Exploring the Predictive Validity of RAN Measures and Their Role in Dyslexia Screening Decisions

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Introduction

Rapid Automatized Naming (RAN) is a task that involves quickly and accurately naming repeated sets of familiar items. Although RAN is typically a good predictor of future reading problems, difficulties with RAN do not impact reading skills as much as difficulties with phonological awareness (PA). When students have strong PA skills but have weaker skills with RAN, the impact on reading skills is typically milder than when students have difficulties with both RAN and PA.

While there is considerable research support for RAN as a strong predictor of reading skill, variation in the strength of the relation between RAN and reading is also evident. A research-based means to directly improve RAN is not known. However, there is evidence to suggest that meaningful improvement in reading skills is associated with improvements in RAN.

The Acadience RAN measures are brief assessments that are individually administered. They are based on established procedures for creating and interpreting RAN tasks used in decades of research by multiple researchers. Acadience RAN is composed of three brief measures: RAN Objects, RAN Letters, and RAN Numbers. Students begin with RAN Objects and proceed to RAN Letters. RAN Numbers is only administered to students who discontinue on the RAN Letters task. A Spanish version of Acadience RAN is also available.

A relative unknown in the research on Acadience RAN is the extent to which it provides information for predicting reading skills above and beyond extant measures of reading skill. Some researchers view RAN as a unique piece of information for understanding a child's reading skill. On the other hand, there has been some speculation that screening for RAN ability can be adequately accommodated using existing measures of reading skills, specifically Letter Naming Fluency. The goal of this research was to examine the extent to which Acadience RAN predicts later reading outcomes while controlling for existing measures of reading.

Acadience RAN

With Acadience RAN, students begin with RAN Objects and proceed to RAN Letters. RAN Numbers is only administered to students who discontinue on the RAN Letters task. Design specifications are provided in the *Acadience RAN Assessment Manual* (Powell-Smith et al., 2020), available from www.acadiencelearning.org.

Acadience RAN may be administered at the beginning, middle, and end of kindergarten and first grade. Administration of each measure begins with a practice activity to ensure student familiarity with the items. Students are presented with a practice page and asked to name the items. Feedback and correction is provided by the assessor. If the student makes an error on any practice item, a second practice trial is given using the same practice page and directions. If the student makes an error on any practice item during the second trial, the measure is discontinued and the student is administered the next measure. After the practice activity, the student is shown a page containing five items (i.e., objects, letters, or numbers) repeated at random over 10 rows and is asked to name the items as quickly as possible. The assessor follows along and indicates items named correctly or incorrectly, skipped over, or not named within 3 seconds. If the student makes four errors in the first two rows, the measure is discontinued and the student is administered the next measure. The final scores reported for each measure are (a) the total time, in seconds, the student takes to complete the measure; and (b) the number of errors the student made on the measure. If the student met the discontinue rule, no scores are recorded for that measure.

Time scores of the three Acadience RAN measures were each considered separately. Every student had a score for RAN Objects, but since RAN Numbers was only used as an alternative for students who discontinued on RAN Letters, each student was assessed with RAN Numbers or RAN Letters, but not both. Because of this alternative, the number of students with each measure was not equal. In addition to the time scores for each measure, a RAN Total score was created and examined. The RAN Total score was composed of either (a) the sum of Objects and Letters *or* (b) the sum of Objects and Numbers.

Acadience Reading K–6

Acadience Reading K–6 assesses the essential early literacy and reading skills identified by the National Reading Panel (2000) and National Research Council (1998) that every child must master to become a proficient reader. The measures serve as indicators of these essential early literacy and reading skills: phonemic awareness, alphabetic principle and phonics, accurate and fluent reading of connected text, and reading comprehension. The measures are used for universal screening and progress monitoring in kindergarten through sixth grade, with a focus on early identification and prevention of later reading difficulties.

The Acadience Reading measures typically collected in kindergarten and first grade are Letter Naming Fluency (LNF), First Sound Fluency (FSF), Phoneme Segmentation Fluency (PSF), Nonsense Word Fluency (NWF), Oral Reading Fluency (ORF), and the Reading Composite Score (RCS). Due to insufficient sample size at the middle and end of first grade, Acadience Reading scores for these times of year were not included in analysis. *Table 1* provides a summary of when LNF, FSF, PSF, and NWF were collected in kindergarten and first grade. The RCS was calculated for the beginning, middle, and end of kindergarten and the beginning of first grade.

Table 1. Acadience Reading K–6 Data Collection Timeline by Grade and Time of Year

	Kindergarten			First Grade
Measure	Beginning	Middle	End	Beginning
LNF	X	X	X	X
FSF	X	X		
PSF		X	X	X
NWF CLS		X	X	X
NWF WWR		X	X	X

Note. LNF = Letter Naming Fluency; FSF = First Sound Fluency; PSF = Phoneme Segmentation Fluency; NWF CLS = Nonsense Word Fluency Correct Letter Sounds; NWF WWR = Nonsense Word Fluency Whole Words Read.

Analyses

The incremental validity of Acadience RAN was tested by examining a series of regression models. The first model predicted later Reading Composite Scores (e.g., end of year) from earlier Reading Composite Scores (e.g., beginning of year). The second regression model added the particular RAN score being tested. This same process was repeated replacing the RCS with students' LNF scores. The change in *R*-squared values predicting later Reading Composite Scores provided a measure of how much additional variance was explained by adding the RAN measure. Large changes in *R*-squared imply that Acadience RAN is predicting a significant amount of additional variability above and beyond either the concurrent RCS or the concurrent LNF score, which would justify the use of Acadience RAN as an additional high-quality predictor of later reading outcomes.

Several linkages were examined with respect to predicting later outcomes. Beginning-of-year scores were used to predict both middle- and end-of-year scores. Middle-of-year scores were used to predict both the end-of-year scores in kindergarten and beginning-of-year scores in first grade. Finally, the end-of-year scores in kindergarten were used to predict the beginning-of-year first-grade RCS. This process resulted in five total linkages across time, with the three RAN measures and RAN Total assessed at each linkage while controlling for RCS or LNF, yielding a total of 40 models (5 linkages x 4 RAN options x 2 covariates) to assess the incremental validity of Acadience RAN. This process was also used in a logistic regression context to predict later Acadience Reading benchmark status, as opposed to the numerical Acadience Reading Composite Score. Because of the planned missing data pattern with RAN Letters and RAN Numbers, regression models were run using Full Information Maximum Likelihood (FIML), as opposed to Ordinary Least Squares, as FIML has been shown to have better statistical properties with the presence of missing data.

Results

The results of the models described are displayed in *Figures 1–4*. *Figure 1* shows the incremental *R*-squared values for each linkage while controlling for the concurrent RCS for each student. *Figure 2* shows the incremental *R*-squared values for each linkage while controlling for concurrent LNF scores. Both figures show largely the same pattern regarding the incremental validity of RAN. In every case, RAN explained additional variation in the RCS outcome, regardless of controlling for the RCS or LNF. At the beginning of year, the incremental variance explained was substantial, with approximately 10% of additional variance in middle-of-year RCS explained by the RAN Total score, even controlling for beginning-of-year RCS. This incremental validity was also present when controlling for LNF. The additional variance explained by RAN declined somewhat at later times of year, but always remained substantial and statistically significant. These results suggest that RAN is adding predictive power above and beyond already existing reading measures.

While RAN is adding significant variance explained, this effect is not uniform. *Figure 3* shows a breakdown of individual RAN measures in the linkage from beginning to middle of year in kindergarten. *Figure 4* shows the breakdown of individual RAN measures in the linkage from beginning to end of year in kindergarten. As evidenced by both figures, the incremental validity of RAN Objects is substantially lower than RAN Letters, RAN Numbers, or the RAN Total score. RAN Letters in particular provides an enormous boost to variance explained, with approximately 20% of the variation in middle-of-year RCS being accounted for by RAN Letters when controlling for LNF. This suggests that not every subtest of RAN is an equally powerful predictor of later reading outcomes, however the RAN Total score is still a powerful predictor. Not only is the incremental validity not uniform across RAN measures, but validity seems to differ by time of year as well. At the beginning of kindergarten, RAN makes a substantial contribution to predicting later Reading Composite Scores, but as time progresses this effect tends to diminish. For example, while always significant, the incremental validity (holding concurrent RCS constant) of RAN Total drops from approximately 10% additional variance explained when predicting middle- and end- of-year kindergarten scores from beginning of year, to less than 3% when explaining beginning-of-year first-grade RCS from end-of-year kindergarten RAN Total. It should be noted that because of the aforementioned differences in sample size for the RAN measures, these measures of incremental validity are built on different sample sizes, so there are differing degrees of confidence in each incremental validity estimate. Despite this sample size difference, it appears that RAN is measuring truly powerful and unique information at the beginning of kindergarten, but this information slowly becomes subsumed by the other existing reading measures.

Figure 1. Incremental Validity of RAN Total and Acadience Reading Composite Score

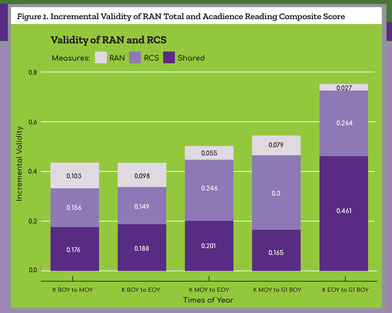


Figure 2. Incremental Validity of RAN Total and Acadience Reading Letter Naming Fluency

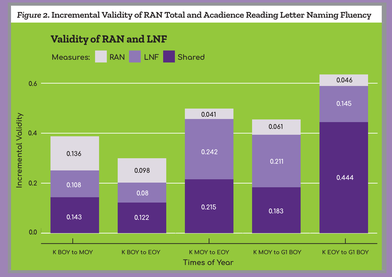


Figure 3. Incremental Validity of Individual RAN Measures from Beginning to Middle of Year

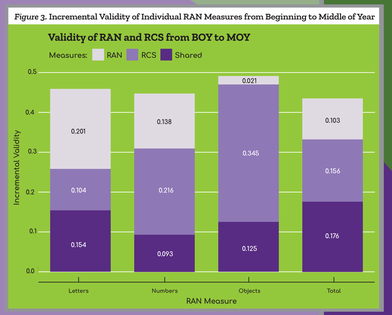
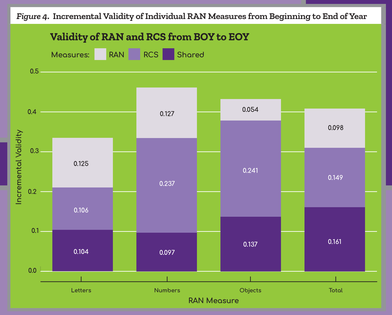


Figure 4. Incremental Validity of Individual RAN Measures from Beginning to End of Year



RAN and Classification Accuracy

While predicting numerical scores can be helpful and informative, Acadience Reading measures are built to assess a student's benchmark status on reading. As such, incremental validity was also examined as the extent to which RAN contributes to the prediction of later benchmark status. The outcome was predicting which students would be At or Above Benchmark at a later time point, and a logistic regression was used with either the RCS or LNF as the initial predictor, then the RAN Total score was added. The extent of incremental validity was the extent to which adding RAN to the logistic regression improved the classification accuracy. Classification accuracy was assessed using the area under the receiver operating characteristic curve (AUC). Models with no predictors have an AUC of .50, and the extent to which the AUC is above .50 indicates that the model does a better-than-chance job of classifying later student outcomes.

We compared separate models in their ability to classify which students would be At or Above Benchmark at later times. Results are shown in *Table 2*. The first column provides a baseline value of .50 with no predictors. The next two columns compare a model with just the RCS and another with RCS and RAN. The last two columns compare a model with just LNF and another with LNF and RAN. In both comparisons, the results closely resemble the results observed for predicting continuous RCS outcomes. RAN adds a substantial amount of classification accuracy at the beginning of kindergarten, indicating that RAN could be important for identifying those students who are less likely to achieve later reading goals. RAN continues to improve classification accuracy at later times of year in kindergarten, though again this added benefit tends to diminish later in the year. Overall, whether controlling for RCS or LNF, RAN provides unique and meaningful information for predicting later reading outcomes.

Table 2. AUCs with RAN and Acadience Measures Predicting Later Benchmark Status

Linkage	None	RCS Only	RCS + RAN	LNF Only	LNF + RAN
K BOY to K MOY	.50	.69	.76	.63	.74
K BOY to K EOY	.50	.66	.75	.65	.75
K MOY to K EOY	.50	.83	.85	.83	.85
K MOY to G1 BOY	.50	.80	.84	.80	.83
K EOY to G1 BOY	.50	.88	.90	.86	.87

Note. RCS = Reading Composite Score; BOY = beginning of year; MOY = middle of year; EOY = end of year; AUC = area under the receiver operating characteristic curve.

Does RAN Matter?

This poster presents results concerning the criterion-related validity of Acadience RAN and the extent to which Acadience RAN provides incremental validity for predicting later reading outcomes, independent of RCS or LNF performance. There has been some conjecture regarding whether the information contained in RAN measures is unique with respect to predicting later reading outcomes. The results presented here suggest that RAN is not only strongly related to later reading outcomes, but also adds significant variability explained, independent of the RCS or LNF. These results suggest that Acadience RAN provides another useful tool for identifying those students who are at risk for future reading difficulties, including dyslexia.

The use of RAN at the beginning of kindergarten is an especially powerful predictor of later outcomes. Year-to-year correlations are typically lower from kindergarten to first grade than for any other cross-year correlation because of the myriad additional influences on kindergarten scores that have not yet been "leveled off" by the beginning of formal instruction. Individual differences in RAN are likely reflections of pre-K processes that differ across students, rather than a measure that can be impacted directly by instruction. RAN is another tool that instructors can use to make informed decisions for their students and a tool that is especially informative at the time when student reading skills are especially dynamic.

While RAN showed incremental validity for all times of year that were examined, the additional variance explained diminished substantially by the middle and end of kindergarten. Interestingly, the overall variance explained for RAN either with LNF or the RCS did not decrease across this same timeframe. One potential explanation for this phenomenon is that the information gained by administering RAN begins to overlap more with the RCS and LNF at the later time points in kindergarten. Future research should aim at disentangling the development of RAN with other features of early reading skill to further determine how RAN predicts important reading outcomes.

Summary

We examined Acadience RAN with respect to being able to predict future reading outcomes, even controlling for concurrent reading skills. We found that Acadience RAN adds powerful predictive capability, above and beyond the Acadience Reading Composite Score from the same time. This predictive ability was present both when predicting the Reading Composite Score and classifying student benchmark status. However, the additional variation explained by Acadience RAN had the tendency to decrease across time such that the effect was weaker by the end of kindergarten versus the beginning. Educators can profitably use RAN to increase precision with screening decisions for students at-risk for reading difficulties.

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