

Comprehensive Test of Phonological Processing

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A growing consensus of the most prominent research in learning disabilities for the past 30 years points toward deficits in the phonological processes as the cause of reading disability. At the center of this research is the current knowledge that children's difficulties in learning to read are most frequently contributed to weaknesses in the ability to process the phonological features of language (Blachman, 1994; Blachman, Tangel, Ball, Black, & McGraw, 1999; Fletcher & Lyon, 1998; Mathes, Howard, Allen, & Fuchs, 1998; National Research Council, 1998; Torgesen, Wagner, Rashotte, 1994; Torgesen, Wagner, Rashotte, Alexander, & Conway, 1997).

The term *phonology* is of Greek origin, *phone* meaning "voice" or "sound." Phonological processing refers to the use of the sound system of language to process written and oral information, including sensitivity to the sound segments in verbal language (Clark & Uhry, 1995; Harm & Seidenberg, 1999; Mathes & Torgesen, 1998; Schatschneider, Francis, Foorman, Fletcher, & Mehta, 1999; Share & Stanovich, 1995; Snowling, 1995; Torgesen, et al., 1994; Torgesen, Wagner, Rashotte, Burgess, & Hecht, 1996). Phonological processing limitations make it difficult to apply the alphabetic principle (knowing what sound goes with what letter) in decoding (reading) unfamiliar words. Therefore, children who have phonological processing problems experience difficulty using the regular patterns of correspondence between letters and sounds in words to identify new words they encounter in text. The leading

research (e.g., Fletcher & Lyon, 1998; Mathes et al., 1998; Mathes & Torgesen, 1998; Torgesen & Davis, 1997) strongly suggests that systematic and explicit instruction positively affects phonological processes but a caveat is present. Such instruction must take place early in the beginning grades of kindergarten through third grade.

Other equally important findings have shown that phonological processing can significantly predict growth in early reading skills. So not only does phonological processing identify potential deficits, it can also forecast a child's performance without intervention (Badian, 1996, 1998; Shaywitz, et al., 1998; Snowling, 1995; Wagner, Torgesen, Rashotte, Hecht, Barker, Burgess, Donahue, & Garon, 1997).

In summary, phonological processes are vital to the mastery of fluent reading. In education, strength lies in its ability to identify children who are presumed to be at risk for reading failure even before beginning reading instruction (Badian, 1996, 1998; Fletcher, Foorman, Shaywitz, & Shaywitz, 1999; Torgesen & Davis, 1997). For these reasons, a well constructed test capable of detecting phonological processing deficits in beginning students would fill an important need.

Comprehensive Test of Phonological Processing

For the past decade, many professionals within education, psychology, and linguistics have focused on the study of phonology and its relation to early reading skills. These pro-

professionals all agreed on the importance of creating a well-constructed, standardized test that would assess phonological abilities. The *Comprehensive Test of Phonological Processing* (CTOPP) (Wagner, Torgesen, & Rashotte, 1999) was developed with that central focus. The manual (1999) claims that the CTOPP satisfies six major research requirements:

It (a) measures reading related phonological skills, (b) provides the examiner with a comparative index of phonological processing strengths and weaknesses, (c) is sufficiently reliable that examiners can have confidence in their results when they are used with individuals, (d) is sufficiently valid that the examiner will know what abilities are being measured, (e) is short enough that the fatigue of both the examiner and examinee is held at a minimum, and (f) has norms that are based on a large normative sample that includes representatives of a broad spectrum of Americans (Wagner, 1999, p. 1).

Theoretical Framework of the CTOPP

The theoretical framework of the CTOPP is based on the most current results of phonological research. The study of phonology may be broken into many levels. [For further reading on this topic, see Foorman, Fletcher, & Francis (1999)] In this article, only three types of phonological processing will be discussed: phonological awareness, phonological memory, and rapid naming. These three processes have been found especially germane for the mastery of written language.

Phonological awareness refers to an individual's attentiveness to and access to the sound construction of one's oral language. Spoken words represent strings of phonemes that signal changes in meaning (Wagner, et al., 1999). Phonemic awareness, therefore, is the ability to recognize the sound segments of the units within syllables (Foorman, et al., 1999; Mauer & Kamhi, 1996). Lack of phonemic awareness obstructs the attainment of word recognition skills which, in turn, obstructs the attainment of fluent reading (Blachman,

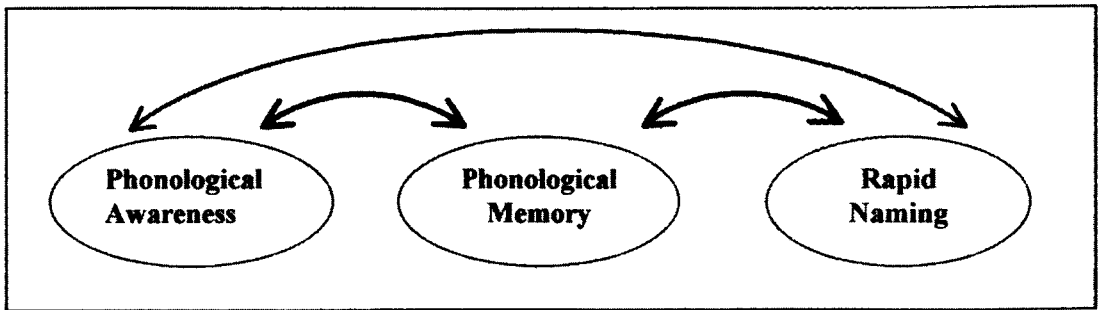
1994; Blachman et al., 1999; Levy, Bourassa, & Horn, 1999; Wagner et al., 1997; Wolf & Bowers, 1999). Phonemic awareness is taught by syllabic sounds so, for example, a teacher might say, "Take the /c/ out of cat and what word do we get?" Thus, the teacher would not say 'c' but make the sound of 'c' written as /c/.

Phonological memory refers to phonological information coded for brief storage in working or short-term memory. Deficits in phonological memory do not seriously affect reading or comprehension of words that are already in one's vocabulary but it greatly affects the learning of new written and spoken vocabulary (Wagner et al., 1999). For example, if a brain injury would leave the phonological memory impaired, one could communicate and read relatively normally but would not be able to learn (or possibly even repeat) other words in another language as in Spanish. [For further information about phonological memory, see Lyon and Krasnegor (1996).]

Rapid naming is the capacity to retrieve phonological codes stored in long-term memory. Phonological codes are a sound description of a concept or a symbol like the name of a letter, number, color, or object (Wagner et al., 1999). For example, if a child would see "r" "e" "d", she retrieves the sounds for the letters and then uses phonemic awareness skills to blend the sounds together to read /red/ (Bowers & Swanson, 1991; Fuchs, Mathes, & Fuchs, 1997; Fuchs, Mathes, Fuchs, & Lipsey, in press; Levy et al., 1999; Mathes et al., 1998; Torgesen et al., 1997). Rapid naming is measured by the length of time required to name stimuli when given in isolation or serially (Badian, 1996, 1998; Levy et al., 1999, Torgesen et al., 1997). [For more information on rapid naming, see Bowers and Wolf (1993).] Individuals who show deficits in rapid naming are anticipated to have problems with reading fluency. Some individuals have double deficits when phonemic awareness and rapid naming are both affected.

All three processes are correlated and yet distinct in function. Figure 1 illustrates this interplay.

Figure 1 Major phonological functions



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These processes are correlated rather than independent, because of factor analytic studies revealing the correlations between them are significantly greater than zero. They are distinct rather than similar, in that correlations between them are less than one. Hence, each function of one factor affects all the others (Wagner, Torgesen, Laughton, Simmons, & Rashotte, 1993; Wagner et. al., 1999).

Age-Based Versions of CTOPP

The CTOPP was constructed to help identify individuals from kindergarten (5-0 years old) to college (24-11 years old) age who may benefit from instructional activities to boost their phonological skills. There are two versions of the test, based on age-specific subtests.

Both versions are individually administered and involve about 30 minutes for administration of the core subtests. The first version, developed for 5- to 6-year-olds contains seven core subtests: elision, rapid color naming, blending words, sound matching, rapid object naming, memory for digits, and nonword repetition, and one supplemental subtest, blending nonwords.

The second version developed for ages 7- through 24-year olds (persons in second grade through college), contains six core subtests: elision, blending words, memory for digits, rapid digit naming, nonword repetition, rapid letter naming. In addition, it includes six supplemental subtests: rapid color naming,

phoneme reversal, rapid object naming, blending nonwords, segmenting words, and segmenting nonwords. The supplemental subtests in both versions are given to aid the examiner to better assess specific phonological strengths and weaknesses.

Subtests

Each subtest fulfills a specific task in gathering data on the functions of phonological processes. Table 1, constructed from the CTOPP manual (1999), gives a concise snapshot of each subtest.

The CTOPP yields three types of composite scores. The Phonological Awareness Composite Score (PACS) is comprised of the standard scores of three subtests for 5- to 6-year-olds (Elision, Blending Words, and Sound Matching) and two subtests for 7- to 24-year-olds (Elision and Blending Words). The Phonological Memory Composite Score (PMCS) is comprised of the standard scores of two subtests for both versions (Memory for Digits and Nonword Repetition). The Rapid Naming Composite Score (RNCS) is comprised of the standard scores of two subtests for 5- to 6-year-olds (Rapid Color Naming and Rapid Object Naming) and two subtests for persons 7 to 24 years old (Rapid Digit Naming and Rapid Letter Naming). Two alternate composite scores of phonological awareness and rapid naming are given for the second version only.

Table 1. CTOPP Subtests and Their Functions

Elision (EL)	20 items; measures the extent to which an individual can say a word, then say what is left after dropping out designated sounds
Blending Words (BW)	20 items; measures an individual's ability to combine sounds to form words
Sound Matching (SM)	20 items; measures the extent to which an individual can match sounds
Memory for Digits (MD)	21 items; measures the extent to which an individual can repeat a series of numbers over a period ranging from two to eight minutes
Nonword Repetition (NR)	18 items; measures an individual's ability to repeat nonwords that range in length from 3 to 15 seconds (Example: "thrat" or "frapher")
Rapid Color Naming (RC)	72 items; measures the speed with which an individual can name the colors of a series of different-colored blocks printed on two pages
Rapid Object Naming (RO)	72 items; measures the speed with which an individual can name a series of objects on two pages
Rapid Digit Naming (RD)	72 items; measures the speed with which an individual can name the numbers on two pages
Rapid Letter Naming (RL)	72 items; measures the speed with which an individual can name the letters on two pages
Blending Nonwords (BN)	18 items; measures an individual's ability to combine speech sounds to make nonwords
Segmenting Words (SW)	20 items; measures an individual's ability to say the separate phonemes that make up a word
Segmenting Nonwords (SN)	20 items; measures an individual's ability to say the separate phonemes that make up a nonword
Phoneme Reversal (PR)	18 items; measures the extent to which an individual can reorder speech sounds to form words

Testing Procedures

Because many of the subtests include tasks with which neither the tester nor the examinee has had prior experience, all procedures have been designed to help ensure that the examinee has a clear understanding of what is expected. An example is phoneme reversal (hearing separate sounds and then saying them in reverse order to create a word), where the tester would say the sounds like, /p/-/m/-/u/-/j/, and ask the child what the word is if the sounds were reversed. All subtests include practice items. Feedback required in the practice items verifies whether or not the examinee has a clear conception of the task. Further, on all the timed subtests (all subtests beginning with "Rapid"), prompting is used. This means that if an individual waits longer

than 2 seconds on an item, he is prompted to move to the next item. Prompting ensures that examinees attempt as many items as possible. If an individual cannot successfully complete the practice items, the subtest is discontinued. All subtests begin administration with the first item and continue until a ceiling is achieved, or until the last item has been administered.

Test Scores and Their Interpretation

The CTOPP yields six kinds of scores: raw scores, age and grade equivalents, percentiles, and standard scores (scale scores) for the subtests, and composite scores. These scores generate the most significant information about CTOPP performance because the analysis of them, strengthened by (a) added test informa-

tion, (b) direct observation of behavior, and (c) knowledge acquired from other sources, will ultimately result in a proper diagnosis of the individual's phonological processing problem (Wagner, 1999).

Normative Information

The CTOPP was normed on a sample of 1,656 persons from 30 states. Four norming sites representing each of the four major U.S. geographic regions resulted in a normative sample representative of the nation as a whole. The norming sites were chosen by three methods for randomization purposes. The first method was contacting psychologists and speech-language pathologists who had participated in previous norming efforts with PRO-ED. Purchasers of the *Test of Phonological Awareness* (Torgesen & Bryant, 1994) were also contacted and, in addition, the authors established major sites in Tallahassee, Florida; Kansas City, Kansas; and Auburn, Washington.

Norms for the CTOPP subtests are given in standard scores having a mean of 10 and standard deviation of 3. Composite scores are based on a distribution with a mean of 100 and a standard deviation of 15. Percentiles of the subtests and composite scores, as well as age and grade equivalents, are published in the CTOPP manual (1999).

Test Reliability and Validity

The CTOPP reports a high degree of reliability that is consistent across three types of potential test error: content, time and error. The strength of the coefficients robustly infers that the CTOPP includes little test error and that users, therefore, can have confidence in its results.

Tests are basically valid if they measure what they propose to measure. The CTOPP reports three types of validity: content description, criterion prediction, and construct identification. The statistics proved strong across all of the validities, which sug-

gest that the CTOPP is a valid measure of phonological processing skills and test examiners can use the CTOPP with confidence.

Conclusion

Based on the CTOPP manual and current research, it is clear that the *Comprehensive Test of Phonological Processing* fulfills stated requirements with regard to being a valid and reliable test measuring the phonological processing skills of an individual (in the United States) from 5- through 24-years-old (Wagner et al., 1999).

In addition, the CTOPP makes four major contributions to the testing community. It identifies individuals who are significantly below their peers in essential phonological abilities and it establishes strengths and weaknesses among developed phonological processes. The CTOPP records individuals' phonological processing skills as a result of special intervention programs. Finally, it serves as a measurement device in research studies examining phonological processing. The authors of the CTOPP encourage further study of this test using different samples, statistical procedures, and related measures, so the results can be shared and the findings can be included in subsequent editions of the manual (Wagner et al., 1999).

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