Is "Response/No Response" Too Simple a Notion for RTI Frameworks?

Exploring Multiple Response Types with Latent Profile Analysis

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Background

One of many challenges facing researchers, practitioners, and policymakers who support implementation of early reading intervention is that at-risk children do not respond similarly to a given program, including those shown to be generally successful. "Response-to-intervention" research in the last two decades has documented this fact time and again. Researchers have tended to describe response as a binary phenomenon: an adequate or better response (program participants demonstrate greater pre-to-posttreatment reading growth than control students) and an inadequate response (participants do no better than controls from pre-to-posttreatment). Efforts to document response have contributed to a developing understanding of relations between early reading problems and efficacious reading interventions. However, the typical "response/no response" perspective may not capture what we suspect is a more complex picture of response and how it may be affected by individual differences.

Research Questions

With the latent profile analysis based on word reading performance at pretreatment, posttreatment, and 1-year follow-up, we aimed to determine 1) whether there are multiple response types in a treatment group of 143 at-risk first-grade readers who generally benefitted from an empirically-validated early reading program (Authors, 2019); and 2) to identify which pretreatment domain-general skills (working memory, non-verbal reasoning, and processing speed) and domain-specific skills (letter knowledge, decoding, passage comprehension, and language) differentiate among them.

Methods

Setting and Participants

Participants were 143 children identified as "at-risk readers" in fall of first grade who had been recruited for a large-scale randomized control trial of an intensive, early reading program (cf. Authors, 2019). The randomized control trial was implemented in three successive years. The children in the current study had been assigned in Years 2 and 3 to the treatment groups. Hence, they represented two cohorts each of whom was followed into second grade. Table 1 and Table 2 present study measures, child demographics, and correlations among variables.

Intervention

There were two treatment conditions. The first focused on building decoding and reading fluency; the second, on strengthening decoding, reading fluency, and reading comprehension. Both treatments were delivered on a 1:1 basis, three times per week, 45 min per session, for 21 weeks, totaling 47.25 hours of instruction (45 min per session x 63 sessions). Students in the two treatment groups together performed significantly more strongly than controls on word reading and reading comprehension (Hedges $g > .40$, ps $< .01$), but did not perform differently from each other (ps $> .50$). On this basis, the treatment groups were combined in analyses for this paper.

Data Analysis

Latent profile analysis was conducted with the word reading score across three time points. We used the mean and standard deviation of the control group at each time point to transform treatment students' scores into z scores. Because we were modeling time-series data and were not able to model curvature with the three time points, we allowed word reading at each point to co-vary within class in the model using M*plus* 8.1. Predictors of response-profile membership were added to the latent analyses as auxiliary variables by the R3STEP function.

Results

As table 3, 4, and *Figure* 1 show, we identified four response groups. Based on the *z*

scores and group comparisons, we described the four profile groups—1 through 4,

respectively— as follows: "mildly responsive" children with stronger initial performance;

"mildly non-responsive" children with stronger initial performance; "strongly non-responsive"

children with weaker initial performance; and "strongly responsive" children with stronger initial

performance. As Table 5 shows, the mildly responsive group showed stronger pretreatment letter

knowledge than the mildly non-responsive group and greater pretreatment decoding and passage

comprehension than the strongly non-responsive group. The strongly responsive group showed

more impressive pretreatment passage comprehension than the strongly non-responsive group.

The mildly non-responsive group showed better pretreatment decoding and passage

comprehension than the strongly non-responsive group. We did not find pretreatment domain-

general skills (i.e., working memory, non-verbal reasoning, and processing speed) to

significantly predict the four response types.

Conclusion

Given the our intervention's focus, intensity, and fidelity with which it was implemented,

it perhaps shouldn't be surprising that 58% of the treated children (41% and 17% from the mildly

responsive and strongly responsive groups, respectively) showed better-than-control word

reading performance at posttreatment in grade 1 and follow-up in grade 2 (*z* scores > .60; see

Table 4 and *Figure* 1). The mildly responsive and strongly responsive groups were comparable

to each other and were similar to controls at pretreatment (*z* scores = .33 ~.45). However, at

posttreatment and follow-up, the two groups demonstrated stronger reading performance than

controls (z scores = .64 ~ 1.84). We believe this superiority over controls reflects program effects, especially in the case of the strongly responsive group.

Notwithstanding this rather upbeat conclusion, we also found program participants who were either strongly non-responsive or mildly non-responsive (6% and 36% of the treated sample, respectively). The mildly non-responsive group performed similarly to controls at pre- and posttreatment in first grade (z scores = -.08 ~.05), but lagged behind them in second grade when they were no longer participating in the reading program (z score = -.46). It is possible that the reading program kept this mildly non-responsive group abreast of the average control-group performance during their participation in the first-grade program and, when it was withdrawn, they could no longer keep up.

Predictors of Variation of Responsiveness

Domain-specific skills differentiated the responsive groups from the non-responsive groups and the two non-responsive groups from each other, highlighting the importance of domain-specific skills in early reading development (Chall, 1983; Ehri, 2005; National Reading Panel, 2000; Stanovich, 2009). Reading comprehension differentiated the two responsive groups from the strongly non-responsive group and distinguished the two non-responsive groups from each other (see Table 5). This finding remained even when word-level skills (letter knowledge and decoding) and language skills were considered simultaneously in the analyses. In contrast, pretreatment domain-general skills did not predict the latent profiles, which is consistent with some prior reading research (e.g., Stuebing et al., 2009; 2015). [984 words]

Table 1
Descriptive Statistics

Demographics and Test Performance	*N*	Mean	SD	Skewness	Kurtosis	Min	Max
Gender (male)	142 (85)	-	-	-	-	-	-
FRL	141 (117)	-	-	-	-	-	-
IEP	130 (7)	-	-	-	-	-	-
Caucasian, Black, Hispanic, Other	44,56,27,15	-	-	-	-	-	-
ELL	139 (20)	-	-	-	-	-	-
Rapid Sound Naming	143	28.23	10.97	0.70	2.55	0.00	76.00
Rapid Letter Naming	143	38.51	12.61	-0.36	1.02	0.00	71.00
Phonemic Decoding Efficiency	143	2.85	3.06	1.09	0.41	0.00	12.00
Word Attack	143	2.82	2.95	0.79	-0.60	0.00	10.00
Vocabulary	143	17.29	6.39	-0.37	0.27	0.00	33.00
Listening Comprehension	143	12.47	5.04	-0.23	-0.63	0.00	22.00
Passage Comprehension	143	9.46	2.91	-0.02	-0.46	3.00	17.00
Non-verbal Reasoning	143	7.05	4.32	1.07	0.98	1.00	22.00
Listening Recall	143	2.21	2.88	1.18	0.91	0.00	12.00
Processing Speed	84	7.94	2.59	0.13	-0.20	1.00	14.00
Word-Grade0 (fall, grade 1)	143	10.66	4.55	-0.36	-0.14	0.00	21.00
Word-Grade1 (spring, grade 1)	139	33.43	9.89	0.11	0.09	10.00	56.00
Word-Grade2 (spring, grade 2)	127	43.76	11.30	-0.14	-0.58	18.00	70.00

Note. N = the number of data points. FRL: Free/Reduced lunch status; ELL: English language learning status; Rapid Sound Naming: Rapid Sound Naming Test (D. Fuchs et al., 2001); Rapid Letter Naming: Rapid Letter Naming Test (D. Fuchs et al., 2001); Phonemic Decoding Efficiency: TOWRE-Phonemic Decoding Efficiency (Torgesen et al., 1999); Word Attack: WMRT-R-Word Attack (Woodcock, 1998); Vocabulary: WASI-Vocabulary (Wechsler, 1999); Listening Comprehension: WJ3-Oral Comprehension Subtest (Woodcock, 2001); Passage Comprehension: WRMT-R-Passage Comprehension Subtest (Woodcock, 1998); Non-verbal Reasoning: WASI-Matrix Reasoning Subtest (Wechsler, 1999); Listening Recall: WMTB-Listening Recall (Pickering & Gathercole, 2001); Processing Speed: WJ3-Cross Out Subtest (Woodcock et al., 2001); Word-Grade 0-2: The Sight Word Efficiency subtest of the TOWRE (Torgesen et al., 1999) at the beginning of 1st grade, the end of 1st grade, and the end of 2nd grade, respectively.

Table 2

Correlations among Variables

Pretreatment Measures	1	2	3	4	5	6	7	8	9	10	11	12
1. Rapid Sound Naming	-											
2. Rapid Letter Naming	.36**											
3. Phonemic Decoding Efficiency	.29**	.30**										
4. Word Attack	.20*	.25**	.69**									
5. Vocabulary	.07	.14	.27**	.21*								
6. Listening Comprehension	.15	.14	.27**	.20*	.58**							
7. Passage Comprehension	.21*	.01	.30**	.28**	.10	.30**						
8. Non-verbal Reasoning	.06	-.08	.17*	.20*	.09	.29**	.25**					
9. Listening Recall	.18*	.14	.26**	.34**	.24**	.33**	.32**	.29**				
10. Processing Speed	.25*	.24*	.22*	.29**	.10	.17	.15	.47**	.31**			
11. Word-Grade0	.44**	.30**	.34**	.31**	.17*	.27**	.56**	.14	.14	.13		
12. Word-Grade1	.25**	.16	.12	.22*	.002	.18*	.37**	.13	.12	.12	.38**	
13. Word-Grade2	.28**	.16	.21*	.189*	.04	.23*	.31**	.16	.11	.12	.33**	.81**

Note: **$p < .001$. Rapid Sound Naming: Rapid Sound Naming Test (D. Fuchs et al., 2001); Rapid Letter Naming: Rapid Letter Naming Test (D. Fuchs et al., 2001); Phonemic Decoding Efficiency: TOWRE-Phonemic Decoding Efficiency (Torgesen et al., 1999); Word Attack: WMRT-R-Word Attack (Woodcock, 1998); Vocabulary: WASI-Vocabulary (Wechsler, 1999); Listening Comprehension: WJ3-Oral Comprehension Subtest (Woodcock, 2001); Passage Comprehension: WRMT-R-Passage Comprehension Subtest (Woodcock, 1998); Non-verbal Reasoning: WASI-Matrix Reasoning Subtest (Wechsler, 1999); Listening Recall: WMTB-Listening Recall (Pickering & Gathercole, 2001); Processing Speed: WJ3-Cross Out Subtest (Woodcock et al., 2001); Word-Grade 0-2: The Sight Word Efficiency subtest of the TOWRE (Torgesen et al., 1999) at the beginning of 1st grade, the end of 1st grade, and the end of 2nd grade, respectively.

Table 3

Model Fit Statistics from Latent Profile Analyses on the Treatment Group

Model for The Treatment Group	ABIC	ΔABIC	Entropy	LMR-LRT
2 Profiles	986.44		.78	10.57, p = .44
3 Profiles	982.32	-4.12	.69	10.78, p = .75
4 Profiles	**971.06**	**-11.26**	**.85**	**17.57, p = .23**
5 Profiles	971.06	0	.84	6.85, p = .67
6 Profiles	964.26	-6.80	.82	10.04, p = .65

Note. ABIC: Sample Size Adjusted Bayesian Information Criterion; LMR-LRT = Lo-Mendel-Rubin Likelihood Ratio Test. ΔABIC: changes on ABIC between the current set of profiles and the previous set of profiles.

Table 4

Descriptive Statistics of Different Profile Groups on Word Reading Performance across Three Time Points

Variables	Strongly Responsive (n = 24)			Mildly Responsive (n = 58)			Mildly Non-Responsive (n = 52)			Strongly Non-Responsive (n = 9)		
	Mean (%tile)	SD	*z*	Mean (%tile)	SD	*z*	Mean (%tile)	SD	*z*	Mean (%tile)	SD	*z*
Word-Grade0	11.75 (48.92)	4.52	.33	12.14 (50.03)	4.36	.45	9.69 (44.69)	3.48	-.08	3.89 (28.22)	4.37	-1.32
Word-Grade1	48.13 (84.26)	5.86	1.84	35.54 (70.38)	4.98	.70	27.77 (57.63)	4.83	.05	13.25 (28.63)	2.82	-1.21
Word-Grade2	59.39 (78.65)	3.95	1.50	48.29 (53.96)	3.68	.64	34.46 (27.22)	3.70	-.46	20.57 (7.86)	2.00	-1.54

Note. * *p* < .05; ** *p* < .001.
Word-Grade 0-2: The Sight Word Efficiency subtest of the TOWRE (Torgesen et al., 1999) at the beginning of 1st grade, the end of 1st grade, and the end of 2nd grade, respectively. %tile = Percentile rank based on the national norm of The Sight Word Efficiency subtest of the TOWRE; *z* = *z* scores using the controls as a local norm at each time point.

Table 5

Pretreatment Domain-General and Domain-Specific Skills Predicting the Group Membership

Variables	Strongly Responsive vs. Mildly Responsive		Strongly Responsive vs. Mildly Non-Responsive		Strongly Responsive vs. Strongly Non-Responsive		Mildly Responsive vs. Mildly Non-Responsive		Mildly Responsive vs. Strongly Non-Responsive		Mildly Non-Responsive vs. Strongly Non-Responsive	
	Coef (*SE*)	*p*	Coef (*SE*)	*P*	Coef (*SE*)	*p*	Coef (*SE*)	*P*	Coef (*SE*)	*p*	Coef (*SE*)	*p*
Working Memory	-.09 (.27)	.74	.06 (.27)	.84	-.69 (.53)	.20	.15 (.20)	.46	-.60 (.46)	.20	-.74 (.46)	.11
Non-Verbal Reasoning	-.01 (.12)	.95	.06 (.10)	.52	.07 (.20)	.71	.07 (.10)	.46	.08 (.20)	.67	.01 (.15)	.94
Processing Speed	.11 (.19)	.58	-.10 (.20)	.61	-.07 (.36)	.85	-.21 (.11)	.06	-.17 (.27)	.52	.03 (.26)	.90
Letter Knowledge	-.81 (.50)	.11	.59 (.53)	.26	1.59 (1.50)	.29	**1.40 (.35)**	**< .001**	2.40 (1.88)	.20	1.00 (1.89)	.60
Decoding	-.91 (.59)	.13	-.62 (.58)	.28	1.03 (.73)	.16	.28 (.44)	.52	**1.94 (.48)**	**< .001**	**1.66 (.63)**	**.01**
Language	1.02 (.55)	.07	.87 (.53)	.10	.67 (.90)	.45	-.16 (.39)	.69	-.35 (.77)	.64	-.20 (.91)	.83
Passage Comprehension	.21 (.24)	.36	.42 (.30)	.16	**1.00 (.28)**	**< .001**	.21 (.32)	.52	**.79 (.36)**	**.03**	**.58 (.21)**	**.01**

Note. Coef = Coefficient; SE = Standard Error;
Letter Knowledge: the factor score of Rapid Sound Naming (D. Fuchs et al., 2001) and Rapid Letter Naming (D. Fuchs et al., 2001); Decoding: the factor score of TOWRE-Phonemic Decoding Efficiency (Torgesen et al., 1999) and WMRT-R-Word Attack (Woodcock, 1998); Language: the factor score of WASI-Vocabulary (Wechsler, 1999) and WJ3-Oral Comprehension Subtest (Woodcock, 2001); Passage Comprehension: WRMT-R-Passage Comprehension Subtest (Woodcock, 1998); Non-verbal Reasoning: WASI-Matrix Reasoning Subtest (Wechsler, 1999); Working Memory: WMTB-Listening Recall (Pickering & Gathercole, 2001); Processing Speed: WJ3-Cross Out Subtest (Woodcock et al., 2001).
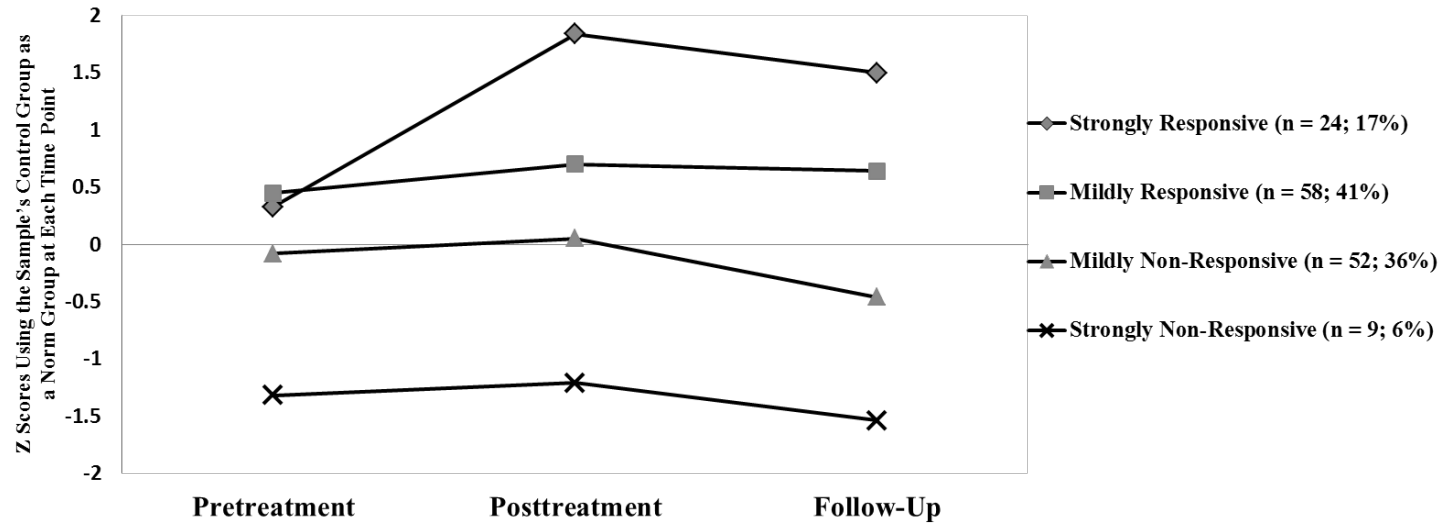
Figure 1. Latent Profile Groups across Three Time Points