



INTRODUCTION TO THE *TOSR*

RATIONALE

The *Test of Semantic Reasoning (TOSR)* is an individually administered assessment which measures semantic skills, in particular depth of vocabulary knowledge, in children and adolescents age 7 through 17. The *TOSR* requires the individual to visually analyze four photographs representing a single word in a variety of contexts. The individual must integrate several skills, including visual processing, inferential thinking, and deductive reasoning to choose the single word (from a choice of four) which best represents the commonality among the images. The *TOSR* was developed by two practicing speech-language pathologists with more than 45 years of combined experience, who recognized the need to measure children's depth of vocabulary knowledge without relying on expressive language skills (e.g., defining or describing words). The *TOSR* is the first of its kind to measure deep, nuanced understanding of words without requiring an oral or written response.

Over the last 15 years, researchers have shown increasing interest in the topics of vocabulary acquisition and the impact of vocabulary knowledge on other academic skills. Research indicates that owning a broad, deep vocabulary base is essential to school achievement, and that there is a strong positive reciprocal relationship between word knowledge and reading comprehension (Baumann, Kame'enui, & Ash, 2003; National Institute of Child Health and Human Development [NICHD], 2000; RAND Reading Study Group, 2002; Silverman & Hartranft, 2015). Mastery of complex vocabulary is required for reading comprehension, which in turn increasingly becomes the cornerstone of education as a student advances. Students must deeply and broadly "own" a significant number of vocabulary words, including words that are not commonly spoken. As students progress through school, they more frequently encounter text containing nuanced words such as *compliant* and *prudent*, which communicate a host of subtle meanings. These words are difficult to master because dictionary definitions are hard to parse, meaning can change based

on context, and background knowledge is often needed to recognize appropriate use. According to Hu and Nation (2000), students need to understand 98% of words in a given text in order to comprehend the meaning. By the time students reach the 12th grade, they will need to know upward of 50,000 words in order to comprehend required texts across multiple content areas (Proctor, Silverman, Harring, & Montecillo, 2012).

Vocabulary storage involves both phonemic (sound patterns) and semantic (meanings) representations of words. The mental lexicon, which provides organized storage of phonemic representations, is distinct from, but connected to, the storage of word meanings (Levelt, Roelofs, & Meyer, 1999). Vocabulary *breadth* refers to the number of lexical entries one has, and *depth* refers to the extent of semantic representations one has for each known word (Levelt et al., 1999).

Both breadth and depth independently influence different aspects of reading skill. For example, while vocabulary breadth predicts decoding ability, vocabulary depth may be a better predictor of reading comprehension (Ouellete, 2006; Ouellette & Beers, 2010; Walley, Metsala, & Garlock, 2003). Highlighting the importance of vocabulary knowledge, in 2009 vocabulary assessment was added to the U.S. Department of Education's National Assessment of Educational Progress (NAEP). The NAEP recognized the need to measure students' ability to apply word knowledge to interpret meaning in text passages. Specifically, the NAEP emphasized the importance of assessing vocabulary depth, noting, "Students may be familiar with the word 'green' when used in the social context of environmentalism; however, they may not have encountered the word to describe someone lacking in experience, as in 'green recruit'" (U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, NAEP, 2013). On the vocabulary assessment, students need to integrate their personal knowledge of words with how the words are used in a passage. Across all three years of reported test data for 4th-, 8th-, and 12th-grade students, performance on the vocabulary measure correlated strongly with reading comprehension scores. In general, students who performed the best on the vocabulary measure also scored in the highest percentile groups on reading comprehension.

Quality vocabulary instruction is critical to the development of vocabulary knowledge. As noted by Tannenbaum, Torgesen, and Wagner (2006),

For vocabulary instruction to affect reading comprehension, the instruction must go beyond establishing a definition for a word; it must develop complex, in-depth knowledge about the words being taught. Good vocabulary instruction therefore provides contextual information in addition to definitional information about a word. A child needs to develop knowledge of the core concept of the word and how the word is used in different contexts to develop flexible knowledge about a word that contributes to reading comprehension. (p. 383)

If students are not receiving active vocabulary instruction, then their ability to master new vocabulary relies on how much they know when they enter

kindergarten, and how much they read thereafter. Students who begin school with a poor vocabulary often fail to catch up with peers even if they read, potentially learning only “half as many academically relevant words as children who came to school with just average vocabulary knowledge” (Proctor et al., 2012, p. 1636). As noted previously, vocabulary breadth is predictive of decoding ability, and children with decoding challenges are less likely to read grade-level texts and more likely to avoid reading (Morgan, Fuchs, Compton, Cordray, & Fuchs, 2008). This further impairs their progress in learning vocabulary.

In addition, one must encounter a word roughly 12 times before it can be fully comprehended (McKeown, Beck, Omanson, & Pople, 1985). Students who do not read broadly and frequently, encountering words repeatedly in multiple contexts, are less likely to learn tier two vocabulary words. Tier two words are those that add to the language user’s ability to communicate nuanced meaning. These words are less frequently heard in oral language but are frequently found in literature and academic texts (Beck, McKeown, & Kucan, 2002). Even students who start school with adequate oral vocabulary, but then do not read, fall behind in vocabulary acquisition (Coyne, Simmons, Kame’enui, & Stoolmiller, 2004). Students with poor early vocabulary or limited reading face a vicious cycle of failure to learn vocabulary, which interferes with comprehension of text and literature, ultimately leading to reading avoidance, which further limits vocabulary development and contributes to ongoing academic struggles (Nagy & Scott, 2000; RAND, 2002).

Multiple factors contribute to a limited vocabulary and early reading challenges, including phonological awareness difficulties, low socioeconomic status, and specific language impairments (SLI) and speech-language disorders (SLD). Most researchers agree that both vocabulary and phonological awareness contribute to reading development, although the exact mechanisms and relationships remain under study (Dickinson, McCabe, Anastasopoulos, Peisner-Feinberg, & Poe, 2003; Lonigan, 2007; McBride-Chang et al., 2005; Muter, Hulme, Snowling, & Stevenson, 2004). Intriguingly, Dickinson et al. (2003) argued that, in typically developing children, both sets of skills work together and contribute relatively equally to literacy. However, a core deficit in either of the skill areas not only has a direct impact on reading development but also moderates (lessens) the relationship between the other skill area and reading. In other words, a child cannot compensate for a specific difficulty in phonological awareness (a commonly identified cause of reading-based learning disabilities) with strong vocabulary abilities, because the phonological deficit interferes with the contribution of vocabulary development to reading.

Socioeconomic status has a substantial influence on vocabulary development. Numerous studies document that children from lower SES households enter kindergarten with significantly smaller vocabularies (breadth) than children from higher SES households, and SES continues to impact vocabulary growth as children progress through school (Beitchman et al., 2008; Hoff; 2013; Rowe & Goldin-Meadow, 2009). Of particular concern is that children who enter school with more limited vocabulary due to SES or other factors tend to respond less well to standard

direct vocabulary instruction and show less improvement in vocabulary than their peers who have larger vocabularies (Loftus et al., 2010).

Finally, students with specific language impairments (SLI) and speech-language disorders (SLD) are also at increased risk for problems with vocabulary development. Compared to typically developing peers, children with speech-language difficulties may need more exposures to new words before mastering them and may require more direct and explicit teaching of word meanings (Alt, Plante, & Creusere, 2004; McGregor, Newman, Reilly, & Capone, 2002; Steele, Willoughby, & Mills, 2013). Students with SLI or SLD also may be less able to pick up word meanings in “natural, incidental situations, including play, conversation and television viewing” (Steele & Mills, 2011, p. 355). Because children with language difficulties also have reading challenges, they typically do not access literature and the expansive vocabulary used therein, putting them at a distinct disadvantage in developing a rich semantic network (Cunningham & Stanovich, 1998; NICHD, 2000; Steele et al., 2013).

The traditional method of assessing receptive vocabulary includes use of standardized tests that require students to indicate familiarity with spoken or written words by selecting a single picture in a field of 4 to 6 drawings or photographs. In school, students often indicate “understanding” of a word by selecting the correct definition in multiple-choice tests, which may simply demonstrate rote memory skills. Assumptions are made that students “know” words if they are able to choose pictures and/or definitions from a field of four. Depth of vocabulary knowledge, however, is much more complex. Some subtests in comprehensive language assessments delve deeper into semantics, by assessing student understanding of class, function, attributes, and synonym/antonym relationships. However, many of the subtests used to measure depth of knowledge of words require students to use verbal responses, potentially confounding the interpretation of results. For example, providing a definition requires solid language formulation skills, offering a synonym or antonym requires word retrieval skills, and describing attributes of nouns requires both word retrieval and verbal formulation. No currently available test assesses a student’s deep and broad ownership of words, and the ability to successfully comprehend these words when used in a variety of contexts without requiring a spoken or written response.

THEORETICAL FRAMEWORK

The theoretical framework on which the *TOSR* is based includes research from psychology, cognitive science, language acquisition, and language disabilities, as well as the co-authors’ extensive experience working with children with language disorders. The *TOSR* requires the examinee to use semantic reasoning to analyze four pictures that represent a vocabulary word in a variety of contexts. The examinee then selects the single word, from a field of four words, which reflects all four depicted contexts or nuances of the word. Semantic reasoning requires both development of word knowledge depth and inductive and deductive reasoning skills.

Vocabulary Development

Although there is debate about the exact process, it is widely accepted that children learn vocabulary through exposure to oral language, especially in the younger years, and through exposure to words in text throughout the school years. At both levels, children may learn the meanings of words through directly provided definitions or explanations or through the use of lexical inferencing, the process of “making informed guesses as to the meaning of a word in light of all available linguistic cues in combination with the learner’s general knowledge of the world, her awareness of the context and her relevant linguistic knowledge” (Hastrup, 1991, p. 40).

The process of learning vocabulary involves two phases, *fast mapping* and *extended mapping*. Children begin learning words by being exposed to the oral language of caregivers. Even with only one exposure, children are able to rapidly guess at the meaning of a word. This rapid process by which children hear a word and connect it with a general understanding of the concept is fast mapping (Carey & Bartlett, 1978). While fast mapping allows children to develop a rapidly expanding lexicon (i.e., breadth of vocabulary), this process does not provide learners with specific, nuanced understanding of words. For example, when children are initially exposed to a word such as “dog,” they tend to overgeneralize, applying that label to all four-legged animals (McGregor, Sheng, & Ball, 2007).

Over time, and through multiple exposures to the word in different contexts, children establish a more nuanced understanding of the word. Errant assumptions about the word are pruned (e.g., a child no longer calls a cow “dog” after learning that dogs are smaller, are pets, and are not farm animals) and depth of understanding increases (e.g., *prudent* can apply to making wise decisions about health, finances, career choice, etc.). This process is extended mapping and is responsible for an increase in depth of vocabulary knowledge (Carey, 2010). In general, children increase both breadth and depth of word knowledge in a predictable manner, with more concrete words that reflect their own experiences learned first, and subtle, abstract, and nuanced words learned later (Biemiller & Slonim, 2001; Stanovich & Cunningham, 1993).

When children infer meaning through lexical inferencing, the text or spoken language must contain enough context clues for the student to extrapolate the appropriate meaning. Students also must bring to the table a variety of factors, including background knowledge, attention to detail, metacognitive skills, and an understanding of how to make inferences from context clues (Hatami & Tavakoli, 2012). In several studies of English-language learners, students reported that they tried to use context clues in 58% to 78% of attempts to figure out the meaning of unknown words, but they were successful less than half the time. Students’ success appeared to be influenced by the number and helpfulness of context clues, and by the students’ ability to make correct inferences from the available clues. (Fraser, 1999; Hastrup, 2008; Paribakht & Wesche, 1999). Beck, McKeown, and Kucan (2013) recommend teaching context clue skills, but they note that explicit clues (e.g., synonyms, definitional phrases, examples) are not typically provided by

authors, and students may lack the linguistic skills to make inferences where less explicit clues are available.

Carey and Bartlett (1978) theorized that at any given time students are in the process of deepening understanding of 1,600 words, meaning they possess only partial knowledge of many words. The process of fully “owning” a word (i.e., recognizing its nuanced meaning orally and in print, and using it orally and in print) can take months to years as students prune, expand, and deepen their understanding of words (Carey & Bartlett, 1978). The student must already have an adequate depth of knowledge of the words, and must be exposed to a variety of texts that contain enough context clues for additional learning to take place while the more global task of text comprehension occurs.

Unfortunately, even if teachers use best-practice vocabulary instruction, which Bromley (2004) argues they often do not, students with learning difficulties struggle because most vocabulary teaching methods still rely heavily on language as the primary input modality, and this approach is less effective for those with learning disabilities and for ELL students (Bromley, 2004). There is a real possibility that some students, particularly those with language learning difficulties, may gain a surface understanding of many words but not learn those words to the depth required to comprehend a given text or utterance. Therefore, assessors can no longer rely on breadth-of-vocabulary tests alone to determine students’ semantic needs competences.

Reasoning Skills

In order to assess students’ nuanced understanding of words, multiple skill areas are tapped. Traditional vocabulary assessment techniques typically require students to provide definitions, descriptions, or explanations of how words fit into categories, or to provide synonyms or antonyms. These types of tasks require students to access intact receptive and expressive linguistic skills in order to convey their depth of understanding. The *TOSR* does not require language formulation. However, in order for a student to indicate the correct single-word response, he or she must engage in visual processing and use fluid reasoning skills. McGrew (2005) defines fluid reasoning as “the use of deliberate and controlled mental operations to solve novel, ‘on the spot’ problems. ... Mental operations often include drawing inferences, concept formation, classification, generating and testing hypotheses, identifying relations, comprehending implications, problem-solving, extrapolating, and transforming information” (p. 151).

In particular, the *TOSR* requires students to use two types of fluid reasoning skills, inductive reasoning and deductive reasoning. Inductive reasoning involves identifying similarities or differences in a set to determine underlying rules or generalities (Klauer, Willmes, & Phye, 2002; Schneider & McGrew, 2012). Deductive reasoning (also known as general sequential reasoning) involves applying known rules to solve problems (Schneider & McGrew, 2012). A number of studies suggest that these reasoning skills are correlated with academic performance and success,

including specific correlations with skills important in reading comprehension (Hannon & Daneman, 2001; Klauer & Phye, 2008).

Students must use inductive reasoning to analyze the four images contained on each *TOSR* test plate. Klauer et al. (2002) describe induction as a “comparison process which deals either with comparing attributes of objects ... or with relations between objects” (p. 4). In order to determine which word the four images represent, the student must inspect the details in each image, determine salient features, compare and contrast the features with the other images, and then infer a common thread.

Students also use deductive reasoning to relate their vocabulary knowledge to the four images. Fangmeier, Knauff, Ruff, and Sloutsky (2006) have proposed that deductive reasoning is a three-phase process that requires accessing and processing the rules or premises that must be applied to the problem; integrating the rules or premises to draw a conclusion; and then validating the conclusion. In the case of the semantic reasoning tasks on the *TOSR*, the student must apply the “rules” he or she has about the meanings of the four word choices to solve the “problem” of the four images. The student must be able to access and process the definitions for the four word options; integrate those definitions to form a conclusion; and then validate that the student’s definition for one of the words matches the inferred connection between the image.

CONCLUSION

The *TOSR* is a new, standardized, nationally normed assessment tool that probes the examinee’s depth and breadth of understanding of vocabulary, and the ability to reason using semantic information. Information obtained from this assessment will provide educators, psychologists, and speech-language pathologists with information on both examinees’ basic receptive vocabulary knowledge, and also on higher-order thinking and reasoning in the semantic domain.