.59, p<.05.***
  - **There was also a significant effect of group *(F(1,24)=10.25, p<.005),* with poorer accuracy for AWS (6.57% vs. 2.75%) but no interaction between these two factors *(F<1).***
- **Neighborhood values did not appear to effect the frequency of stuttering episodes, with averages of 2.12 stuttering occurrences on the words from both low-density and high-density neighborhoods.**

Results, Neighborhood Frequency

- RTs showed a significant effect of neighborhood frequency.
  - Participants had faster RTs for words with common sound patterns (high neighborhood frequency) (1.066 vs 1.00 sec, $F(1,24)=39.08$ $p<.0001$)
- There was a marginal effect of group, with slower responding in AWS *($F(1,24)=2.96$, $p<.10$),* but no interaction *($F<1$).*
- Accuracy data showed the same pattern.
  - More errors on items with rare sound patterns (4.00 vs. 1.39%, $F(1,24)=15.51$, $p<.001$).
  - Marginal effect of group ($F(1,24)=3.14$, $p<.10$), and no interaction ($F(1,24)=1.56$, $p>.05$).
- Neighborhood frequency did not appear to affect the frequency of stuttering episodes.
  - Averages of 2.32 vs. 2.20 stuttering occurrences, $t(24)=0.43$, $p>.05$.

Discussion: Adult responses

- We found effects of lexical neighborhood, neighborhood frequency and word frequency in response latency patterns of both fluent and stuttering participants.

- The size of neighborhood effects was fairly comparable across groups, suggesting no basic differences in lexical organization between people who stutter and those who do not.
  - However, AWS showed greater effects of word frequency

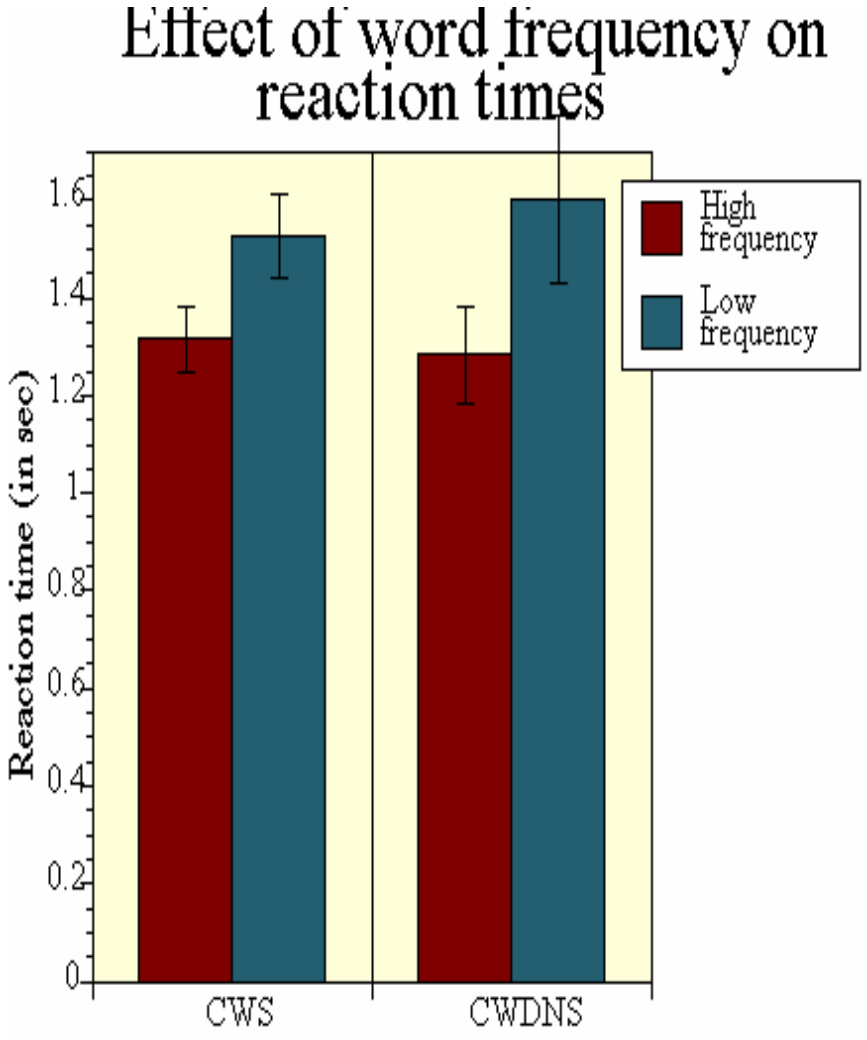
- However, even for very simple stimuli, people who stutter made more naming errors, suggesting a basic difference between groups in a basic level of language processing.
  - E.g., calling the swan “bird” or “goose”, the spider “bug”, the rake “broom”

Current Child Study

- 11 Children who stutter and 11 CWDNS
- Matched for age (within 3 months), gender, and PPVT (within 15 points)
  - Age ranges from 6 yr. 4 mo. to 16 yr. 2 mo.
  - 9 m, 2 f in each group
  - Avg. PPVT in CWS of 118, in CWDNS of 115

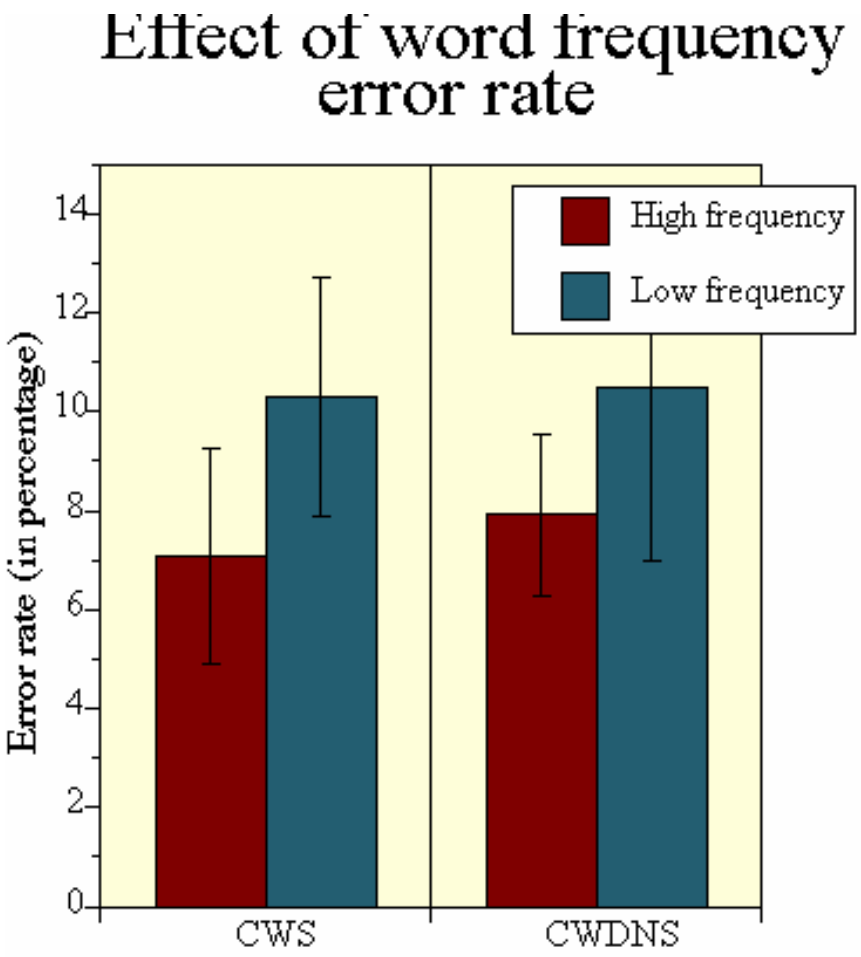
Results, word frequency & RTs

- The reaction time data show a strong effect of word frequency ($F(1,10)=13.74$, $p<.005$),
  - but no interaction with group ($F<1$).



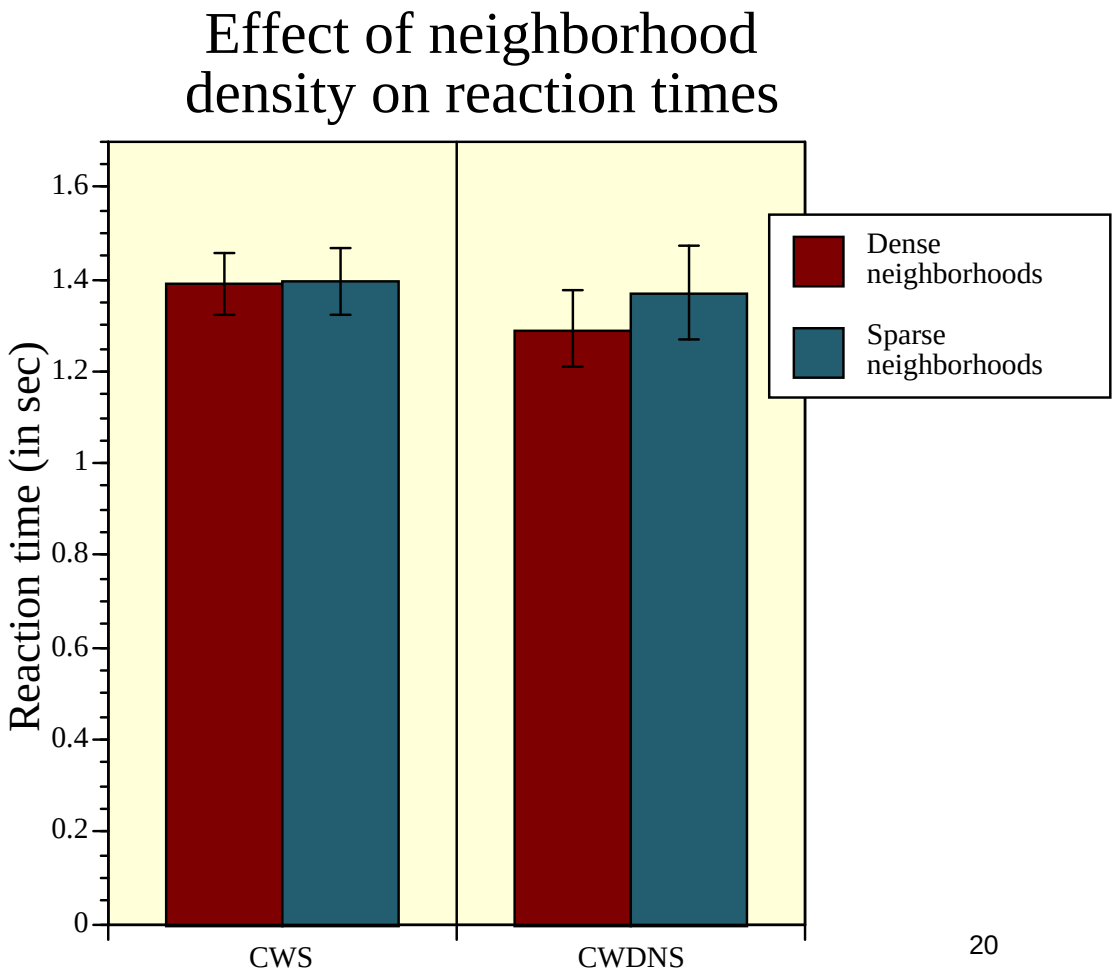
Results, word frequency, acc.

- Although no effects are significant, we see the same pattern as with adults - greater accuracy with high frequency words for both groups.
- The accuracy data show no significant effects, but the trend is in the same direction as the RT data (F(1,10)=1.53, P>.20)



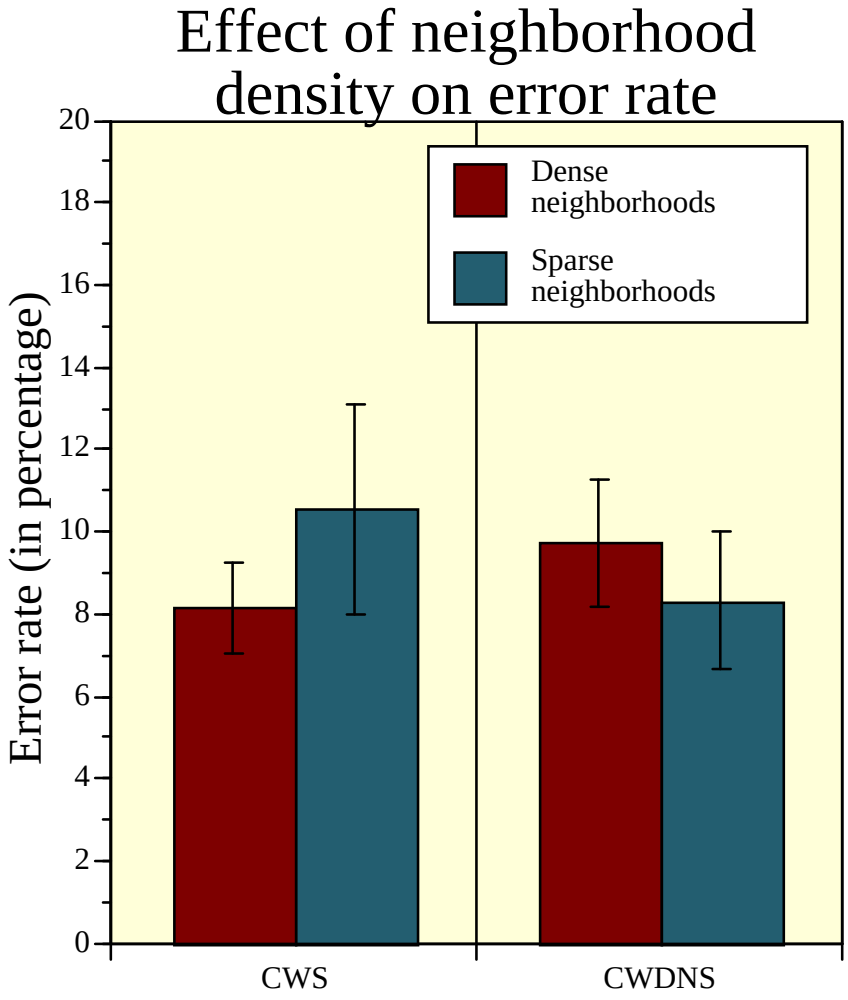
Neighborhood density, RTs

- As with the adults, the reaction times show no effects of density, nor any interaction with group.



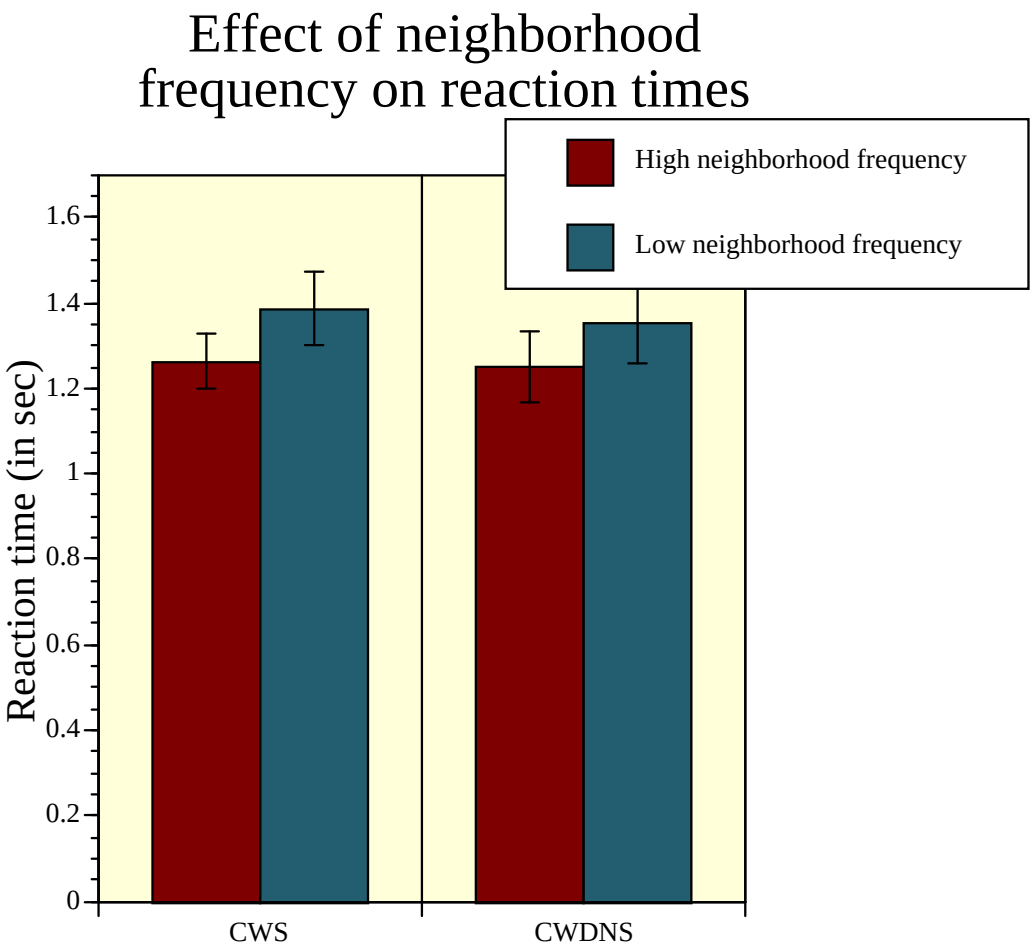
Neighborhood density, accuracy

- The error rate likewise shows no effect of neighborhood density.



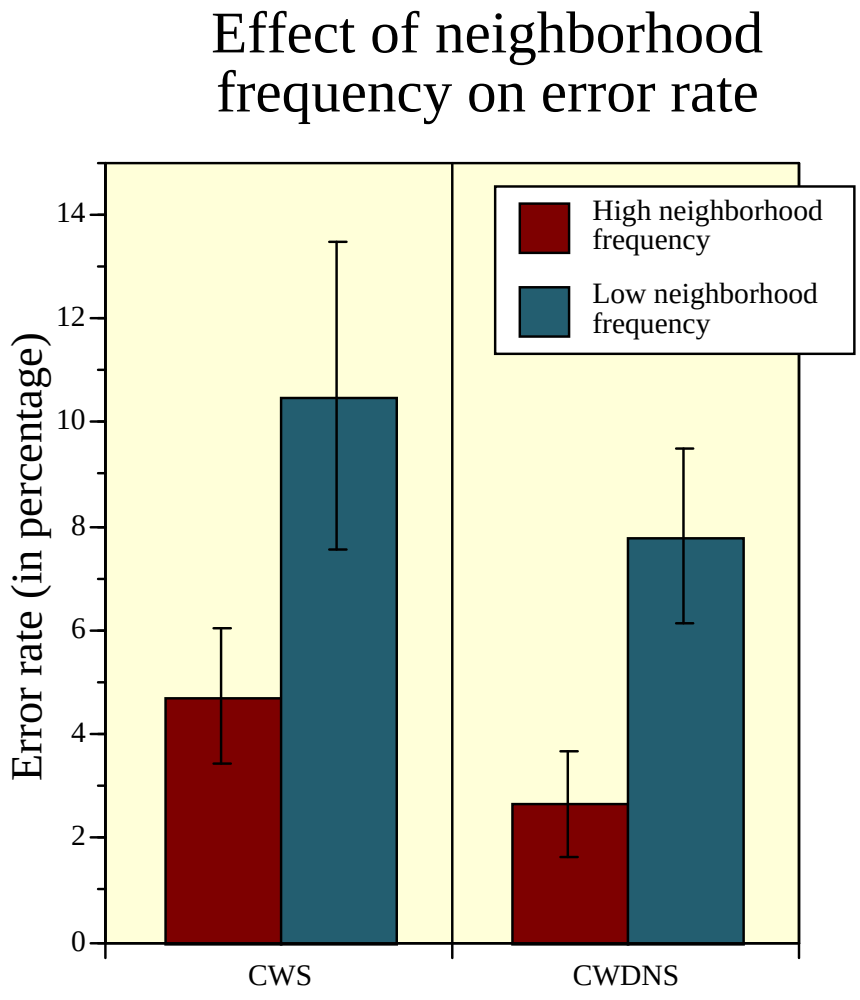
Neighborhood frequency, RTs

- The RT data shows a strong effect of neighborhood frequency ($F(1,10)=6.96$, $p<.05$), but this is similar in both CWS and CWDNS, with both groups responding faster to items with high neighborhood frequency.



Neighborhood frequency, acc.

- The accuracy data shows a similar pattern: A strong overall effect of neighborhood frequency ($F(1,10)=12.73$, $p<.01$) but no interaction ($F<1$)
- CWDNS show the same pattern as CWS, with more errors on items with low neighborhood frequency.



Conclusions, Child study

- But as of now, it looks like children who stutter show similar patterns to children who do not.
- The fact that they stutter does not seem to have implications for lexical access.

Conclusions

- AWS made more word-finding errors in general, but the pattern of errors they make seems to be the same as for AWDNS.
- Likewise, CWS and CWDNS made similar errors, and there was no profile of increased errors for the CWS.
- This suggests that the problems faced by individuals who stutter are unlikely to be at the stage of accessing word ***forms***.
- Rather, any linguistic problems they experience may be further back in the system, perhaps at the lemma level of representation and access, or at levels of syntactic representation (Levelt, 1989).

- **Future research should focus on these earlier stages of processing.**
  - **References for citations in this poster are available on request.**