Video Article

Practical Methodology of Cognitive Tasks within a Navigational Assessment

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Abstract

This paper describes an approach for measuring navigation accuracy relative to cognitive skills. The methodology behind the assessment will thus be clearly outlined in a step-by-step manner. Navigational skills are important when trying to find symbols within a speech-generating device (SGD) that has a dynamic screen and taxonomical organization. The following skills have been found to impact children's ability to find symbols when navigating within the levels of an SGD: sustained attention, categorization, cognitive flexibility, and fluid reasoning[1,2]. According to past studies, working memory was not correlated with navigation[1,2].

The materials needed for this method include a computerized tablet, an augmentative and alternative communication application, a booklet of symbols, and the Leiter International Performance Scale-Revised (Leiter-R)[3]. This method has been used in two previous studies. Robillard, Mayer-Crittenden, Roy-Charland, Minor-Corriveau and Bélanger[1] assessed typically developing children, while Rondeau, Robillard and Roy-Charland[2] assessed children and adolescents with a diagnosis of Autism Spectrum Disorder. The direct observation of this method will facilitate the replication of this study for researchers. It will also help clinicians that work with children who have complex communication needs to determine the children's ability to navigate an SGD with taxonomical categorization.

Video Link

The video component of this article can be found at http://www.jove.com/video/52286/

Introduction

The methodology used to assess cognitive and navigational skills can vary widely. Few studies have been published regarding cognitive and navigational skills. Previously, Wallace, Hux, and Beukelman (2010) studied the impact of cognition on navigation with adults who experienced a traumatic brain injury[4]. They found that cognitive flexibility impacted navigational skills for this population. The method described in this paper conducted by Robillard, Mayer-Crittenden, Roy-Charland, Minor-Corriveau and Bélanger has been published in 2013[1]. Rondeau, Robillard and Roy-Charland also used this method in a similar study[2]. For the purpose of this paper, step-by-step instructions with visual supports will demonstrate the methodology used in order to encourage duplication of this technique with other populations for research purposes, and to support clinicians who want to assess navigational and cognitive skills for clients who have complex communication needs.

Speech-generating devices (SGD) produce an electronic voice using a synthesizer and can have dynamic levels with links that allow the user to access new words by changing levels (*i.e.* to change from a page of symbols to another)[5,6]. The ability to navigate between these levels is required in order to find symbols within the multiple levels of an SGD[6,7]. The importance of cognitive skills in the ability to navigate the levels of an SGD has been demonstrated[1,2,4]. Results of a study that analyzed the impact of language abilities on navigational skills revealed that language skills were not a good predictor of navigational skills among children[8]. By having a better understanding of the cognitive factors that can impact navigation, clinicians can offer a more reliable assessment of children with complex communication needs. The cognitive factors that will be addressed in this study are: sustained attention, categorization, cognitive flexibility and fluid reasoning. See Robillard and collaborators for a description of these cognitive factors[1].

Since very few studies have looked at the impact of cognitive factors on navigation, an assessment protocol has not yet been put into practice. Over the years, other fields in speech-language pathology have established assessment batteries in order to better identify children in need of those services. For example, it is a well-known fact that non-word repetition and sentence imitation, two tasks that rely heavily on verbal working memory, along with select language assessment tools, can successfully identify children with language impairments[9-14]. However, in the field of augmentative and alternative communication (AAC), very little attention has been given to the relation between cognition and the ability to navigate an AAC device. Even less attention has been given to the development of a systematic method to follow. Very few tools exist for the assessment of navigation skills in children. Since there exist a variety of assessment tools that can be used to assess nonlinguistic cognitive skills, it is understandable that determining which tools or tasks to use could be very overwhelming for a clinician[15]. Clinicians commonly use feature matching with individuals who use AAC. It involves matching the person's abilities to the design features of the SGD. It is therefore important that clinicians are best able to match the cognitive skill levels and the person's navigation abilities to the appropriate device.

Until recently, very few studies have been conducted using an electronic tablet. Waddington and collaborators[16] suggested that functional communication skills could be taught using an intervention approach that includes the use of a computerized tablet to children with ASD who have limited or no speech. Moreover, a systemic review by Kagohara and collaborators[17] suggested that children with a developmental disability could be taught to use technology such as a tablet for a variety of communication purposes. The method described in this paper will provide researchers and clinicians with a detailed guide to use when assessing cognitive and navigational skills.

Protocol

This study was approved by the Laurentian University Research Ethics Board. Only participants for whom informed parents signed the consent form participated.

1. Setting

1. Assess participants in a private room if possible.
2. In order to reduce the impact of possible fatigue on the cognitive and navigational scores, it is not recommended to administer all of the tests at one time, instead, assess the participants over two to four sessions that vary from 30 min to 2 hours each.
3. When using this procedure for research purposes, to control for the element of test practice on subtests that were last given, randomly determine the order in which the navigational task and cognitive subtests are administered, and ensure that they are not the same for all participants.

2. Procedure

1. Navigational Task
    1. Materials: Use a computerized tablet and an augmentative and alternative communication application with a 16-location grid and taxonomic categorization. Use the symbols that come preloaded with the augmentative and alternative communication application. Use the navigational task that involves the retrieval of 25 words (see **Table 1**) and 5 practice words before beginning the formal assessment. Use a booklet that contains the symbols for each of the target words. Note: Each symbol is present alone on one page.

Words From the Practice Portion
1. foot
2. banana
3. cat
4. boat
5. fork
Words From the Formal Navigational Task
1. dog
2. hand
3. apple
4. car
5. spoon
6. frog
7. shoes
8. mouth
9. fish
10. carrot
11. chair
12. flower
13. duck
14. table
15. boy
16. airplane
17. turtle
18. cookie
19. baby

20. belt	
21. tree	
22. bus	
23. pencil	
24. farmer	
25. bicycle	

Table 1. Words from the Navigational Task.

2. Sit/stand at an angle, across from the participant in order to observe if they can select the appropriate symbols on the computerized tablet, and to facilitate turning the pages of the booklet. Place the computerized tablet directly in front of the participant, flat on the table or at a 45-degree angle to control the reflection from the lighting in the room. Place the booklet upright using an easel with the symbols between yourself and the participant.
3. Ask the participant if they have previously used a smartphone or a computerized tablet. Note: This variable is only important if this method is being used for research.
4. Explain that symbols can be found under folders representing categories, that the home button links to the first level and that the back button links to the previous level. State: "The symbols can be found in each of the different folders that represent different categories (point to the different folders). This button over here (touch the home button) links to this level (demonstrate for the participant) and this button over here (touch the back button) links to the previous level. See?"
5. Present in a booklet, alone on one page, the symbols that need to be found in the tablet. Say the words that represent the symbols aloud.
6. Keep the booklet open while the participant navigates within the levels of the computerized tablet to find the symbols.
7. Give as many verbal and physical prompts as needed during the practice portion, for example: "What category does this word belong to?"
8. Begin the formal navigational task after the 5 practice words have been successfully retrieved.
9. Touch the home button on the application between trials in order to consistently start from the first level.
10. Ask the participant to retrieve all 25 words within the levels of the computerized tablet using the same procedure as the practice portion, with the exception that prompts are not given.
11. If a symbol cannot be retrieved, tell the participant that by turning the page of the image booklet, the item can be skipped.
12. Score items as correct if the participant correctly selects the symbol that matches the target in the booklet.
13. Give a score of zero when a symbol is incorrectly retrieved.
14. When the participant does not make a selection within 5 minutes, remind the participant that by turning the page of the symbol booklet, that item can be skipped.
15. End the test once all of the 25 items are presented or after the participant reaches the ceiling of failing to retrieve 8 consecutive symbols.

2. Cognitive Tests
    1. Administer the following subtests of the Leiter International Performance Scale-Revised (Leiter-R)[3] according to the instruction manual. For each subtest, after providing the non-verbal instructions, monitor the participant and record the number of correct responses. Note: The Leiter-R is a non-verbal test that requires the participant and clinician to communicate only with non-verbal cues such as pantomime, gestures, pointing and a questioning manner. The tasks on the Leiter-R generally involve a pointing or matching response. Materials include stimulus easels, cards, and foam shapes.
        1. Administer the Attention Sustained subtest.
            1. Point back and forth between the target picture and one correct answer on the page and simulate a crossing out motion to indicate to the participant the need to find and cross out as many items as possible that are identical to the target within an array of geometric shapes, within a time limit of 30 to 60 sec[3].
        2. Administer the Picture Context subtest.
            1. Use pantomime to indicate to the participant that the stimulus card relates to an empty box on the easel illustration[3]. Gesture back and forth to indicate the need to identify a pictured object that has been removed from a large display by using contextual cues[3].
        3. Administer the Figure Ground subtest.
            1. Point back and forth between stimuli material and the easel and shrug in a questioning manner to indicate to the participant the need to identify embedded figures or designs presented on a card within a complex stimulus[3].
        4. Administer the Sequential Order subtest.
            1. Gesture back and forth between stimuli material and tray slots to indicate to the participant the need to select a related stimuli that progresses in a corresponding order. For example, place shapes or cards in the wrong order and shake head "no"[3].

Representative Results

For both studies that used this methodology[1,2], cognition was correlated to navigational scores. The higher the cognitive scores were, the higher were the navigational scores[1,2]. Positive correlation coefficients were obtained for cognitive flexibility and navigation in the study with the ASD population. These results were more similar to those of Wallace *et al.*[4] whose participants included adults who experienced a traumatic brain injury than to those obtained by the study with typically developing children. In fact, in the later, cognitive flexibility was not correlated with navigation. However, certain cognitive skills were able to predict the navigational ability of a typically developing population[1]. For these children, sustained attention, categorization and reasoning skills permitted the ability to predict navigational skills[1]. Age was not an important factor for the prediction of navigational skills. The results are depicted in **Table 2**. Complete details on the results of these studies can be found in the results section of the above-mentioned papers. It is evident that cognitive skills were an important factor in the ability to navigate an SGD. However, since the predicting factors varied from one author to the next, further studies are needed with different clinical subpopulations and age groups in order to more clearly determine the underlying role of cognitive factors on navigational skills. Studies with larger populations, as well as with children and adults who have complex communication needs and use SGDs to communicate are also needed.

Population	Cognitive Factors Correlated with Navigational Skills
Children with typical development	Sustained attention
	Categorization
	Fluid reasoning
Children and adolescents with a diagnosis of Autism Spectrum Disorders	Cognitive flexibility
	Sustained attention
	Categorization
	Fluid Reasoning

Table 2. Results from studies by Robillard and colleagues[1] and Rondeau and colleagues[2] that used this methodology.

Discussion

The aim of this video was to outline the methodology used to explore the cognitive factors that impact a child's ability to navigate an SGD. Since the study by Robillard and colleagues[1] was the first of its kind with children, there was no pre-established protocol.

The decision to include children with typical development was made to obtain information on basic learning strategies and difficulties that relate to the use of this technology[18-20]. The symbols were presented in a booklet (on one page) at the same time as the word for the symbol was said aloud to control for the participant's ability to correspond the symbol to the referent and to ensure that only navigation was being measured. A pilot test determined that a 16-location grid was required. When more than 16 symbols per level were used, the complexity of the navigational task was greatly increased because of the need to scan more items per level to locate the symbols. Using less than 16 symbols per grid would have led to a greater need to change pages and may have increased the complexity of the navigational task. The number of words to identify for the navigational task (25) was also determined through pilot testing and was based on the number of items that the children could reasonably complete within a single session without needing a break.

SymbolStix[23] symbols were used because they came preloaded with Proloquo2Go[21]. Other types of symbols could also be used. The words selected were chosen from the younger stages of receptive vocabulary tests such as the Peabody Picture Vocabulary Test – Fourth Edition (PPVT-4)[22] and the Échelle du vocabulaire en images Peabody (ÉVIP)[24]. The words chosen were judged to be familiar for most children aged 4 to 6 years. The words chosen included concrete nouns that represented objects, animals or people. The order of presentation of the words was also determined through pilot testing. The words that had the highest success rate from the pilot group were placed at the beginning, while those with the lowest success rate were placed towards the end. Items were also placed in an order that would ensure that two successive symbols were not located under the same category. Some symbols could be found at the third level and others at the fourth level. Throughout the experimental navigational task, there was a progression in the level of difficulty. At first, the targeted words were under the same categories used in the practice portion. As the task progressed, new categories were introduced. In order to not discourage the participants, the most difficult words to retrieve were placed at the end of the task and were not administered to the children having reached a ceiling of eight consecutive errors, as this prompted the termination of the task. The participants were given a score of 0 for the items that were not administered.

As for the cognitive measures, the Leiter-R was selected because all subtests are non-verbal and could therefore be administered to children who have complex communication needs. Attention Sustained was selected to measure the ability to sustain attention. Picture Context was selected to measure categorization. Figure Ground was selected as a measure of cognitive flexibility. Sequential Order was selected to measure fluid reasoning. A new version of the Leiter-R[3], the Leiter-3[25] would also be a good measure of cognition.

The results by Robillard and colleagues[1] showed that cognitive skills have an impact on the navigational skills of typically developing children who are new to AAC use. Sustained attention (Attention Sustained, Leiter-R), categorization (Picture Context and Classification, Leiter-R), fluid reasoning (Form Completion, Sequential Order and Repeated Patterns, Leiter-R), were all correlated with navigation[1]. A more detailed discussion of the results can be found in Robillard and collaborators[1]. Cognitive flexibility (Figure Ground, Leiter-R) was correlated with navigation in children and adolescents with a diagnosis of Autism Spectrum Disorder (ASD)[2], but was not correlated with navigation for young children with typical development. Among the factors correlated with navigation, the subsets that best predicted typically developing children's navigational skills with a taxonomic organization included sustained attention, categorization, and fluid reasoning. Due to the small number of participants in the study on ASD, linear regressions were not possible. However, the correlation results open the possibility that cognitive flexibility could be an important factor for the prediction of navigational skills of children with ASD. New studies are needed with a larger number of participants. The speed of selecting symbols was not a variable in the previous studies, but could be added as a measure of processing speed.

Procedural limitations are present in this method. The administration of the assessment tools was carried out in multiple settings (*i.e.* private room, school with background noise, clinic). This could have impacted the participants' performance. Visual acuity could have been assessed to rule out difficulties with vision. Some participants could have difficulty understanding the representations of the words even though symbols were presented in a booklet during the navigational task. The navigational task does not represent real communication and was in fact the first use of an AAC device after minimal training only. Navigational skills could be aided by personalizing the device, which could reduce the cognitive demands. This procedure was outlined for assessing children and was not examined for an adult population. Also, the validity of the cognitive factors could be questioned because they are difficult to isolate.

In order to reduce the limitations described above, all participants should be assessed in a private room with no distractions or background noise. When this is not possible, distractions should be limited in order to not impact the participants' performance. When hearing and vision testing is not possible, difficulties could be ruled out by asking the participants' families about hearing and vision acuity.

Other applications than Proloquo2Go[21,25] could be used. Other non-verbal cognitive tests could also be used to measure cognition, as long as they include numerous subtests that isolate the different cognitive components. Caution is needed when modifying the procedure outlined in this paper or when using alternative approached to assessing cognition, such as non-standardized cognitive tests, as the results could differ from the expected outcome.

It is important to understand how cognitive factors contribute to navigational abilities. The improper selection of an SGD could cause children and their caregivers to become frustrated and abandon the use of a device for communicative purposes. When choosing an SGD for young children, attention, categorization, and reasoning skills can be assessed to help predict their success with dynamic paging using a taxonomic organization[1]. For children and adolescents with ASD, cognitive flexibility may offer the best prediction of navigational skills[2]. More studies with other, larger clinical populations using the described method are required in order to determine the impact of cognition on navigation in children who require and use augmentative and alternative communication strategies.

Disclosures

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