# Preliminary Results, Scales and Seasonal Assessments of Three-Year-Old Students Expanding Individual Growth & Development Indicators of Language and Early Literacy for Universal Screening in Multi-Tiered Systems of Support with Three-Year-Olds

Technical Report #8

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This Technical Report presents preliminary findings or intermediary results of our work. Please contact the authors for a more up-to-date version or for permission before citing or distributing. For more information, email igdilab@umn.edu.

Scott McConnell, Alisha Wackerle-Hollman, and colleagues developed Individual Growth and Development Indicators, or *IGDIs*. Intellectual property from this research has been licensed to Early Learning Labs, Inc., and subsequently to Renaissance Learning for commercial development and sale. Scott and the University of Minnesota have royalty and equity interest in Renaissance Learning. These relationships have been reviewed and managed by the University of Minnesota in accordance with its conflict of interest policies.

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**Abstract**

This document presents preliminary results for IGDI seasonal assessments designed for 3-year-olds (IGDI3 measures). The areas of focus for this report are sample characteristics and scale characteristics. Scale characteristics are presented for each of the IGDI3 measures (oral language, alphabet knowledge, and phonological awareness). Additionally, we present results of preliminary analyses of scaling within measures when different item types are included within a measure. This document also presents a descriptive plan for our continued analyses of data from IGDI3 measures.

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## Project Introduction

This document has been developed as part of a four year (2016 – 2020) research and development project funded by the Institute of Education Sciences, *Expanding Individual Growth & Development Indicators of Language and Early Literacy for Universal Screening in Multi-Tiered Systems of Support with 3-Year-Olds*. The overarching purpose of this project is to is to extend the practical array of Individual Growth and Development Indicators (IGDIs) for assessing language and early literacy development to 3-year-old preschool children in ways that inform and enhance multi-tiered systems of support, and to enrich current knowledge of the developmental course of language and early literacy development in this early preschool age group. Over the course of this project, we will develop and evaluate measures appropriate for 3-year-old children[1] in areas of oral language, phonological awareness, and alphabet knowledge, assess the psychometric characteristics of these measures (including their classification accuracy for identifying candidates for more intensive intervention) and use these measures to describe growth across time in PK3 and PK4 in ways that help describe the broader domain of language and early literacy development, and that note relations

[1] While we refer to 3-year-old children throughout this report, IGDIs are *not* age-normed nor intended to support inferences of age-based development. Rather, the focus here is development and evaluation of measures and data utilization tools that support assessment of language and early literacy skills that precede, developmentally, those measured by current IGDIs – and that, in broad terms, are likely to be developed by children more than one and less than two years prior to kindergarten entry – a "grade" we reference as PK3.

between achievement in this area and characteristics of services children receive in early childhood classrooms.

**Purpose of this Report**

This document presents preliminary results for IGDI seasonal assessments designed for 3-year-olds (IGDI3 measures). The areas of focus for this report are sample characteristics and scale characteristics. Scale characteristics are presented for each of the IGDI3 measures (oral language, alphabet knowledge, and phonological awareness). This document also presents a descriptive plan for our continued analyses of data from IGDI3 measures.

## Preliminary Results

**Sample Characteristics**

This section summarizes the sample of children completing IGDI3 measures in year 3, by season (fall, winter, spring) and by domain (oral language, alphabet knowledge, and phonological awareness). Domains are sometimes referred to as measures, and are abbreviated as OL for oral language, AK for alphabet knowledge, and PA for phonological awareness.

The following table shows for each domain and formid the corresponding season of administration (fall, winter, spring), test type (computerized adaptive test CAT or linear), total number of item responses in the data set (n_responses), number of unique children (n_children), and the number of unique items (n_items). Note that, with CAT, the items within the form would be generated adaptively for each test taker. With a linear form, all children taking the form would see the same set of items.

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*Table of information for domains and formid*

| domain | formid | season | test_type | n_responses | n_children | n_items |
|---|---|---|---|---|---|---|
| si | 011119003 | spring | linear | 5025 | 201 | 25 |
| rh | 041119003 | spring | linear | 5275 | 211 | 25 |
| pa | 221118001 | fall | cat | 10375 | 415 | 76 |
| pa | 221119001 | winter | cat | 9950 | 398 | 75 |
| pa | 221119002 | spring | cat | 5025 | 201 | 65 |
| pa | 221119003 | spring | linear | 5400 | 216 | 25 |
| ak | 271118001 | fall | cat | 10600 | 424 | 143 |
| ak | 271119001 | winter | cat | 10200 | 408 | 143 |
| ak | 271119002 | spring | cat | 5300 | 212 | 143 |
| ak | 271119003 | spring | linear | 4975 | 199 | 25 |
| ol | 281118001 | fall | linear | 6244 | 223 | 28 |
| ol | 281118002 | fall | linear | 2856 | 102 | 28 |
| ol | 281118003 | fall | linear | 3024 | 112 | 27 |
| ol | 281118004 | fall | linear | 5805 | 215 | 27 |
| ol | 281118005 | fall | linear | 2727 | 101 | 27 |
| ol | 281118006 | fall | linear | 2943 | 109 | 27 |
| ol | 281119001 | winter | cat | 10275 | 411 | 298 |
| ol | 281119002 | spring | cat | 10275 | 411 | 296 |

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**Scale Characteristics**

Scale characteristics are summarized here for oral language, alphabet knowledge, and phonological awareness. Results for each measure are presented by season, fall, winter, and spring.

**Oral language.** ***Fall administration.*** The fall administration of OL involved six linear forms, each of which combined items, some of them overlapping across forms, from Point to Picture and Picture Naming. Point to Picture items were developed specifically for this study. Picture Naming items came from the age 4 item banks. The goal for fall administration was to evaluate the feasibility of combining both item types into a single measure.

Results from CTT item analyses are presented first, by form. Each table contains the item id, mean scored response (m, also known as p-value or item difficulty), standard deviation (sd), number of responses (n), number of children with missing responses (na), the item total correlation (itc, a measure of item discrimination), the corrected item total correlation (citc), and the alpha internal consistency for the full scale if the item were deleted (aid).

*Item analysis for fall OL formid 281118001*

| | m | sd | n | na | itc | citc | aid |
|---|---|---|---|---|---|---|---|
| 210006 | 0.761 | 0.427 | 222 | 1 | 0.496 | 0.410 | 0.738 |
| 210008 | 0.709 | 0.455 | 220 | 3 | 0.298 | 0.190 | 0.752 |
| 210012 | 0.740 | 0.440 | 219 | 4 | 0.409 | 0.313 | 0.746 |
| 210014 | 0.960 | 0.197 | 223 | 0 | 0.294 | 0.249 | 0.749 |
| 210016 | 0.941 | 0.235 | 222 | 1 | 0.268 | 0.213 | 0.749 |
| 210018 | 0.950 | 0.218 | 222 | 1 | 0.314 | 0.265 | 0.750 |
| 210030 | 0.933 | 0.251 | 223 | 0 | 0.287 | 0.229 | 0.751 |
| 210031 | 0.955 | 0.207 | 223 | 0 | 0.272 | 0.224 | 0.749 |
| 210038 | 0.924 | 0.266 | 223 | 0 | 0.230 | 0.167 | 0.752 |
| 210039 | 0.986 | 0.116 | 221 | 2 | 0.106 | 0.078 | 0.754 |
| 210040 | 0.630 | 0.484 | 219 | 4 | 0.451 | 0.349 | 0.742 |
| 210049 | 0.960 | 0.197 | 223 | 0 | 0.305 | 0.260 | 0.749 |
| 210051 | 0.735 | 0.442 | 223 | 0 | 0.290 | 0.187 | 0.752 |
| 210052 | 0.910 | 0.286 | 223 | 0 | 0.252 | 0.184 | 0.753 |
| 210054 | 0.769 | 0.422 | 221 | 2 | 0.477 | 0.390 | 0.746 |
| 210057 | 0.588 | 0.493 | 221 | 2 | 0.393 | 0.283 | 0.750 |
| 210058 | 0.964 | 0.186 | 223 | 0 | 0.331 | 0.289 | 0.749 |
| 210063 | 0.794 | 0.406 | 223 | 0 | 0.477 | 0.395 | 0.738 |
| 280083 | 0.444 | 0.498 | 196 | 27 | 0.411 | 0.299 | 0.742 |
| 280091 | 0.848 | 0.360 | 204 | 19 | 0.381 | 0.300 | 0.743 |
| 280142 | 0.714 | 0.453 | 203 | 20 | 0.353 | 0.246 | 0.746 |
| 280164 | 0.734 | 0.443 | 203 | 20 | 0.282 | 0.174 | 0.751 |
| 280200 | 0.572 | 0.496 | 201 | 22 | 0.460 | 0.353 | 0.741 |
| 280217 | 0.845 | 0.362 | 207 | 16 | 0.230 | 0.138 | 0.753 |
| 280245 | 0.541 | 0.499 | 205 | 18 | 0.279 | 0.158 | 0.753 |

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| | m | sd | n | na | itc | citc | aid |
|---|---|---|---|---|---|---|---|
| 280257 | 0.462 | 0.500 | 195 | 28 | 0.343 | 0.226 | 0.746 |
| 280299 | 0.341 | 0.475 | 182 | 41 | 0.500 | 0.405 | 0.738 |
| 280333 | 0.562 | 0.497 | 201 | 22 | 0.553 | 0.456 | 0.732 |

*Item analysis for fall OL formid 281118002*

| | m | sd | n | na | itc | citc | aid |
|---|---|---|---|---|---|---|---|
| 210008 | 0.673 | 0.471 | 101 | 1 | 0.409 | 0.305 | 0.786 |
| 210011 | 0.873 | 0.335 | 102 | 0 | 0.568 | 0.510 | 0.776 |
| 210016 | 0.941 | 0.236 | 102 | 0 | 0.442 | 0.395 | 0.784 |
| 210018 | 0.950 | 0.218 | 101 | 1 | 0.519 | 0.479 | 0.783 |
| 210024 | 0.970 | 0.171 | 101 | 1 | 0.343 | 0.306 | 0.788 |
| 210030 | 0.950 | 0.218 | 101 | 1 | 0.312 | 0.260 | 0.788 |
| 210033 | 0.891 | 0.313 | 101 | 1 | 0.379 | 0.312 | 0.786 |
| 210038 | 0.922 | 0.270 | 102 | 0 | 0.496 | 0.444 | 0.783 |
| 210039 | 0.980 | 0.139 | 102 | 0 | 0.450 | 0.423 | 0.787 |
| 210047 | 0.644 | 0.481 | 101 | 1 | 0.377 | 0.272 | 0.788 |
| 210049 | 0.941 | 0.236 | 102 | 0 | 0.553 | 0.512 | 0.781 |
| 210052 | 0.931 | 0.254 | 102 | 0 | 0.469 | 0.420 | 0.783 |
| 210053 | 0.765 | 0.426 | 102 | 0 | 0.450 | 0.362 | 0.782 |
| 210058 | 0.951 | 0.217 | 102 | 0 | 0.349 | 0.301 | 0.787 |
| 210060 | 0.902 | 0.299 | 102 | 0 | 0.402 | 0.339 | 0.785 |
| 210062 | 0.618 | 0.488 | 102 | 0 | 0.383 | 0.276 | 0.790 |
| 210063 | 0.861 | 0.347 | 101 | 1 | 0.403 | 0.329 | 0.785 |
| 210065 | 0.550 | 0.500 | 100 | 2 | 0.190 | 0.062 | 0.802 |
| 280083 | 0.630 | 0.485 | 92 | 10 | 0.465 | 0.368 | 0.782 |
| 280091 | 0.863 | 0.346 | 95 | 7 | 0.320 | 0.244 | 0.788 |
| 280142 | 0.818 | 0.388 | 99 | 3 | 0.293 | 0.204 | 0.790 |
| 280164 | 0.614 | 0.489 | 101 | 1 | 0.428 | 0.325 | 0.785 |
| 280200 | 0.469 | 0.502 | 98 | 4 | 0.325 | 0.213 | 0.791 |
| 280217 | 0.871 | 0.337 | 101 | 1 | 0.439 | 0.370 | 0.782 |
| 280245 | 0.446 | 0.500 | 101 | 1 | 0.304 | 0.190 | 0.793 |
| 280257 | 0.441 | 0.499 | 93 | 9 | 0.408 | 0.300 | 0.786 |
| 280299 | 0.436 | 0.499 | 94 | 8 | 0.440 | 0.336 | 0.782 |
| 280333 | 0.588 | 0.495 | 97 | 5 | 0.589 | 0.504 | 0.773 |

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*Item analysis for fall OL formid 281118003*

| | m | sd | n | na | itc | citc | aid |
|---|---|---|---|---|---|---|---|
| 210007 | 0.955 | 0.207 | 112 | 0 | 0.409 | 0.354 | 0.729 |
| 210008 | 0.794 | 0.406 | 107 | 5 | 0.351 | 0.232 | 0.735 |
| 210013 | 0.982 | 0.133 | 112 | 0 | 0.251 | 0.212 | 0.734 |
| 210016 | 0.964 | 0.187 | 111 | 1 | 0.155 | 0.098 | 0.737 |
| 210018 | 0.964 | 0.187 | 111 | 1 | 0.403 | 0.354 | 0.728 |
| 210019 | 0.982 | 0.133 | 112 | 0 | 0.168 | 0.129 | 0.737 |
| 210026 | 0.973 | 0.162 | 112 | 0 | 0.114 | 0.065 | 0.739 |
| 210030 | 0.991 | 0.095 | 111 | 1 | 0.047 | 0.018 | 0.739 |
| 210038 | 0.955 | 0.207 | 112 | 0 | 0.144 | 0.082 | 0.737 |
| 210039 | 0.982 | 0.134 | 111 | 1 | 0.230 | 0.191 | 0.734 |
| 210044 | 0.865 | 0.343 | 111 | 1 | 0.289 | 0.189 | 0.733 |
| 210049 | 0.946 | 0.226 | 112 | 0 | 0.358 | 0.296 | 0.728 |
| 210050 | 0.964 | 0.187 | 111 | 1 | 0.447 | 0.400 | 0.726 |
| 210052 | 0.920 | 0.273 | 112 | 0 | 0.213 | 0.132 | 0.737 |
| 210058 | 0.991 | 0.095 | 111 | 1 | 0.310 | 0.284 | 0.734 |
| 210063 | 0.786 | 0.412 | 112 | 0 | 0.526 | 0.426 | 0.718 |
| 210064 | 0.732 | 0.445 | 112 | 0 | 0.521 | 0.412 | 0.716 |
| 280083 | 0.750 | 0.435 | 108 | 4 | 0.589 | 0.490 | 0.710 |
| 280091 | 0.846 | 0.363 | 104 | 8 | 0.425 | 0.323 | 0.726 |
| 280142 | 0.809 | 0.395 | 110 | 2 | 0.511 | 0.412 | 0.718 |
| 280164 | 0.583 | 0.495 | 108 | 4 | 0.303 | 0.155 | 0.739 |
| 280200 | 0.382 | 0.488 | 110 | 2 | 0.353 | 0.214 | 0.736 |
| 280217 | 0.890 | 0.314 | 109 | 3 | 0.173 | 0.079 | 0.741 |
| 280245 | 0.524 | 0.502 | 105 | 7 | 0.392 | 0.255 | 0.733 |
| 280257 | 0.429 | 0.497 | 105 | 7 | 0.395 | 0.258 | 0.734 |
| 280299 | 0.469 | 0.502 | 98 | 14 | 0.589 | 0.478 | 0.710 |
| 280333 | 0.532 | 0.501 | 109 | 3 | 0.561 | 0.443 | 0.712 |

*Item analysis for fall OL formid 281118004*

| | m | sd | n | na | itc | citc | aid |
|---|---|---|---|---|---|---|---|
| 210010 | 0.650 | 0.478 | 214 | 1 | 0.389 | 0.290 | 0.792 |
| 210015 | 0.850 | 0.357 | 214 | 1 | 0.341 | 0.265 | 0.790 |
| 210021 | 0.758 | 0.429 | 211 | 4 | 0.425 | 0.339 | 0.785 |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 210029 | 0.925 | 0.264 | 214 | 1 | 0.208 | 0.149 | 0.795 |
| 210032 | 0.915 | 0.279 | 213 | 2 | 0.302 | 0.241 | 0.792 |
| 210034 | 0.514 | 0.501 | 214 | 1 | 0.231 | 0.118 | 0.800 |
| 210035 | 0.766 | 0.424 | 214 | 1 | 0.276 | 0.183 | 0.795 |
| 210036 | 0.744 | 0.437 | 215 | 0 | 0.459 | 0.374 | 0.785 |
| 210041 | 0.940 | 0.239 | 215 | 0 | 0.335 | 0.285 | 0.790 |
| 210042 | 0.901 | 0.299 | 213 | 2 | 0.321 | 0.257 | 0.790 |
| 210045 | 0.642 | 0.481 | 215 | 0 | 0.507 | 0.418 | 0.782 |
| 210046 | 0.660 | 0.475 | 212 | 3 | 0.443 | 0.349 | 0.786 |
| 210048 | 0.850 | 0.357 | 214 | 1 | 0.386 | 0.313 | 0.787 |
| 210055 | 0.665 | 0.473 | 212 | 3 | 0.373 | 0.274 | 0.790 |
| 210056 | 0.967 | 0.178 | 214 | 1 | 0.220 | 0.181 | 0.792 |
| 210061 | 0.772 | 0.420 | 215 | 0 | 0.515 | 0.439 | 0.783 |
| 210066 | 0.664 | 0.474 | 214 | 1 | 0.490 | 0.400 | 0.783 |
| 280014 | 0.967 | 0.179 | 213 | 2 | 0.365 | 0.328 | 0.789 |
| 280092 | 0.407 | 0.493 | 182 | 33 | 0.490 | 0.398 | 0.782 |
| 280096 | 0.917 | 0.276 | 205 | 10 | 0.179 | 0.116 | 0.795 |
| 280105 | 0.962 | 0.191 | 211 | 4 | 0.322 | 0.282 | 0.790 |
| 280109 | 0.709 | 0.456 | 199 | 16 | 0.538 | 0.457 | 0.778 |
| 280134 | 0.653 | 0.477 | 196 | 19 | 0.499 | 0.408 | 0.781 |
| 280150 | 0.682 | 0.467 | 192 | 23 | 0.545 | 0.461 | 0.779 |
| 280225 | 0.820 | 0.386 | 205 | 10 | 0.553 | 0.485 | 0.778 |
| 280248 | 0.283 | 0.452 | 191 | 24 | 0.260 | 0.160 | 0.795 |
| 280296 | 0.429 | 0.496 | 196 | 19 | 0.492 | 0.398 | 0.782 |

*Item analysis for fall OL formid 281118005*

| | m | sd | n | na | itc | citc | aid |
|---|---|---|---|---|---|---|---|
| 210005 | 0.950 | 0.219 | 100 | 1 | 0.410 | 0.361 | 0.772 |
| 210009 | 0.930 | 0.256 | 100 | 1 | 0.428 | 0.367 | 0.769 |
| 210010 | 0.752 | 0.434 | 101 | 0 | 0.294 | 0.185 | 0.778 |
| 210015 | 0.869 | 0.339 | 99 | 2 | 0.372 | 0.288 | 0.772 |
| 210017 | 0.990 | 0.100 | 101 | 0 | 0.333 | 0.309 | 0.776 |
| 210020 | 0.901 | 0.300 | 101 | 0 | 0.404 | 0.335 | 0.770 |
| 210023 | 0.870 | 0.338 | 100 | 1 | 0.499 | 0.428 | 0.764 |
| 210027 | 0.960 | 0.198 | 99 | 2 | 0.507 | 0.467 | 0.769 |
| 210029 | 0.890 | 0.314 | 100 | 1 | 0.455 | 0.382 | 0.770 |

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| | m | sd | n | na | itc | citc | aid |
|---|---|---|---|---|---|---|---|
| 210032 | 0.870 | 0.338 | 100 | 1 | 0.496 | 0.425 | 0.766 |
| 210036 | 0.723 | 0.450 | 101 | 0 | 0.475 | 0.376 | 0.765 |
| 210042 | 0.950 | 0.219 | 100 | 1 | 0.347 | 0.295 | 0.772 |
| 210048 | 0.832 | 0.376 | 101 | 0 | 0.374 | 0.284 | 0.772 |
| 210055 | 0.713 | 0.455 | 101 | 0 | 0.156 | 0.037 | 0.788 |
| 210056 | 0.950 | 0.218 | 101 | 0 | 0.615 | 0.577 | 0.763 |
| 210059 | 0.717 | 0.453 | 99 | 2 | 0.421 | 0.310 | 0.772 |
| 210061 | 0.842 | 0.367 | 101 | 0 | 0.514 | 0.438 | 0.764 |
| 280014 | 0.969 | 0.173 | 98 | 3 | 0.512 | 0.476 | 0.770 |
| 280092 | 0.494 | 0.503 | 87 | 14 | 0.294 | 0.165 | 0.782 |
| 280096 | 0.919 | 0.274 | 99 | 2 | 0.303 | 0.236 | 0.775 |
| 280105 | 0.980 | 0.141 | 100 | 1 | 0.285 | 0.251 | 0.776 |
| 280109 | 0.857 | 0.352 | 98 | 3 | 0.513 | 0.442 | 0.762 |
| 280134 | 0.687 | 0.466 | 99 | 2 | 0.508 | 0.409 | 0.762 |
| 280150 | 0.719 | 0.452 | 96 | 5 | 0.381 | 0.275 | 0.771 |
| 280225 | 0.806 | 0.397 | 98 | 3 | 0.515 | 0.433 | 0.764 |
| 280248 | 0.367 | 0.485 | 90 | 11 | 0.243 | 0.123 | 0.784 |
| 280296 | 0.505 | 0.503 | 97 | 4 | 0.404 | 0.279 | 0.774 |

*Item analysis for fall OL formid 281118006*

| | m | sd | n | na | itc | citc | aid |
|---|---|---|---|---|---|---|---|
| 210003 | 0.954 | 0.210 | 109 | 0 | 0.123 | 0.057 | 0.641 |
| 210004 | 0.972 | 0.166 | 107 | 2 | 0.328 | 0.280 | 0.630 |
| 210010 | 0.661 | 0.476 | 109 | 0 | 0.239 | 0.091 | 0.639 |
| 210015 | 0.861 | 0.347 | 108 | 1 | 0.252 | 0.145 | 0.639 |
| 210022 | 0.862 | 0.346 | 109 | 0 | 0.316 | 0.214 | 0.628 |
| 210025 | 0.954 | 0.210 | 109 | 0 | 0.358 | 0.299 | 0.627 |
| 210028 | 0.626 | 0.486 | 107 | 2 | 0.273 | 0.122 | 0.642 |
| 210029 | 0.899 | 0.303 | 109 | 0 | 0.334 | 0.246 | 0.623 |
| 210032 | 0.898 | 0.304 | 108 | 1 | 0.263 | 0.171 | 0.632 |
| 210036 | 0.692 | 0.464 | 107 | 2 | 0.409 | 0.275 | 0.624 |
| 210037 | 0.917 | 0.277 | 109 | 0 | 0.103 | 0.016 | 0.644 |
| 210042 | 0.945 | 0.229 | 109 | 0 | 0.112 | 0.040 | 0.643 |
| 210043 | 0.519 | 0.502 | 108 | 1 | 0.364 | 0.216 | 0.631 |
| 210048 | 0.935 | 0.248 | 107 | 2 | 0.328 | 0.255 | 0.629 |

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| | m | sd | n | na | itc | citc | aid |
|---|---|---|---|---|---|---|---|
| 210055 | 0.645 | 0.481 | 107 | 2 | 0.198 | 0.048 | 0.652 |
| 210056 | 0.897 | 0.305 | 107 | 2 | 0.423 | 0.340 | 0.620 |
| 210061 | 0.879 | 0.328 | 107 | 2 | 0.430 | 0.339 | 0.621 |
| 280014 | 0.953 | 0.212 | 107 | 2 | 0.188 | 0.122 | 0.636 |
| 280092 | 0.565 | 0.498 | 92 | 17 | 0.518 | 0.391 | 0.602 |
| 280096 | 0.870 | 0.337 | 108 | 1 | 0.158 | 0.053 | 0.646 |
| 280105 | 0.991 | 0.097 | 106 | 3 | 0.155 | 0.125 | 0.639 |
| 280109 | 0.830 | 0.377 | 106 | 3 | 0.547 | 0.455 | 0.607 |
| 280134 | 0.683 | 0.468 | 101 | 8 | 0.419 | 0.286 | 0.615 |
| 280150 | 0.740 | 0.441 | 104 | 5 | 0.431 | 0.310 | 0.614 |
| 280225 | 0.821 | 0.385 | 106 | 3 | 0.368 | 0.257 | 0.630 |
| 280248 | 0.390 | 0.490 | 100 | 9 | 0.070 | -0.087 | 0.670 |
| 280296 | 0.462 | 0.501 | 104 | 5 | 0.400 | 0.254 | 0.624 |

Confirmatory factor analyses were run next, with three models fit per form. The first model included all P2P and PN items, the second only the P2P items, and the third only the PN items. Models were all fit in Mplus with a single factor and categorical outcomes. Fit results are presented here with one table per form. Overall, results support the combination of P2P and PN items into one measure. Note that in formid 281118005, one item (itemid 210056) was removed from the model because of a linear dependency which negatively impacted model fit.

*Model fit for fall OL formid 281118001*

| Items | ChiSq | RMSEA | CFI | WRMR |
|---|---|---|---|---|
| all | sig | 0.056 | 0.825 | 1.117 |
| P2P | sig | 0.063 | 0.826 | 1.131 |
| PN | sig | 0.046 | 0.949 | 0.848 |

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*Model fit for fall OL formid 281118002*

| Items | ChiSq | RMSEA | CFI | WRMR |
|---|---|---|---|---|
| all | sig | 0.039 | 0.968 | 0.873 |
| P2P | non sig | <.001 | 1.000 | 0.713 |
| PN | sig | 0.067 | 0.889 | 0.826 |

*Model fit for fall OL formid 281118003*

| Items | ChiSq | RMSEA | CFI | WRMR |
|---|---|---|---|---|
| all | sig | 0.112 | 0.883 | 1.314 |
| P2P | sig | 0.097 | 0.960 | 1.062 |
| PN | non sig | <.001 | 1.000 | 0.590 |

*Model fit for fall OL formid 281118004*

| Items | ChiSq | RMSEA | CFI | WRMR |
|---|---|---|---|---|
| all | non sig | 0.021 | 0.982 | 0.868 |
| P2P | non sig | 0.019 | 0.978 | 0.848 |
| PN | non sig | <.001 | 1.000 | 0.587 |

*Model fit for fall OL formid 281118005*

| Items | ChiSq | RMSEA | CFI | WRMR |
|---|---|---|---|---|
| all | sig | 0.069 | 0.898 | 1.008 |
| P2P | sig | 0.066 | 0.929 | 0.923 |
| PN | sig | 0.067 | 0.897 | 0.864 |

*Model fit for fall OL formid 281118006*

| Items | ChiSq | RMSEA | CFI | WRMR |
|---|---|---|---|---|
| all | sig | 0.081 | 0.777 | 1.134 |
| P2P | non sig | 0.034 | 0.937 | 0.825 |
| PN | sig | 0.116 | 0.800 | 1.187 |

Finally, Rasch modeling was used to calibrate the P2P items onto the existing PN scale, where the PN items served as anchors with known parameter values based on prior administrations from age 4 studies. This was achieved by fitting a Rasch model in

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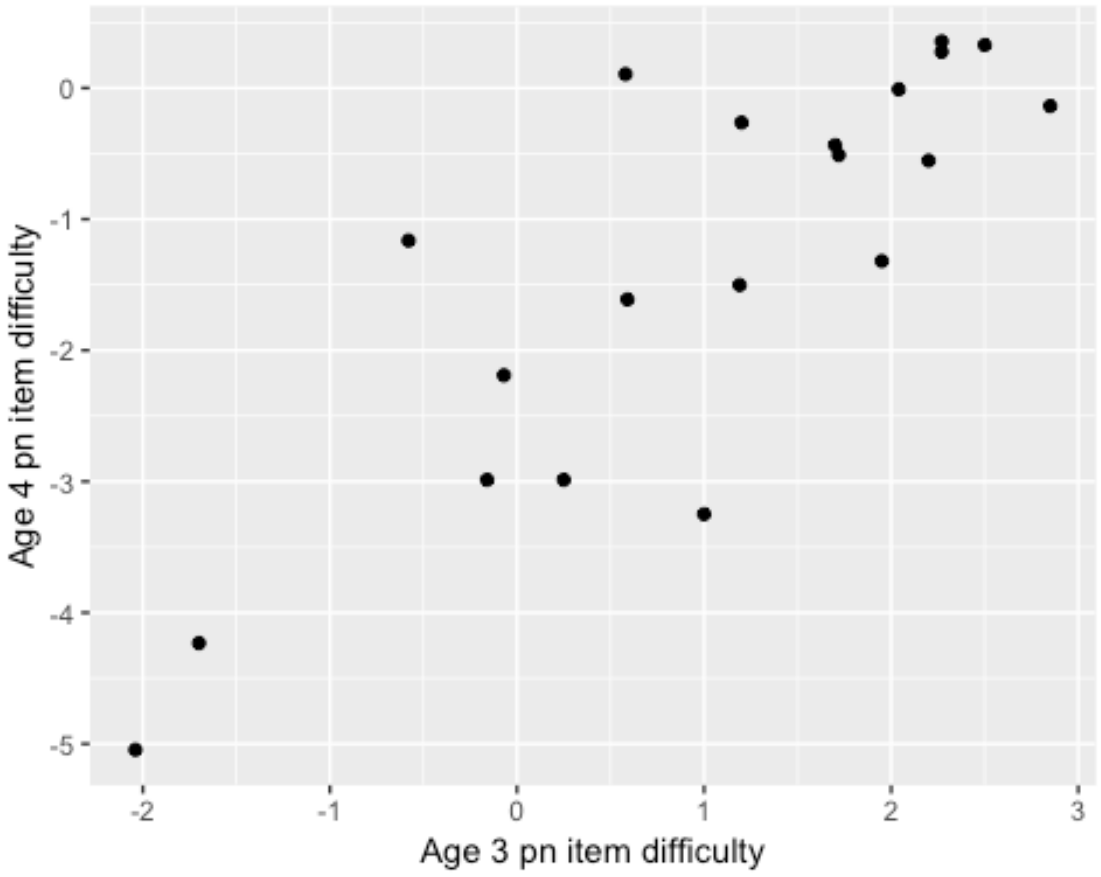
Winsteps to the full OL fall data set for age 3 across all six forms, obtaining item difficulties for all items, P2P and PN, and then linking parameters to the existing PN scale using a mean/sigma transformation.

There were 20 PN items in the fall OL administration that served as anchors to the existing PN scale. Having calibrated these items within the fall OL administration first, we can compare their item locations from age 3 with the existing values from age 4. The following plot shows a linear relationship between the two, without any significant outliers, which supports the linking of scales. Age 3 results, as theta values, are on the x-axis and age 4 results are on y. Note that there is a shift downward in item difficulty from x to y, with items tending to have higher locations for age 3 (more difficult, ranging from about theta -2 to 3) than for age 4 (less difficult, ranging from about theta -5 to 0).

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After finding the linear transformation coefficients (A = 1.17, B = -2.51), the fall OL item locations, from the original Winsteps calibration, were all converted to the age 4 scale. These linked item locations were then used to estimate ability, referred to as theta, for each child based on the items they responded to.

The following table contains descriptive statistics for children participating in the fall OL administration. The mean, median, sd, skewness (skew), kurtosis (kurt), minimum (min), maximum (max), number of children (n), and children with missing values (na) are shown in columns for ability estimates (theta), number of items administered (n_items), total number correct treating missings as zeros (total), and proportion correct (prop, total over n_items). Note that the mean theta is below zero, as expected for a scale that is defined by an older age group. The n_items reveals that some children responded to as many as 110 items, with an average of 54. On average, children responded correctly to 75 percent of the items they saw.

*Descriptive statistics for fall OL ability estimation*

| | mean | median | sd | skew | kurt | min | max | n | na |
|---|---|---|---|---|---|---|---|---|---|
| theta | -0.451 | -0.374 | 0.935 | -0.253 | 2.738 | -3.487 | 1.667 | 434 | 0 |
| n_items | 54.376 | 55.000 | 5.261 | 0.388 | 48.046 | 27.000 | 110.000 | 434 | 0 |
| total | 41.094 | 43.000 | 8.572 | -0.704 | 4.894 | 11.000 | 82.000 | 434 | 0 |
| prop | 0.754 | 0.782 | 0.138 | -0.737 | 3.161 | 0.273 | 0.982 | 434 | 0 |

The following plot compares distributions of ability and item difficulty along the theta scale. Note that the y-axis is scaled relative to each distribution (as what are called densities) so that a comparison in terms of counts of items and persons is not possible. Instead, the plot is helpful for determining the alignment in locations for items and test takers. Different color shading is used for P2P and PN items, which tend to capture lower and higher theta values respectively. The items shown were not all administered in the

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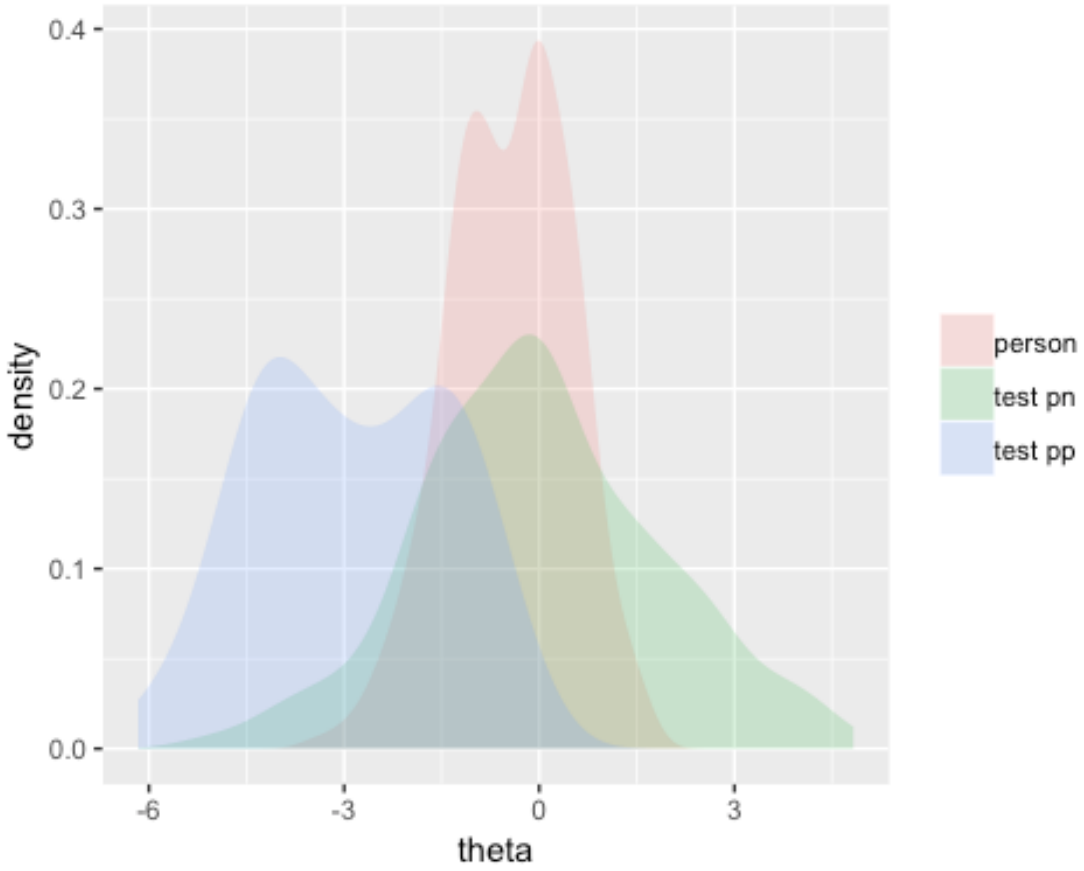
fall, but serve to demonstrate the full scope of the OL bank after linking to age 4 PN.




***Winter administration.*** The winter administration of OL involved a single formid and was based on CAT with test length 25 items. These items could come from P2P, PN, or both, depending on the performance of the test taker. Prior to estimating theta for children, item parameters from the data export were replaced with those from the linking above prior to estimating theta.

The table below shows descriptive statistics for the winter OL administration. Mean theta was slightly higher in winter than for fall, as expected, with a maximum value of 2.815. The number of items was fixed at 25, and did not vary over children**.**

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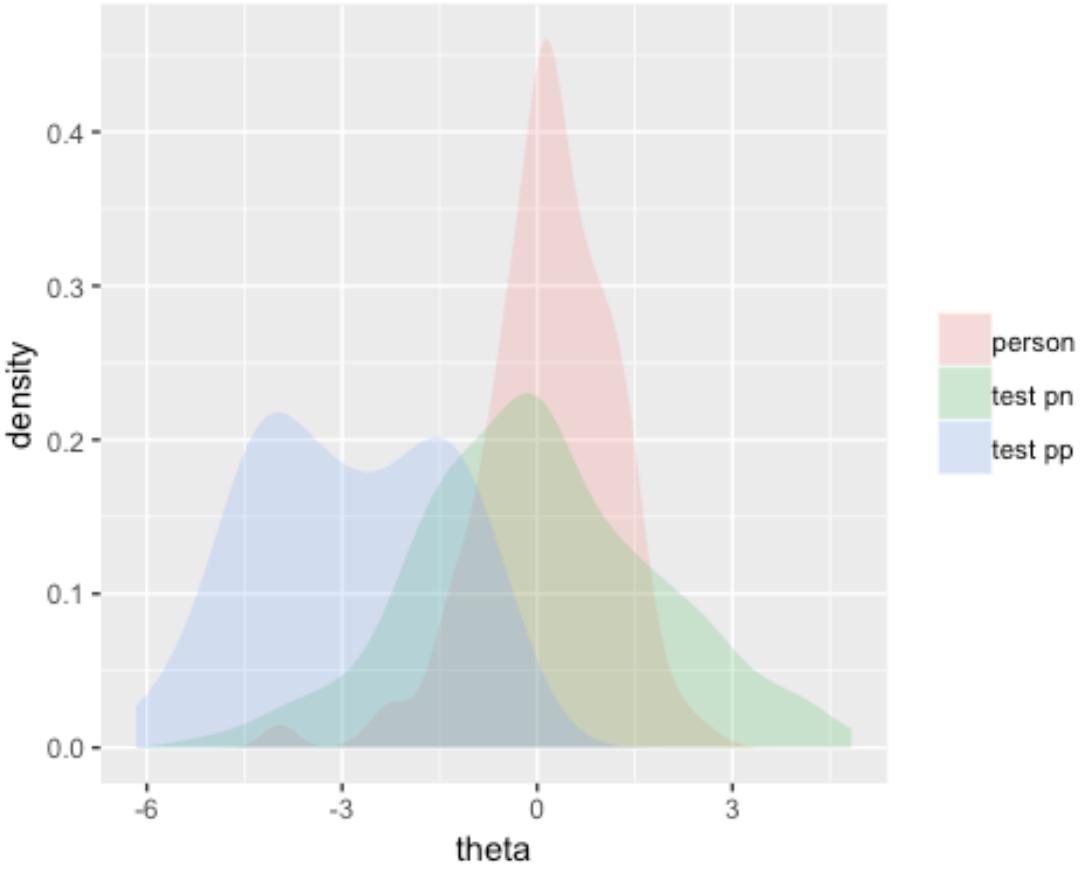
*Descriptive statistics for winter OL ability estimation*

| | mean | median | sd | skew | kurt | min | max | n | na |
|---|---|---|---|---|---|---|---|---|---|
| theta | 0.171 | 0.18 | 1.009 | -0.758 | 4.940 | -4 | 2.815 | 411 | 0 |
| n_items | 25.000 | 25.00 | 0.000 | NaN | NaN | 25 | 25.000 | 411 | 0 |
| total | 10.645 | 11.00 | 2.224 | -0.701 | 5.313 | 0 | 16.000 | 411 | 0 |
| prop | 0.426 | 0.44 | 0.089 | -0.701 | 5.313 | 0 | 0.640 | 411 | 0 |

The plot below compares distributions of items and children across the theta scale, with shaded curves for P2P and PN items, as well as winter ability estimates. Note that the item curves display distributions of items available in the OL test bank, not necessarily items administered.




***Spring administration.*** The spring administration of OL also involved a single formid and was based on CAT with test length 25 items. These items could again come

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from P2P, PN, or both, depending on the performance of the test taker. Prior to estimating theta for children, item parameters from the data export were replaced with those from the linking above prior to estimating theta.

The table below shows descriptive statistics for the spring OL administration. Mean theta was slightly higher in spring than for winter, as expected. The number of items was again fixed at 25, and did not vary over children.

*Descriptive statistics for spring OL ability estimation*

| | mean | median | sd | skew | kurt | min | max | n | na |
|---|---|---|---|---|---|---|---|---|---|
| theta | 0.483 | 0.527 | 1.030 | -0.898 | 5.139 | -4 | 3.407 | 411 | 0 |
| n_items | 25.000 | 25.000 | 0.000 | NaN | NaN | 25 | 25.000 | 411 | 0 |
| total | 11.136 | 11.000 | 2.255 | -0.640 | 5.488 | 0 | 19.000 | 411 | 0 |
| prop | 0.445 | 0.440 | 0.090 | -0.640 | 5.488 | 0 | 0.760 | 411 | 0 |

The plot below compares distributions of items and children across the theta scale, with shaded curves for P2P and PN items, as well as spring ability estimates. Item curves again display distributions of items available in the OL test bank, not necessarily items administered.

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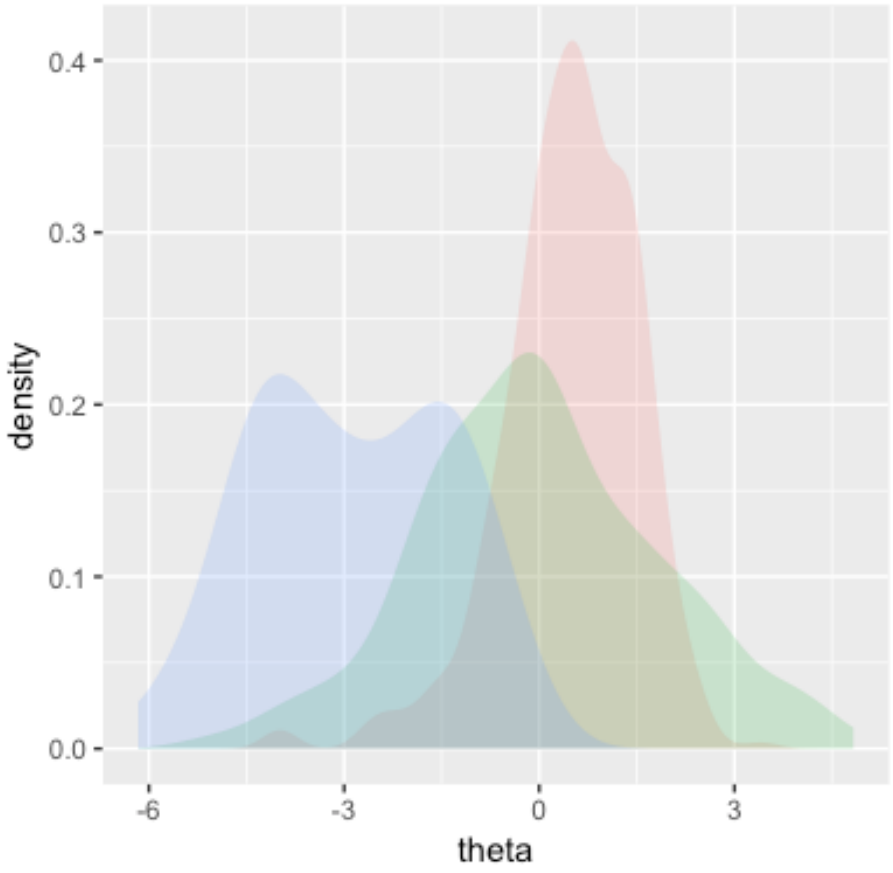


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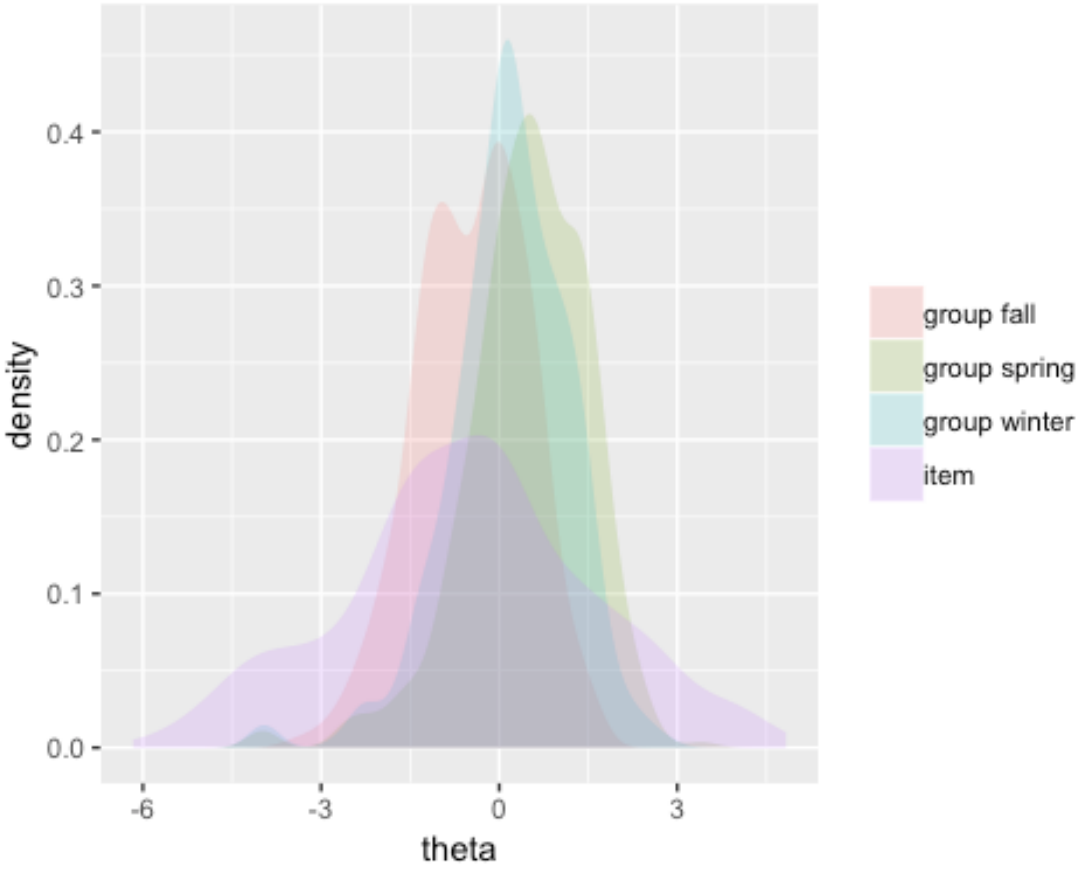
Finally, the plot below displays distributions of ability estimates across the theta scale for fall, winter, and spring administrations of OL. Item locations are shown in a single distribution, rather than being divided into P2P and PN.




**Alphabet knowledge.** The fall, winter, and spring administrations of alphabet knowledge (AK) all employed CAT with test length set to 25 items. The AK bank contained 143 items and four different types of tasks: letter find (lf, 20 items), letter naming (ln, 52 items), letter orientation (lo, 19 items), and point to letter (pl, 52 items). The spring AK administration also included a linear test with 25 items, administered to a subset of 199 children.

The following three tables provide descriptive statistics for AK ability estimates in the fall, winter, and spring administrations. Mean theta increased from -0.244 in the

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fall to 0.198 in the winter and 0.599 in the spring. Total and proportion correct increased slightly, but remained close to 50 percent, as is the target performance level for the CAT algorithm. Note that the spring data included both the CAT and linear test forms.

*Descriptive statistics for fall AK ability estimation*

| | mean | median | sd | skew | kurt | min | max | n | na |
|---|---|---|---|---|---|---|---|---|---|
| theta | -0.244 | -0.477 | 1.319 | 0.512 | 2.564 | -2.697 | 3.296 | 424 | 0 |
| n_items | 25.000 | 25.000 | 0.000 | NaN | NaN | 25.000 | 25.000 | 424 | 0 |
| total | 11.559 | 11.500 | 4.844 | 0.125 | 3.407 | 0.000 | 25.000 | 424 | 0 |
| prop | 0.462 | 0.460 | 0.194 | 0.125 | 3.407 | 0.000 | 1.000 | 424 | 0 |

*Descriptive statistics for winter AK ability estimation*

| | mean | median | sd | skew | kurt | min | max | n | na |
|---|---|---|---|---|---|---|---|---|---|
| theta | 0.198 | 0.155 | 1.408 | 0.064 | 2.245 | -3.575 | 3.04 | 408 | 0 |
| n_items | 25.000 | 25.000 | 0.000 | NaN | NaN | 25.000 | 25.00 | 408 | 0 |
| total | 13.463 | 13.000 | 4.369 | 0.407 | 2.909 | 0.000 | 24.00 | 408 | 0 |
| prop | 0.539 | 0.520 | 0.175 | 0.407 | 2.909 | 0.000 | 0.96 | 408 | 0 |

*Descriptive statistics for spring AK ability estimation*

| | mean | median | sd | skew | kurt | min | max | n | na |
|---|---|---|---|---|---|---|---|---|---|
| theta | 0.599 | 0.70 | 1.265 | -0.172 | 2.373 | -3.059 | 3.324 | 410 | 0 |
| n_items | 25.000 | 25.00 | 0.000 | NaN | NaN | 25.000 | 25.000 | 410 | 0 |
| total | 14.644 | 14.00 | 5.477 | 0.111 | 2.016 | 2.000 | 25.000 | 410 | 0 |
| prop | 0.586 | 0.56 | 0.219 | 0.111 | 2.016 | 0.080 | 1.000 | 410 | 0 |

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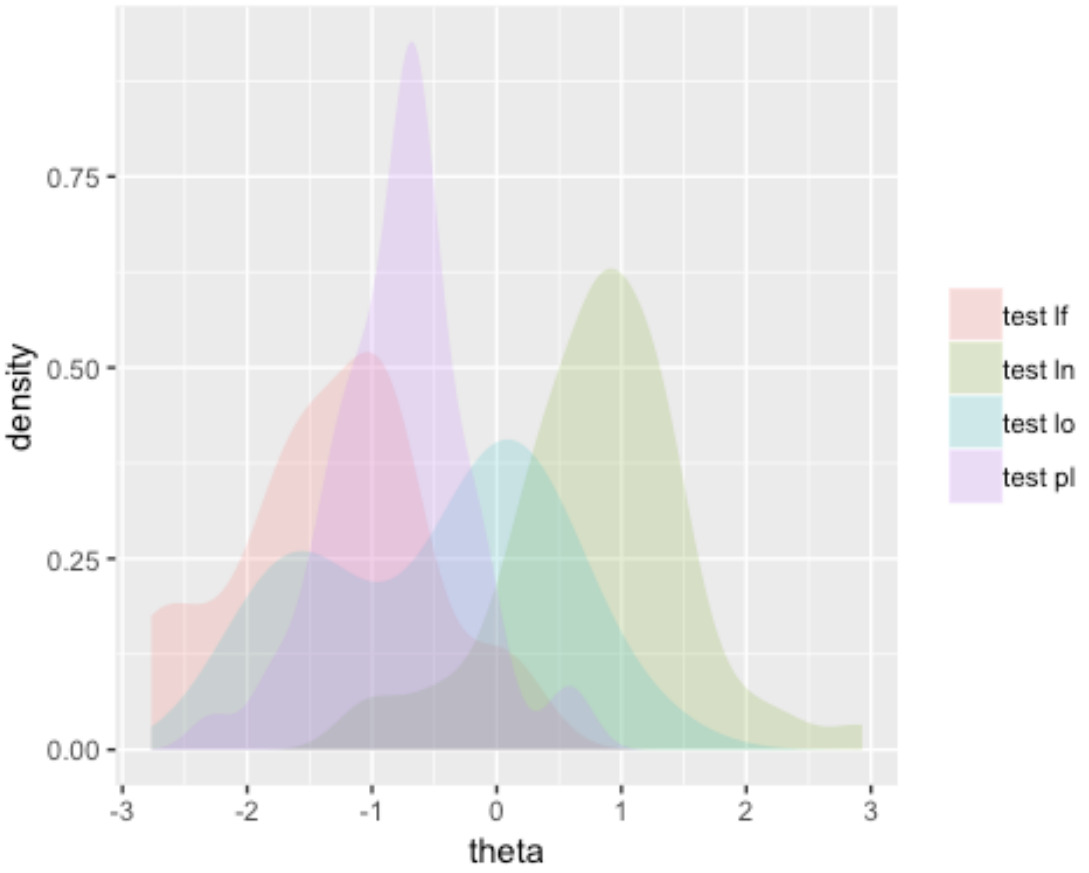
The plots below compare distributions of items and children across the theta scale, with shaded curves for the four tasks, as well as seasonal ability estimates. The first plot shows just the distributions of items, whereas the second shows all items as a single distribution, with fall, winter, and spring ability distributions as well.

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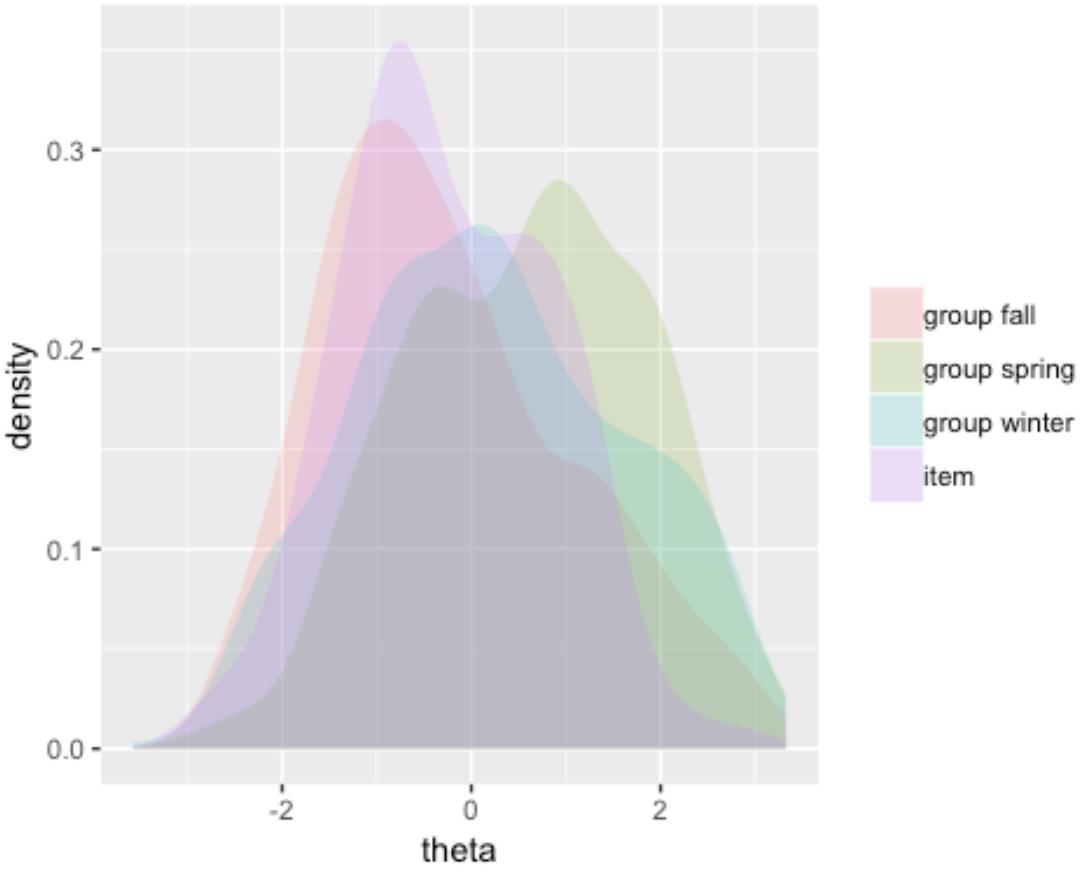


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**Phonological awareness.** Like ak, the fall, winter, and spring administrations of phonological awareness (pa) employed CAT with test length set to 25 items. Spring included a linear test form with 25 items administered to 216 children. The PA bank contained 76 items all of the same task, referred to as robot blending.

The following three tables provide descriptive statistics for PA ability estimates in the fall, winter, and spring administrations. Mean theta increased from -0.426 in the fall to -0.044 in the winter administration, and to 0.189 in the spring.

*Descriptive statistics for fall PA ability estimation*

| | mean | median | sd | skew | kurt | min | max | n | na |
|---|---|---|---|---|---|---|---|---|---|
| theta | -0.426 | -0.471 | 0.832 | 0.328 | 3.504 | -2.604 | 2.268 | 415 | 0 |
| n_items | 25.000 | 25.000 | 0.000 | NaN | NaN | 25.000 | 25.000 | 415 | 0 |

| | mean | median | sd | skew | kurt | min | max | n | na |
|---|---|---|---|---|---|---|---|---|---|
| total | 13.239 | 12.000 | 4.107 | 0.775 | 3.402 | 4.000 | 25.000 | 415 | 0 |
| prop | 0.530 | 0.480 | 0.164 | 0.775 | 3.402 | 0.160 | 1.000 | 415 | 0 |

*Descriptive statistics for winter PA ability estimation*

| | mean | median | sd | skew | kurt | min | max | n | na |
|---|---|---|---|---|---|---|---|---|---|
| theta | -0.044 | -0.152 | 0.974 | 0.155 | 2.901 | -3.269 | 2.269 | 398 | 0 |
| n_items | 25.000 | 25.000 | 0.000 | NaN | NaN | 25.000 | 25.000 | 398 | 0 |
| total | 14.535 | 14.000 | 4.563 | 0.449 | 2.397 | 3.000 | 25.000 | 398 | 0 |
| prop | 0.581 | 0.560 | 0.183 | 0.449 | 2.397 | 0.120 | 1.000 | 398 | 0 |

*Descriptive statistics for spring PA ability estimation*

| | mean | median | sd | skew | kurt | min | max | n | na |
|---|---|---|---|---|---|---|---|---|---|
| theta | 0.189 | 0.12 | 1.016 | 0.152 | 2.174 | -2.226 | 2.269 | 404 | 0 |
| n_items | 25.000 | 25.00 | 0.000 | NaN | NaN | 25.000 | 25.000 | 404 | 0 |
| total | 16.626 | 17.00 | 5.145 | -0.043 | 1.776 | 5.000 | 25.000 | 404 | 0 |
| prop | 0.665 | 0.68 | 0.206 | -0.043 | 1.776 | 0.200 | 1.000 | 404 | 0 |

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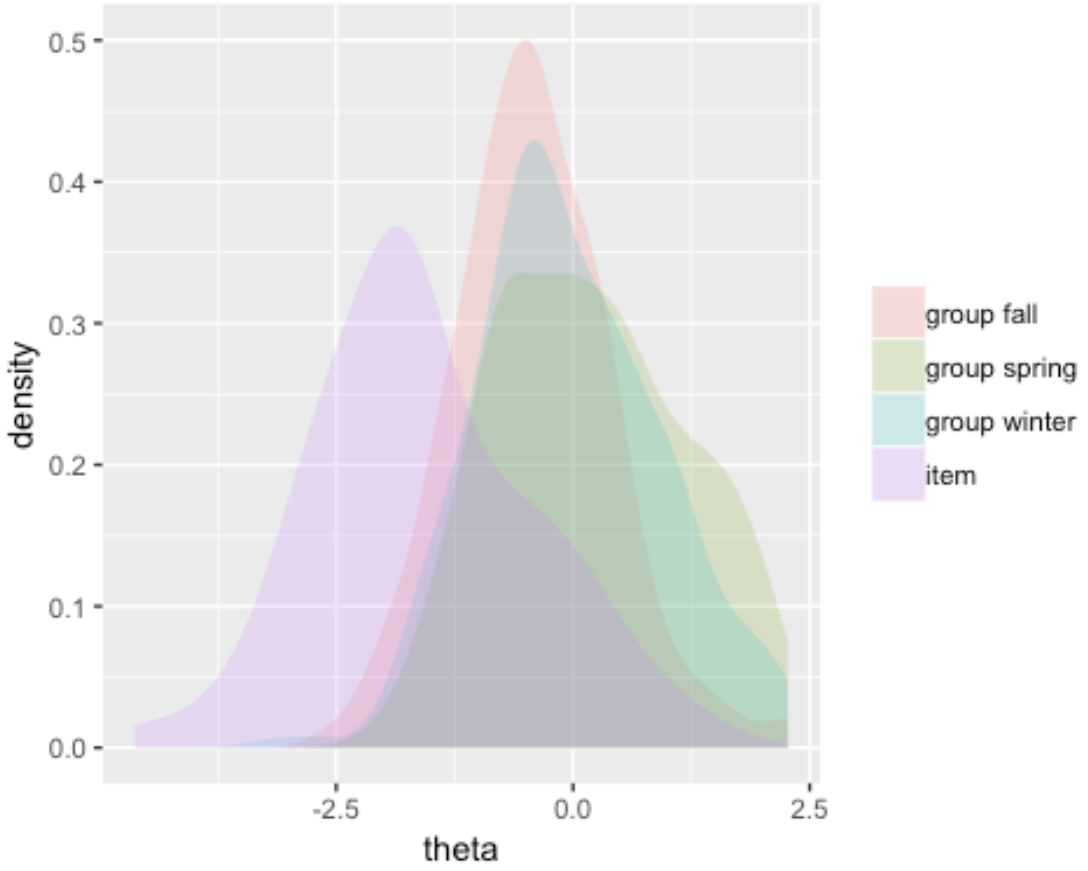
The plot below compares distributions of items and children across the theta scale, with shaded curves for items as well as fall and winter ability estimates.

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**Comparing Measures**

Results were compared across seasons and measures. After merging all ability estimates into a single data frame, there were 313 children who had complete data (that is, estimated theta values) across all nine administrations (three seasons, three measures each). Correlations (r) were estimated for these 313 children, shown in the following table. Within measures, correlations across seasons were strongest overall for ak, with r ranging from 0.77 to 0.82. Correlations across season were weaker for ol, with r ranging from 0.66 to 0.76, and for pa, with r ranging from 0.49 to 0.67. Correlations across measures were weaker overall, as expected.

| | fall_ak | fall_ol | fall_pa | spring_ak | spring_ol | spring_pa | winter_ak | winter_ol | winter_pa |
|---|---|---|---|---|---|---|---|---|---|
| fall_ak | 1.00 | 0.35 | 0.32 | 0.77 | 0.23 | 0.19 | 0.82 | 0.33 | 0.16 |
| fall_ol | 0.35 | 1.00 | 0.38 | 0.33 | 0.66 | 0.34 | 0.36 | 0.69 | 0.32 |
| fall_pa | 0.32 | 0.38 | 1.00 | 0.29 | 0.26 | 0.49 | 0.28 | 0.35 | 0.54 |
| spring_ak | 0.77 | 0.33 | 0.29 | 1.00 | 0.36 | 0.31 | 0.82 | 0.36 | 0.24 |
| spring_ol | 0.23 | 0.66 | 0.26 | 0.36 | 1.00 | 0.48 | 0.28 | 0.76 | 0.32 |
| spring_pa | 0.19 | 0.34 | 0.49 | 0.31 | 0.48 | 1.00 | 0.23 | 0.44 | 0.67 |
| winter_ak | 0.82 | 0.36 | 0.28 | 0.82 | 0.28 | 0.23 | 1.00 | 0.35 | 0.21 |
| winter_ol | 0.33 | 0.69 | 0.35 | 0.36 | 0.76 | 0.44 | 0.35 | 1.00 | 0.36 |
| winter_pa | 0.16 | 0.32 | 0.54 | 0.24 | 0.32 | 0.67 | 0.21 | 0.36 | 1.00 |

Correlations were also estimated using pairwise complete data, where any children with scores on a pair of measures in a given season contributed to the correlation for those measures and season. The next table shows these pairwise correlations along with corresponding counts of test takers in parentheses.

| | fall_ak | fall_ol | fall_pa | spring_ak | spring_ol | spring_pa | winter_ak | winter_ol | winter_pa |
|---|---|---|---|---|---|---|---|---|---|
| fall_ak | 1.00 (424) | 0.36 (424) | 0.27 (410) | 0.76 (371) | 0.28 (370) | 0.25 (366) | 0.81 (348) | 0.34 (355) | 0.15 (346) |
| fall_ol | 0.36 (424) | 1.00 (434) | 0.41 (415) | 0.35 (380) | 0.69 (379) | 0.42 (375) | 0.38 (356) | 0.65 (363) | 0.34 (354) |
| fall_pa | 0.27 (410) | 0.41 (415) | 1.00 (415) | 0.29 (364) | 0.29 (363) | 0.50 (360) | 0.27 (344) | 0.34 (351) | 0.53 (345) |
| spring_ak | 0.76 (371) | 0.35 (380) | 0.29 (364) | 1.00 (410) | 0.41 (398) | 0.35 (396) | 0.80 (352) | 0.36 (356) | 0.26 (345) |
| spring_ol | 0.28 (370) | 0.69 (379) | 0.29 (363) | 0.41 (398) | 1.00 (411) | 0.54 (391) | 0.35 (347) | 0.74 (350) | 0.34 (341) |
| spring_pa | 0.25 (366) | 0.42 (375) | 0.50 (360) | 0.35 (396) | 0.54 (391) | 1.00 (404) | 0.27 (344) | 0.43 (348) | 0.68 (339) |
| winter_ak | 0.81 (348) | 0.38 (356) | 0.27 (344) | 0.80 (352) | 0.35 (347) | 0.27 (344) | 1.00 (408) | 0.41 (400) | 0.23 (386) |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| winter_ol | 0.34 (355) | 0.65 (363) | 0.34 (351) | 0.36 (356) | 0.74 (350) | 0.43 (348) | 0.41 (400) | 1.00 (411) | 0.37 (388) |
| winter_pa | 0.15 (346) | 0.34 (354) | 0.53 (345) | 0.26 (345) | 0.34 (341) | 0.68 (339) | 0.23 (386) | 0.37 (388) | 1.00 (398) |

## Upcoming Results

The next steps for analyses will focus contrasting groups analysis and classification accuracy. Through contrasting groups analysis, we seek to answer what Rasch scale score best discriminates individuals identified by their teacher as making adequate progress, as compared to those individuals not making adequate progress and in need of additional intervention, for each data collection format in Fall of PK3. Regarding classification accuracy, we seek to understand to what extent do the results meet a priori standards for screening in educational settings (i.e., sensitivity, specificity, area under the curve) using teacher-assigned group as criterion and IGDI scores as predictors.

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