



## ORIGINAL RESEARCH ARTICLE

# Assessing Executive Functions of Turkish-German Bilinguals, Turkish Speaking Children with S/LI and Turkish Speaking Monolingual Children

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## Abstract

Specific language impairment has been found to be associated with dysfunction in executive functions whereas bilingual children are thought to be superior at these skills compared to monolingual children. The present study investigated executive functions in three groups of children: Turkish-German bilinguals, Turkish speaking children with S/LI and Turkish speaking monolingual children. Groups were matched on first language and chronological age. EF performance tapping conflict inhibition/attentional control, inhibition, short term memory, working memory, monitoring and updating were compared among groups. Children with S/LI scored at a lower level compared to other two groups on all executive functions tasks used in this study. Bilingual children outperformed the other groups on most of the tasks measuring working memory and inhibition.

## Keywords

Specific language impairment, Bilingualism, Executive functions, Conflict inhibition, Short term memory, Working memory, Verbal fluency

## Introduction

Specific Language Impairment (S/LI) is a disorder in which language ability is delayed despite having no obvious hearing, cognitive or neurological problems which impede the lexical, morphosyntactic and discourse-pragmatic abilities [1]. Although children with S/LI have non-advantage IQs in the average range, in recent years, there's increasing evidence that they have some executive function difficulties [2,3].

Executive functioning (EF) is used as an umbrella term for mental operations that require the coordination of several sub-processes to achieve a particular goal. These include attention, memory, inhibition, planning, shifting, flexible thinking and verbal fluency [4].

Of these functions, "inhibition" is the most reliably documented dysfunction in children with S/LI [5,6]. Inhibitory control, the ability to suppress the activation, processing or expression of information that interferes with the efficient attainment of a cognitive or behavioral goal, is thought to be the basis of the other EFs and has a strong relationship with language [7-9]. In tasks measuring inhibition, people are asked to suppress a dominant response in order to perform a conflicting action. These tasks can include verbal as well as nonverbal responses.

Verbal fluency, the ability to generate novel verbal responses [10] is another executive function domain which subsequently been established in many independent studies to be a hallmark of S/LI in children [11-14]. Typical examples of verbal fluency are semantic and phonemic fluency tasks. In phonemic fluency tasks, as many words as possible starting with a certain phoneme (eg. /s/) are asked to generate in one minute while words belonging to a certain semantic category (eg. vehicles) are asked in semantic fluency tasks [15]. The fluency tasks are used as an efficient screening instrument of general verbal functioning since it requires one to access mental lexicon, focusing on task, selecting



**Citation:** Uysal AA, Maviş I (2018) Assessing Executive Functions of Turkish-German Bilinguals, Turkish Speaking Children with S/LI and Turkish Speaking Monolingual Children. Int Arch Commun Disord 1:008.

**Received:** January 09, 2018; **Accepted:** April 24, 2018; **Published:** April 26, 2018

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words meeting certain constraints and avoiding repetition [16]. These processes are strongly linked to goal-directed behaviors like flexibility of thoughts, strategic planning and error-monitoring [17].

Consistent findings have emerged in children with S/LI regarding “short term memory” and “working memory” [18-22]. Short term memory is responsible for holding sensory events, movements, and cognitive information like digits, words or other items for a short period of time. In contrast to short term memory, working memory refers to cognitive processes used for both temporarily maintaining and also manipulating information. It is thought to be strongly related with some higher order cognitive abilities like reasoning, problem solving or learning [23]. Typical tasks measuring short term memory and working memory are digitspan tasks. Digitspan Forward is a task of short-term auditory memory, sequencing, and simple verbal expressions [24] while Digitspan Backwards is more sensitive to deficits in working memory. Children with S/LI are reported to perform poorly on both measures of Digitspan Forward and Digitspan Backwards [25-28]. However, discussions continue about whether working memory deficits in S/LI are specific to processing, manipulation, and storage of information from the verbal domain [29] or the result of a “generalized slowing” across linguistic and nonlinguistic tasks alike [21,30].

Bilingual children with TD or S/LI? also show similar difficulties in the early stages of acquisition of language to monolingual children with S/LI [31-34]. After achieving proficiency in two languages, bilinguals show cognitive gains compared with monolinguals and children with S/LI on tasks requiring executive functions [35-38]. Numerous reasons are proposed for bilingual children’s superiority on tasks requiring executive functions. Of these, dual-language management has received the most attention [37,38]. Research conducted by Carlson and Meltzoff (2008) revealed an increased ability on tasks of working memory and attention shifting among bilingual children compared to monolinguals and early second language learners. Another research by Poarch and van Hell (2012) [39] has also indicated increased attention and inhibition abilities among bilinguals. The authors explain their findings by asserting that bilingual children constantly need to choose one lexeme and inhibit the other activated one. However, Costa and colleagues (2009) [37] claim that bilingualism enhances executive functions not only through choosing appropriate lexemes but also with monitoring of which language

to use in different social and communicative practices.

Thus, the aim of this study was to examine whether Turkish monolingual children with S/LI and Turkish-German bilinguals? with TD display a unique profile of neuropsychological and executive functioning compared to their age and gender matched peers with typical development on a variety of executive tasks tapping both verbal and nonverbal domains. The specific research questions to be addressed by the study were:

1. Do monolingual Turkish speaking children with S/LI between 5-6 years of age exhibit impairments on executive tasks assessing conflict inhibition, short term memory, working memory and verbal fluency?
2. Do Turkish-German bilingual children between 5-6 years of age display cognitive advantages compared to their age and gender matched Turkish speaking monolingual peers with typical development on executive tasks assessing conflict inhibition, short term memory, working memory and verbal fluency?

## Method

### Participants

Three groups of subjects participated in the present study; Turkish speaking monolingual children with S/LI (n = 14), Turkish-German bilinguals (n = 14), and a control group of? monolingual children with typical development (n = 14). There were 8 males and 6 females in each group. The mean ages of the groups were as follows: children with S/LI, 5 years; 9 months (SD = 8.5 months, R = 60-83 months), bilingual children, 5 years; 10 months (SD = 8.2 months, R = 60-83 months) and children with typical development, 6 years 1 month (SD = 8 months, R = 60-83 months) (Table 1).

The S/LI group was recruited from Anadolu University Speech and Language Therapy Center units with the help of speech and language therapists (SLTs) and psychologists. Based on criteria used to identify S/LI [1] children with normal hearing (hearing deficit below 25 dB), and normal nonverbal IQ (IQ above 85 on Leiter) were included. Language abilities of children with S/LI were at least 12 months below their chronological age as measured by a standardized language test in Turkish (TEDiL) [40] and no participants had diagnosis of neurological impairments or behavioral problems.

The bilingual children were fluent speakers of Turkish and German recruited from monolingual German-speaking schools in Berlin, Germany. L1 of all chil-

**Table 1:** Demographics of participants.

Groups	Gender		Age (months)			
	Girls	Boys	M	SS	Min. - Max.	
Monolingual Children with Typical Development	6	8	73.7	8	60	83
Turkish-German Bilingual Children	6	8	69.9	8.5	60	83
Children with SLI	6	8	70.9	8.2	60	83
Total	18	24	69	7.3	60	83

dren was Turkish and they were all exposed to German since they were 3-years-old. Parents of the bilingual children indicated that although Turkish was the main language spoken at the home; they have been exposed to both languages while watching TV or interacting with their siblings. Informed consents were taken from all of the parents of the participants before the study.

## Measures

In the study, two tasks for conflict inhibition, two for digit memory and two for verbal fluency were administered. Stroop-like Day and Night Test (verbal) and Luria's Hand Game (nonverbal) measure conflict inhibition, Digitspan Forward and Digitspan Backward measure short term memory and working memory respectively. Verbal fluency tasks refer to the ability to recall and produce words by two semantic (animals, girls' & boys' names) and two phonemic (/k/ /b/) measures in this study.

### Stroop-like day-night test

Day and Night task is a conflict inhibition task in which children have to suppress a dominant response associated with a perceptual stimulus while selecting and executing a competing, conflicting subdominant response, coordinating a goal-directed behavior [41].

The Day and Night test begins with some practice sets. Cards with cartoon drawings presenting the sun or the moon are shown to children. Examiners ask children to say the opposite of what a picture depicts. After a maximum of three practice sets, sixteen responses are coded, and no feedback is given during testing. The number of correct responses is summed to obtain the total score.

### Luria's hand game

Initially children are trained to imitate two different hand gestures by the experimenter (a fist and a pointed finger) [42]. After gaining competency on this, the child is asked to make the opposite gesture made by the experimenter. After completing six practice trials, a total of fifteen trials are completed and the number of correct gestures is the score obtained from the task.

### Digitspan forward

The Digit Span Forward task required children to recall and repeat verbatim a series of numbers presented

by the examiner after a two-digit practice trial with corrective feedback [43,44]. The first span included 2 digits, the following one included one more digit and the last span included 6 digits. The test was ended in case participants could not repeat correctly on both trials of a single string length. The subject's score was equal to the maximum of digits repeated correctly.

### Digitspan backwards

The Digit Span Backward test is similar to The Digit Span Forward test [43,44]. However, children are required to repeat the digit spans in a reverse order. The subject has two trials for each span and the number of correct digits repeated without any error in one of two trials is summed.

### Phonemic/Letter fluency

Children are required to generate words that begin with a "designated" letter as quickly as possible in 60 second time limit for each phoneme [45]. In this study, words starting with /b/ and /k/ are asked to be generated.

### Semantic/Category fluency

In the semantic fluency condition, children are asked to generate as many different items as possible with the designated semantic verbal fluency category cues of "animals", "names of girls/boys" [46].

Children were tested individually at school or clinic and all tasks were presented in a fixed order in two separate sessions. Both sessions lasted approximately 30 minutes each and included a 15 minutes break halfway through.

## Results

Table 2 shows the means and standard deviations of the eight executive tasks' scores elicited from the three participant groups. To investigate group differences, one-way analysis of variance (ANOVA) was performed on each test (Table 3).

### Conflict inhibition in monolingual, bilingual and children with specific language impairment

Comparison of the verbal conflict inhibition performance (Day and Night Test) across all the three study groups did not show statistically significant differences ( $F(2, 39) = 0.917, p = 0.05$ ). However, there was statis-

**Table 2:** Mean scores (and standard deviations) of groups on the executive tests.

Tasks	Monolingual Children	Children with SLI	Bilingual Children
Day and Night Task	13.92 ( $\pm 0.37$ )	13.35 ( $\pm 0.46$ )	14.07 ( $\pm 0.33$ )
Luria's Hand Task	12.78 ( $\pm 0.26$ )	10.92 ( $\pm 0.28$ )	12.85 ( $\pm 0.25$ )
Forward Digit Span Task	7.00 ( $\pm 0.46$ )	3.78 ( $\pm 0.33$ )	5.71 ( $\pm 0.50$ )
Backward Digit Span Task	2.28 ( $\pm 0.42$ )	2.00 ( $\pm 0.39$ )	4.85 ( $\pm 0.44$ )
Phonemic Fluency/k/	5.21 ( $\pm 0.45$ )	2.28 ( $\pm 0.42$ )	4.85 ( $\pm 0.45$ )
Phonemic Fluency/b/	3.14 ( $\pm 0.46$ )	1.28 ( $\pm 0.26$ )	2.85 ( $\pm 0.45$ )
Semantic Fluency (Animals)	9.57 ( $\pm 1.17$ )	5.35 ( $\pm 1.10$ )	7.35 ( $\pm 0.78$ )
Semantic Fluency (Girls/Boys names)	8.42 ( $\pm 0.69$ )	3.35 ( $\pm 0.65$ )	5.57 ( $\pm 0.85$ )

**Table 3:** ANOVA results of the groups on executive tasks.

Test	Source of Variance	Sum of Squares	df	Mean Square	F	p	Multiple Comparisons
Day and Night	Between Groups	4	2	2		0.13	1 ≈ 2 ≈ 3
	Within Groups	85.07	39	2.18	0.917		
	Total	89.07	41				
Luria's Hand Game	Between Groups	33.47	2	16.73		0.5	1 < 2 ≈ 3
	Within Groups	39	39	1	16.738		
	Total	72.47	41				
Digitspan Forward	Between Groups	73.28	2	36.64		0	1 < 2 ≈ 3
	Within Groups	107.21	39	2.74	13.329		
	Total	180.5	41				
Digitspan Backwards	Between Groups	69.33	2	34.66		0	3 > 1 ≈ 2
	Within Groups	96.57	39	2.47	14		
	Total	165.9	41				
Phonemic Fluency (/k/)	Between Groups	71.47	2	35.73	12.795	0.5	1 < 2 ≈ 3
	Within Groups	108.92	39	2.79			
	Total	180.4	41				
Phonemic Fluency (/b/)	Between Groups	28	2	14		0	1 < 2 ≈ 3
	Within Groups	90.28	39	2.31	6.047		
	Total	118.28	41				
Semantic Fluency (Animals)	Between Groups	124.42	2	62.21		0	2 > 3 ≈ 2
	Within Groups	585.85	39	15.02	4.142		
	Total	710.28	41				
Semantic Fluency (The Names of Girls/Boys)	Between Groups	181	2	90.5		0	2 > 1 ≈ 3
	Within Groups	298.07	39	7.64	11.841		
	Total	479.07	41				

1 = Children with SLI; 2 = Monolingual Turkish speaking children with typical development; 3 = Turkish-German bilingual children with typical development.

tically significant differences between groups in terms of nonverbal conflict inhibition task determined by Fist and Finger Test ( $F(2, 39) = 16.738, p = 0.001$ ). A Tukey post-hoc test revealed that the performance of children with S/LI ( $10.9 \pm 0.28$ ) was significantly lower than children with TD ( $12.78 \pm 0.26, p = 0.001$ ) as well as bilingual children ( $12.85 \pm 0.50, p = 0.25$  this is not significant). The comparison of children with TD and bilingual groups showed no significant differences in this respect ( $p = 0.981$ ).

### Short term memory and working memory in monolingual, bilingual and children with specific language impairment

There was a statistically significant difference between groups in terms of short term memory determined by one-way ANOVA ( $F(2, 39) = 13.32, p = 0.001$ ). The Digitspan Forward performance of the group with S/LI ( $3.7 \pm 0.33$ ) was statistically significantly lower than the TD group ( $7.00 \pm 0.46, p = 0.001$ ) and bilingual group ( $5.7 \pm 0.50, p = 0.010$ ). There was no statistically significant difference between the TD and bilingual children ( $p = 0.113$ ).

There were also statistically significant differences between groups in terms of working memory as determined by one-way ANOVA ( $F(2, 39) = 14.00, p = 0.001$ ). The Digitspan Backwards performance of the bilingual

group ( $4.8 \pm 0.44$ ,) was statistically significantly higher than the S/LI group ( $2.00 \pm 0.39, p = 0.001$ ) and TD group ( $2.2 \pm 0.42, p = 0.001$ ). There was no statistically significant difference between the TD and S/LI group ( $p = 0.881$ ).

### Semantic and phonemic fluency in monolingual, bilingual and children with specific language impairment

The difference between groups was significant with regard to Phonemic Fluency Task (i.e. /k/) ( $F(2, 39) = 12.79, p = 0.001$ ) as determined by one-way ANOVA. Tukey post-hoc test showed that the performance of S/LI group was ( $2.2 \pm 0.42$ ) significantly lower than the TD group ( $5.2 \pm 0.45, p = 0.001$ ) and the bilingual group ( $4.8 \pm 0.45, p = 0.001$ ). There was no statistically significant difference between the TD and the bilingual group ( $p = 0.839$ ).

There was a statistically significant difference between groups as determined by one-way ANOVA in terms of Phonemic Fluency (i.e. /b/) ( $F(2, 39) = 6.047, p = 0.005$ ). The performance of S/LI group was ( $1.2 \pm 0.26$ ) significantly lower than the TD group ( $3.1 \pm 0.46, p = 0.007$ ) and bilingual group ( $2.8 \pm 0.45, p = 0.025$ ). There was no statistically significant difference between the TD and bilingual group ( $p = 0.839$ ).

The difference between groups determined by one-

way ANOVA in terms of Semantic Fluency (i.e. animals) ( $F(2, 39) = 4.14, p = 0.023$ ) was significant. The performance of TD group was ( $9.5 \pm 1.1$ ) significantly higher than the children with S/LI ( $5.35 \pm 1.1, p = 0.017$ ). There were no statistically significant differences between the S/LI and bilingual groups ( $p = 0.369$ ) or bilingual and the TD group ( $p = 0.297$ ).

There was also statistically significant difference between groups as determined by one-way ANOVA test in terms of Semantic Fluency (i.e. girls/boys names) ( $F(2, 39) = 11.84, p = 0.001$ ). The performance of TD group ( $8.4 \pm 0.69, p = 0.001$ ) was significantly higher than the S/LI group ( $3.3 \pm 0.65$ ) and bilingual group ( $5.57 \pm 0.85, p = 0.025$ ). There was no statistically significant difference between the S/LI and the bilingual group ( $p = 0.099$ ).

## Discussion

The aim of the present study was to compare three groups of children, namely children with S/LI between 5-6 year-olds, their age and gender matched monolingual Turkish speaking children with typical development and Turkish-German bilingual children on executive tasks assessing conflict inhibition, short term memory, working memory and fluency. On all executive functions tasks used in this study, children with S/LI scored at a lower level compared to other two groups.

Specifically, based on Digitspan Forward Test measuring short term memory, children with S/LI obtained significantly lower scores than children with typical development and Turkish-German speaking bilingual children. Monolingual children with typical development scored higher than bilinguals although the difference was not statistically significant. These results are expected and in parallel with a vast amount of previous research reporting short term memory deficits in children with S/LI [25,30]. Bilingual children outperformed children with S/LI on Digitspan Backward task which requires processing besides storage. Although bilingual children's scores on this task were higher than children with typical development, group differences just failed to reach the criterion for statistical significance. These results are also consistent with recent increasing studies of bilingual advantage on working memory tasks [47-50]. Bilingual superiority in working memory tasks are thought to be arising from the continuous selection and processing of lexical information in two languages. Recent models of lexical access in bilinguals reveal that lexical items in both languages remain active in bilinguals independent of the language required for a task [51-53]. The pattern of the performance of bilingual children on inhibition and working memory tasks finds support for the Inhibitory Control Model and Adaptive Control Hypothesis [54,55]. These models assert that bilinguals use these mechanisms more proficiently than monolinguals due to continuous management of the two languages.

However, it is a quite surprising result that there was

not any significant difference between groups in terms of Day & Night Task assessing verbal conflict inhibition although the scores of bilinguals were higher than the other groups. This is probably due to the fact that the task was easy for this age group since the scores of the three groups was so high. We should also remember [41] reports about the performance on the day-night task improved in children between the ages of 3.5 and 5.0 years. Accordingly, it is claimed that children older than age 5 years may show performance near the maximum [56]. Further research is needed to establish validity and reliability of this task for 5 and 6-year-old in Turkey. On the other hand, significant group differences were found for the Fist & Finger task measuring nonverbal conflict inhibition. Children with S/LI scored lower when compared with the other two groups. The results of this study tend to be in line with the results of previous studies carried with children with S/LI in confirming the evidence for nonverbal inhibition dysfunction in this group [5,57-60]. Our results further support the hypothesis that individuals with S/LI have broad executive difficulties that are not restricted to the verbal tasks only [21].

Children with typical development produced significantly higher responses on semantic fluency task than the other groups. With regard to performance on phonemic fluency task, children with S/LI performed significantly lower than the other two groups. These results are also consistent with previous studies that found problems in these domains in children with S/LI both in terms of efficiency [61] and accuracy [62]. These findings also support the hypotheses that fluency also depending on some elements of executive functions, namely inhibition and working memory since group with S/LI also have lower performance on these tasks too [63]. However bilingual group scored lower than children with typical development on fluency tasks although their inhibition and working memory scores were the highest. This is probably due to the fact that bilinguals in our sample were all sequential learners and were living in their L2 country. Although their L1 (Turkish) language test scores were within normal limits, their experience with Turkish in their daily lives was limited. Another possible reason of these findings is continuous competition between two languages during retrieval. Bilingual children are found to be slower on picture naming tasks [64] and showing poorer performance on verbal fluency tasks [65,66] although they have similar conceptual vocabulary with their monolingual peers [67,68]. So, future researches should also include tasks or batteries encompassing novel word learning tasks with measuring reaction times. This form of study would allow the lexical abilities of bilinguals to be thoroughly examined.

There are a number of limitations associated with the current study that must be carefully considered when interpreting its results. The main limitation of this study is the small sample size. More research is needed

that involve a larger sample with a wider age range as well as longitudinal analyses. The second limitation is the lack of the bilingual children with S/LI which is a very hard to reach. With a large enough sample size, this form of study would allow seeing the possible cognitive advantages/disadvantages of bilingualism on language development.

In summary, this study adds to the evidence that children with S/LI demonstrate executive function deficits both in verbal and nonverbal domains and there is a bilingual advantage in working memory and inhibition performance.

## Acknowledgment

We acknowledge that “COST Action IS0804 Language Impairment in a Multilingual Society: Linguistic Patterns and the Road to Assessment” and “WG4: The role of Executive Functions in Multilingualism”, where a pilot of this study was presented, gave us an opportunity to share the tests and the tasks used in this study. No grant/funding was received for this research.

## Conflict of Interest

The authors declare that they have no conflict of interest.

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