

Inhibitory Control in Children who Stutter

Kurt Eggers [a,b], Luc F. De Nil [a,c], and Bea R. H. Van den Bergh [d]

[a] Faculty of Medicine, Dept Neurosciences, ExpORL, University of Leuven, Belgium. [b] Dept. Speech-Language Therapy and Audiology, Lessius University College, Belgium.
[c] Graduate Dept. of Speech-Language Pathology, University of Toronto, Canada. [d] Dept. of Developmental & Clinical Psychology, Tilburg University, The Netherlands.

KATHOLIEKE UNIVERSITEIT LEUVEN

Empowered by Lessius

1. Introduction

- Inhibitory control (IC), as described by Rothbart (1989), is the capacity to plan and to suppress inappropriate approach responses under instructions or in novel or uncertain situations.
- IC forms an integral part of Rothbart's model of temperament, which she defines as 'constitutional differences in reactivity and self-regulation'. Reactivity refers to motor, emotional, and attentional responses to internal and external stimuli. Self-regulation are those processes serving to modulate this reactivity (e.g. Approach/Withdrawal, Inhibitory control, and Attention). Temperamental concepts are being used to explain behavioral and physiological patterns and responses that are evoked under conditions of stress (e.g. novelty situations, unfamiliar persons).
- Using the Children's Behavior Questionnaire (CBQ) (Rothbart, et al., 2001) we found differences in IC between CWS and CWNS (Eggers, et al., 2009 & submitted) (Figure 1).
- IC plays a significant role in determining how various mental processes work together in the successful performance of a task (Dowesett & Livesey, 1999) and is strongly related to the conscious use of attention (Kochanska, '97).
- According to Barkley (1997) response inhibition refers to three interrelated processes: a) inhibition of a prepotent respons, b) stopping of an ongoing response, and c) protection of self-directed responses from competing events or interference.

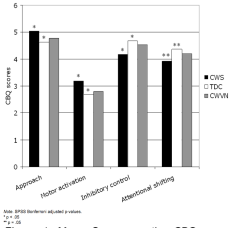

Figure 1. Mean Scores on the CBQ Scales with Significant Between-Group Differences for CWS, TDC, and CWVN.

2. Aim of the study

- To examine whether previously found questionnaire-based differences on IC can be corroborated by direct, behavioral, neuropsychological computer tasks.

3. Participants

- 60 children (48 boys and 12 girls): 30 CWS (4;10 – 10.00; mean = 7;05) and 30 age (± 3M) and gender-matched CWNS (4.10 – 9;11; mean = 7;05); all native Flemish speakers, with no known/reported neurological, psychological, developmental problems, and normal or corrected to normal vision.
- Subtest Vocabulary & Block Design of the WISC-R (Vander Steene et al., 1986).
- Subtests Vocabulary & Sentence Production of the Language Test for Children (van Bon & Hoekstra, 1982)>Pc16.
- Articulation (ASIA-5; Stes & Elen, 1992) & hearing screening (Accuscreen; Wood, 2003).
- Socio-economic status based on the educational level of both parents.
- Diagnosis CWS: min. 3 % WWD and/or MWR, and at least 'mild' on the SSI-3, based on a sample of min.300W collected during two free play situations.

4. Procedure

- Participants were all paid volunteers, recruited after initial contact with their fluency specialist (for the CWS) or through their schools (for the CWNS). All tests were conducted in a quiet setting at the home of the participant during one or two visits by the first author, a qualified fluency specialist.



Figure 2. Go- and nogo-target of the ANT gonogo-task.

- Gonogo-task (De Sonneville, 2005): go-stimulus (50%): children need to press the button as soon as possible, nogo-stimulus (50%): tendency to press must be inhibited. (signal duration: fixed, 800ms., valid response: 200-2300ms., events interval: fixed rate: 2800 ms.; 8 practice sessions & 48 trials) (Figure 2).

5. Results

- Independent-samples t-tests were employed to evaluate possible differences on chronological age, SES, IQ-score, and a simple reaction time task. No significant between-group differences were found ($p > .05$).
- A MANOVA was used to test whether the two groups differed in gonogo-task-variables. Participant group was the independent variable. The four dependent variables were: number of hits, misses, false alarms, and premature responses. The overall MANOVA was significant, F (3, 56) = 4.89, $p < .005$. Tests of between-subjects effects were significant for number of false alarms, F (1, 58) = 6.27, $p < .05$, and number of premature responses, F (1, 58) = 8.57, p < .005 (Figure 3).

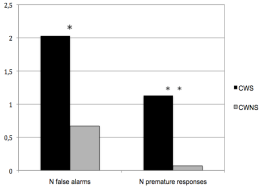

Figure 3. Mean Scores on gonogo-variables with Significant Between-Group Differences for CWS and CWNS.

- Mean reaction time for false alarms almost approached significance, t (44) = -1.99, p = .53.

6. Conclusions

- CWS exhibited a less controlled response style, with more frequent reactions to nogo-signals and more premature responses. This is compliant with our earlier CBQ-based findings on IC in CWS.
- Classically, IC was assumed to be triggered by nogo-signals; recent studies however link the go-signal to the release of IC. Inhibition may act proactively during pre-stimulus period, ending with the arrival & identification of a go-signal. Several cortical areas play a modulating role in this proactive inhibition, with the major focus on the subthalamic nucleus (Ballanger, et al., 2009).
- (Low) IC could increase the amount of stress-related situations that CWS encounter. IC could also play a role in linguistic processing, moderating error-detection or error-processing (e.g., Vasic & Wijnen, 2006).
- Clinical considerations are premature since further research is still needed. This may provide additional information on spontaneous recovery and on treatment outcome.

7. Acknowledgements

- This research was funded by Lessius University College. The authors would like to thank all the families, schools and fluency specialists who participated in this study and students Julie Germanes and Sophie Sambre for their assistance.

8. References

- Ballanger, B., van Eimeren, T., Moro, E., Lozano, A. M., Hamani, C., Boulinguez, P., Pellechia, G., Houle, S., Poon, Y. Y., Lang, A. E., and Strafella, A. (2009). Release your horses: Deep Brain Stimulation of the subthalamic nucleus improves motor functions at the expense of response inhibition. A H215O PET study. NeuroImage, 47, S39-S41. Barkley, R. A. (1997). Behavioral inhibition, sustained attention, and executive functions: constructing a unified theory of ADHD. *Psychological Bulleting*, 121, 65-94.
- De Sonneville, L. (2005). Amsterdamse Neuropsychologische Taken: Wetenschappelijke en klinische toepassingen. [Amsterdam Neuropsychological tasks: scientific an clinical applications]. *Tijdschrift voor neuropsychologie*, 0, 27-41.
- Dowsett, S. M., & Livesey, D. J. (1999). The development of inhibitory control in preschool children: Effects of "executive skills" training. *Developmental Psychobiology*, 36, 161-174.
- Eggers, K., De Nil, L. F., & van Den Bergh, B. R. H. (2009). Factorial temperament structure of stuttering, voice disordered, and normal speaking children. Journal of Speech, Language, and Hearing Research. In press.
- Eggers, K., De Nil, L. F., & van Den Bergh, B. R. H. (Submitted). Temperament dimensions of stuttering, voice disordered, and normal speaking children.
- Kochanska, G. (1997). Multiple pathways to conscience for children with different temperaments: From toddlerhood to age 5. *Developmental Psychology*, 3, 228-240.
- Rothbart M. K., Ahadi S. A., Hershey K. L. & Fisher P. (2001). Investigation of temperament at three to seven years: The Children's Behavior Questionnaire. Child Development, 72, 1394-1408.
- Rothbart, M. K. (1989). Temperament and development. In G. Kohnstamm, J. Bates, & M. K. Rothbart (Eds.), Temperament in childhood (pp. 187-248). Chichester, England: Wiley.
- Stes, R., & Elen, R. (1992). Antwerps Screenings Instrument voor Articulatie: vijfjarigen. [Antwerp Screening Instrument for Articulation]. Herentals: Vlaamse Vereniging voor Logopedisten.
- Vander Steene, G., van Haassen, P. P., De Bruyn, E. E. J., Coetsier, P., Pijl, Y. J., Poortinga, Y. H., Spelberg, H. C., & Stinissen, J. (1986). Wechsler Intelligence Scale for Children-Revised. Nederlandse uitgave: Verantwoording. Lisse: Swets & Zeitlinger.
- Van Bon, W. H. J., & Hoekstra, W. G. (1982). Taaltests voor kinderen. Lisse: Swets & Zeitlinger.
- Vasic, N., & Wijnen, F. (2005). Stuttering as a monitoring deficit. In R. J. Hartsuiker, R. Bastiaanse, A. Postma, & F. Wijnen, (Eds.), Phonological encoding and monitoring in normal and pathological speech. Hove (East Sussex): Psychology Press.
- Wood, S. (2003). Otoacoustic emissions and automated ADR screener. Denmark: GN Autometrics a/s.

Contact: kurt.eggers@lessius.eu