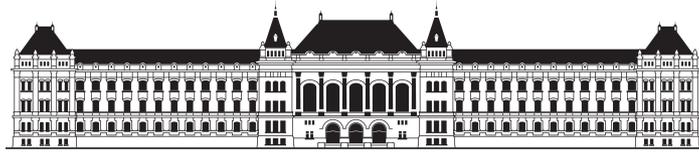


Budapest University of Technology and Economics

PhD School in Psychology – Cognitive Science



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**Cognitive control and its contribution to language difficulties in
children with Specific Language Impairment**

Thesis booklet

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Introduction

First language acquisition is an easy and automatic process for most children. There are some children, however, whose language acquisition is slower and they show difficulties in different aspects of language production and comprehension without obvious reasons like hearing impairment, neurological problem or intellectual disability. The literature refers to these children as children with specific impairment (SLI; e.g., Leonard 1998/2014). Children with SLI show primarily language problems (e.g., problems in morphosyntactic acquisition and later in sentence production and comprehension, as well as in word learning and in the retrieval of already acquired words) but several studies suggest that impairments are also present in other, nonlinguistic domains (e.g., Gathercole & Baddeley, 1990: short-term memory, Montgomery & Evans, 2009: working memory, Tallal & Piercy, 1973; Leonard, 1998: processing of rapidly changing or less salient verbal information, Ullman & Pierpont, 2005: implicit learning) as well. Recent studies suggest that the impairment of cognitive control – the ability to resolve conflict between contradicting representations (Novick, Trueswell, & Thompson-Schill, 2005, 2010, Miller & Cohen, 2001) – is also associated with SLI (e.g., Evans & Pollack, 2011, Im-Bolter, Johnson, & Pascual-Leone, 2006, Henry, Messer, & Nash, 2012) while other studies did not find a group difference in this domain (e.g., Archibald & Gathercole, 2006, Reichenbach, Bastian, Rohrbach, Gross & Sarrar, 2016). It is also not clear whether the impairment of non-linguistic abilities contributes to language problems or they co-occur.

Cognitive control might be necessary for language processes when multiple contradicting representations are activated. In the dissertation the contribution of cognitive control to word retrieval (*Thesis points 3 and 5*) and sentence

comprehension, more specifically to the comprehension of sentences with anaphors (*Thesis point 4*) – will be investigated.

The aim of the dissertation is to find out whether cognitive control is impaired in children with SLI (*Thesis points 1, 2, 4, 5*) on the one hand and to explore whether the impairment of cognitive control contributes to language problems (*Thesis points 3, 4, 5*). To answer these questions, we tested cognitive control and language abilities in tasks which potentially require cognitive control in children with SLI and in TD children.

The topic has a clinical relevance and a theoretical importance as well. On the clinical side, if our research and further studies will find that the impairment of cognitive control contributes to language problems in children with SLI, then training of cognitive control should be included in the speech therapy of children with SLI. From a theoretical perspective our research could also contribute to our knowledge about the role of cognitive control to language processes in general. If both cognitive control and language functions are weaker in SLI than in TD children and performance on the two domains are related to each other, that would suggest that cognitive control plays a role in language processes.

The four studies presented in the dissertation test three hypotheses.

1) First, we hypothesized that cognitive control abilities are weaker in children with specific language impairment than in typically developing peers (see our results related to this hypothesis in *Thesis points 1* and *2*)

2) Our second hypothesis was that children with SLI show more pronounced difficulties in those conditions of the language tasks that potentially require cognitive control (see results related to this hypothesis in *Thesis 3, 4* and *5*).

3) According to our third hypothesis, performance on cognitive control tasks and language tasks which potentially require cognitive control will be associated with each other (see results related to this hypothesis in *Thesis 4* and *5*).

Thesis 1. Children with SLI show impairments on some, but not all cognitive control tasks.

Study 1 measured performance of children with SLI and TD children on verbal and non-verbal versions of four cognitive control tasks (listening span task, odd-one out task, verbal and nonverbal n-back task, verbal and nonverbal Stroop task and verbal and nonverbal fluency task). A significantly weaker performance appeared on the listening span and verbal fluency tasks suggesting weaker cognitive control in children with SLI than in TD children.

Study 3 and *Study 4* assessed performance on three out of the eight paradigms above – backward digit span, n-back task, Stroop task –, and found a weaker performance in the SLI group than in TD children on the backward digit span and the n-back tasks.

Publications related to these this point:

Lukács Á, Ladányi E, Fazekas K, & Kemény F (2016). Executive functions and the contribution of short-term memory span in children with specific language impairment. *Neuropsychology* 30(3), 296-303.

Ladányi E., Kas B., & Lukács Á. (2017). The role of cognitive control in anaphor resolution in children with specific language impairment. *Applied Psycholinguistics* 38, 1173–1199.

Ladányi E., Fazekas K., Kemény F., & Lukács Á. (2014). Lexical deficits, working memory and cognitive control in Specific Language Impairment. *Learning and Perception, Supplement*, 60.

Ladányi E., & Lukács Á. (under revision in JSLHR). Cognitive control impairment and its contribution to word production difficulties in specific language impairment.

Thesis 2. Weaker performance on some of the cognitive control tasks is accounted for by weaker verbal short-term storage capacity in children with SLI while the group difference is present even after accounting for weaker short-term storage capacity in other cognitive control tasks.

In *Study 1 and Study 4* the role of verbal short-term memory was investigated in cognitive control impairments of children with SLI. In *Study 1* performance differences on the listening span and verbal fluency tasks disappeared when simple verbal span was included as a covariate. These results suggest that cognitive control is intact in children with SLI, while short term memory is impaired leading to weaker performance on cognitive control tasks. In contrast, in *Study 4* children with SLI showed a weaker performance on the backward digit span and n-back task even after accounting for their weaker short-term memory capacity.

Publications related to this thesis point:

Lukács Á, Ladányi E, Fazekas K, & Kemény F (2016). Executive functions and the contribution of short-term memory span in children with specific language impairment. *Neuropsychology* 30(3), 296-303.

Ladányi E., Fazekas K., Kemény F., & Lukács Á. (2014). Lexical deficits, working memory and cognitive control in Specific Language Impairment. *Learning and Perception, Supplement*, 60.

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Thesis 3. Children with SLI are generally slower in naming pictures but they resolve conflict as successfully as their TD peers during word retrieval.

In *Study 2*, a picture naming task was created in which we manipulated the level of

conflict 1) by presenting pictures in a semantically homogeneous vs. semantically mixed context 2) by presenting pictures with low name agreement – i.e. pictures which may be named with more than one name (e.g.: a picture of a sofa) – vs. pictures with high name agreement – for which a single dominant name exists (e.g., a picture of an apple). The naming of pictures presented in a homogeneous context and of those with low name agreement is assumed to require conflict resolution for inhibiting already named semantically similar words in the first case and other possible names of the picture in the second case. Conflict resolution is expected to manifest in longer reaction times relative to the low conflict condition. Our results showed that 1) for children with SLI it generally took longer to name the pictures and 2) both the SLI and the TD group needed more time to produce the names of pictures with high conflict than that of low conflict 3) but the difference was not bigger in the case of the SLI group than in the TD group. These results suggest that children with SLI were able to resolve conflict during word production as successfully as TD children.

Publication related to this thesis point:

Ladányi E., Lukács Á. (2016). Lexical Conflict Resolution in Children with Specific Language Impairment. *Journal of Communication Disorders*, 61, 119-130.

Thesis 4. Children with SLI show weaker performance on the comprehension of sentences presumably requiring conflict resolution (comprehension of sentences with an anaphoric expression) than their TD peers and sentence comprehension performance is associated with cognitive control scores in children with SLI.

In *Study 3*, 7-11 year old children with SLI and age-matched TD children completed a sentence-picture verification task with anaphoric expressions and performed an n-back, a backward digit span and a Stroop task. The reference of anaphoric expressions

is not always obvious therefore more than one referents can be activated and the correct interpretation of the sentence might require cognitive control for the resolution of conflict between these alternative referents. If cognitive control is impaired in children with SLI and it is necessary for conflict resolution during the comprehension of anaphoric sentences than children will show a weaker performance on the sentence comprehension task and it will be associated with cognitive control measures.

According to our results children with SLI showed significantly weaker performance on the sentence comprehension task, on the n-back task and on the backward digit span task. Sentence comprehension scores were associated both with the n-back and the backward digit span scores but according to a linear regression analysis the n-back performance alone was the best model of sentence comprehension performance. Neither the backward digit span, nor the non-word repetition span (both measuring verbal short-term storage capacity) contributed to the model meaning that there is a relationship between cognitive control and the comprehension of sentences with anaphors, and this association does not appear due to the shared verbal storage component of the two tasks.

Publication related to this thesis point:

Ladányi E., Kas B., & Lukács Á. (2017). The role of cognitive control in anaphor resolution in children with specific language impairment. *Applied Psycholinguistics* 38, 1173–1199.

Thesis 5. Children with SLI show significantly weaker performance on word production tasks presumably requiring conflict resolution (the letter fluency test and the size-color-shape rapid automatized naming test) than their TD peers and performance on these word production tasks is associated with cognitive control performance in children with SLI and TD children.

In *Study 4*, 7 to 11 years old children with SLI and age-matched TD children performed two word production tasks which might require cognitive control (the fluency task and the rapid automatized naming (RAN) task) and their cognitive control was also assessed with a backward digit span task, an n-back task and a Stroop task. Cognitive control might be recruited for the resolution of conflict between the irrelevant words/already produced words/to be produced words and the target word during the fluency task and between already produced sizes/colors/shapes and the target size/color/shape as well as between lexical units referring to the size, the color and the shape and the current target item (e.g., when the name of the shape is activated instead when the color is the target word). If cognitive control plays a role in conflict resolution during these word production tasks then performance on these tasks would be associated with cognitive control performance. Furthermore, if cognitive control is impaired in children with SLI, than they will show a weaker performance both on the word retrieval tasks and the cognitive control tasks than their TD peers. Children with SLI showed a weaker performance on the n-back and backward digit span tasks relative to the TD group and weaker performances on the backward digit span task were associated with lower letter fluency scores and longer naming times in the RAN task while weaker n-back performance was associated with longer naming times in the RAN task. Performance on both word retrieval tasks was best predicted by the backward digit span and non-word repetition scores which is the measure of short-term memory. Our results support the hypothesis that domain-general cognitive control plays a role in word production under conflict but short-term memory also has an important role.

Publications related to this thesis point:

Ladányi E., Fazekas K., Kemény F., Lukács Á. (2014). Lexical deficits, working memory and

cognitive control in Specific Language Impairment. *Learning and Perception, Supplement*, 60.

Ladányi E., & Lukács Á. (under revision in JSLHR). Cognitive control impairment and its contribution to word production difficulties in specific language impairment.

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