## Supplementary Materials

## S1. Analyzing the relationship between ratio acuities measured by Weber fraction and math abilities.

We conducted supplementary analyses to explore whether results would change when we used weber fractions (ws) in place of accuracy as measures of nonsymbolic ratio acuity. Specifically, we re-calculated bivariate correlations, (with and without list-wise deletion Table S1 and S3; Figure S1) and re-conducted hierarchical regressions (Table S4) using weber fractions. For these analyses, the trimmed sample resulted in 74 participants for weber fractions for models predicting FKA, algebra, math fundamentals, and trigonometry. For models predicting symbolic fraction comparison, an additional 3 participants were excluded for below chance level performance, resulting in analytic samples of 71 participants.

Results with ws were consistent with our main text results and highlighted the relationship between line acuity and symbolic math abilities. This was true of bivariate correlations (FKA: $r=-.29, p=.011$, Math Fundamental: $r=-.25, p=.027$, Trig: $r=-.23, p$ $=.046$ ). It was also true of regressions, with line ratio significantly predicting FKA ( $\beta=-.364, p$ $=.007)$, algebra( $\beta=-.265, p=.048$ ), math fundamentals $(\beta=-.264, p=.046)$, and trigonometry ( $\beta=-.288, p=.035$ ) before Raven's scores were added to the models. When Raven's was entered, line ratio no longer significant predicted any outcomes other than Math Fundamentals ( $\beta=-.289, p=.029$ ).


Table S1. Bivariate correlation among ws from comparison tasks and tests ( $n=74$, except for FF: $n=71$ ).

|  | Circle Ratio | Dot Ratio | Line | Circle | Dot | FF | Inhibition | FKA | ALG | MF | Trig | Raven |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Line Ratio | . 42 ** | .29* | . 07 | . 02 | . 15 | -. 04 | . 12 | -.29* | -. 20 | -. 26 * | -. $23 *$ | -.28** |
| Circle Ratio |  | . $31{ }^{* *}$ | . 25 * | . $41^{* *}$ | . $41{ }^{* *}$ | -. 10 | . 06 | -. 01 | -. 06 | -. 14 | -. 08 | -. 21 |
| Dot Ratio |  |  | -. 08 | . 09 | . 17 | . 21 | . 12 | . 09 | . 15 | . 16 | . 13 | . 08 |
| Line |  |  |  | . 23 * | . 20 | . 13 | . 05 | . 00 | -. 10 | -. 06 | -. 08 | $-.27 *$ |
| Circle |  |  |  |  | . 13 | -. 07 | . 02 | . 12 | . 02 | . 08 | . 00 | . 03 |
| Dot |  |  |  |  |  | . 17 | . 07 | -. 04 | -. 21 | -. 10 | -. 12 | -. 12 |
| FF |  |  |  |  |  |  | -. 02 | . 13 | . 10 | .24* | . 02 | . 06 |
| Inhibition |  |  |  |  |  |  |  | -. 07 | . 00 | -. 10 | -. 06 | -. 19 |
| FKA |  |  |  |  |  |  |  |  | .50** | . $43 *$ | . $41^{* *}$ | . $37{ }^{* *}$ |
| ALG |  |  |  |  |  |  |  |  |  | .80** | . $71{ }^{* *}$ | . 43 ** |
| MF |  |  |  |  |  |  |  |  |  |  | . $65 *$ | . 40 ** |
| Trig |  |  |  |  |  |  |  |  |  |  |  | . 32 ** |

Note, FF = fraction comparison, FKA = fractional knowledge, ALG = algebra, MF = math fundamental, Trig = Trigonometry * $p<.05,{ }^{* *} p<.01$

Table S2. Bivariate correlation among accuracies from comparison tasks and tests without using a list-wise deletion.

|  | Ratio Line | Ratio Circle | Ratio Dot | Line | Circle | Dot | FF | Inhibition | FKA | ALG | MF | Trig | Raven |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| RPS composite | . $78 *$ | . $53 * *$ | . $89 * *$ | . $46 *$ | . $31^{* *}$ | . $40 *$ | . 20 | -. 07 | . 23 * | . $18{ }^{+}$ | . $25 *$ | . $21{ }^{*}$ | .29** |
| Line Ratio |  | . $39 *$ | . $40 * *$ | . $26 *$ | . 04 | . $19^{+}$ | . 19 | -. 09 | . $35 *$ | . $32 *$ | . $37 *$ | . $31{ }^{* *}$ | . $33 *$ |
| Circle Ratio |  |  | . $51{ }^{* *}$ | . $20{ }^{+}$ | . 01 | . 22 | . 02 | -. 10 | . $19^{+}$ | . 01 | . 09 | . 06 | . 12 |
| Dot Ratio |  |  |  | . $48{ }^{* *}$ | .40** | . $43^{* *}$ | . 20 | -. 07 | . 13 | . 06 | . 13 | . 11 | . $22^{*}$ |
| Line |  |  |  |  | .47** | . $33^{* *}$ | . 04 | -. 09 | . 02 | . 10 | . 07 | . 01 | . 16 |
| Circle |  |  |  |  |  | . $25^{*}$ | . 07 | -. 01 | -. 13 | . 02 | -. 09 | -. 02 | -. 10 |
| Dot |  |  |  |  |  |  | -. 04 | . 01 | . 03 | .22* | . 17 | . 14 | . 14 |
| FF |  |  |  |  |  |  |  | -. 07 | . $38{ }^{* *}$ | .27* | . $42 * *$ | .22* | . 15 |
| Inhibition |  |  |  |  |  |  |  |  | -. 11 | -. 11 | -. 16 | -. 11 | -. 23 |
| FKA |  |  |  |  |  |  |  |  |  | . $55^{* *}$ | . $57 *$ | . $51{ }^{* *}$ | . $39 * *$ |
| ALG |  |  |  |  |  |  |  |  |  |  | . $84 *$ | . $75 *$ | . $45 *$ |
| MF |  |  |  |  |  |  |  |  |  |  |  | . $72 *$ | . $44^{* *}$ |
| Trig |  |  |  |  |  |  |  |  |  |  |  |  | . $36 * *$ |

Note, FF = fraction comparison, FKA = fractional knowledge, ALG = algebra, MF = math fundamental, Trig = Trigonometry *p <.05, ** $p<.01$

Table S3. Bivariate correlation among ws from comparison tasks and tests without using a list-wise deletion.

|  | Ratio Circle | Ratio Dot | Line | Circle | Dot | FF | Inhibition | FKA | ALG | MF | Trig | Raven |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Line Ratio | . $39^{* *}$ | . $31{ }^{* *}$ | . 13 | . 05 | . $20^{+}$ | -.24* | . 11 | -.45** | -. $34^{* *}$ | -.40** | -.34** | -.35** |
| Circle Ratio |  | . $31^{* *}$ | . $26{ }^{*}$ | . $42 *$ | . $38{ }^{* *}$ | -. 10 | . 06 | -. 01 | -. 06 | -. 11 | -. 08 | -. $24 *$ |
| Dot Ratio |  |  | -. 05 | . 03 | . 17 | . 13 | . 16 | -. 01 | . 09 | . 08 | . 09 | -. 08 |
| Line |  |  |  | . $22 *$ | . 16 | . 03 | . 03 | -. 06 | -. 09 | -. 07 | -. 06 | -.23* |
| Circle |  |  |  |  | . $19^{+}$ | -. 05 | -. 03 | . 15 | . 04 | . 09 | . 02 | . 07 |
| Dot |  |  |  |  |  | . 11 | $<.01$ | -. 03 | $-.21^{*}$ | -. 12 | -. 13 | -. 14 |
| FF |  |  |  |  |  |  | -. 07 | .38** | .27* | .42** | .22* | . 15 |
| Inhibition |  |  |  |  |  |  |  | -. 11 | -. 11 | -. 16 | -. 11 | -.23* |
| FKA |  |  |  |  |  |  |  |  | . $55 * *$ | . $57{ }^{* *}$ | . $51{ }^{* *}$ | . $39 * *$ |
| ALG |  |  |  |  |  |  |  |  |  | . $84 *$ | . $75 *$ | . $45 *$ |
| MF |  |  |  |  |  |  |  |  |  |  | .72** | . $44^{* *}$ |
| Trig |  |  |  |  |  |  |  |  |  |  |  | . $36 * *$ |

Note, FF = fraction comparison, FKA = fractional knowledge, ALG = algebra, MF = math fundamental, Trig = Trigonometry * $p<.05,{ }^{* *} p<.01$

Table S4 a-e. Results from the hierarchical regression analyses predicting scores on Symbolic fraction comparison, FKA, Algebra, Math Fundamentals, and Trigonometry (ws, n= 74, except for symbolic fraction comparison).

## a. Symbolic Fraction Comparison ( $\mathrm{n}=71$ )

|  |  | Step 1 <br> $R^{2}=.06$ |  | Step 2 <br> $\Delta R^{2}=.10$ |  |  |  | Step 3 <br> $\Delta R^{2}=.001$ |  |  |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\beta$ | $p$ | $\mathrm{sr}^{2}$ | $\beta$ | $p$ | $\mathrm{sr}^{2}$ | $\beta$ | $p$ | $\mathrm{sr}^{2}$ |  |
| Line | .132 | .299 | .016 | .204 | .106 | .036 | .213 | .104 | .037 |  |
| Circle | -.128 | .309 | .015 | -.060 | .650 | .003 | -.065 | .629 | .003 |  |
| Dot | .172 | .166 | .028 | .220 | .089 | .040 | .222 | .090 | .040 |  |
| Inhibition | -.043 | .719 | .002 | -.061 | .605 | .004 | -.055 | .647 | .003 |  |
| Line Ratio |  |  |  | -.036 | .788 | .001 | -.026 | .850 | .000 |  |
| Circle |  |  |  | -.288 | .072 | .045 | -.283 | .082 | .042 |  |
| Ratio |  |  |  | .292 | $.024^{*}$ | .071 | .284 | $.033^{*}$ | .064 |  |
| Dot Ratio |  |  |  |  |  |  | .038 | .773 | .001 |  |
| Raven |  |  |  |  |  |  |  |  |  |  |

 Circle Ratio $=$ Circle ratio acuity, Dot Ratio $=$ Dot ratio acuity.

## b. Fractional Knowledge

|  |  | Step 1 <br> $R^{2}=.02$ | Step 2 <br> $\Delta R^{2}=.11$ |  |  |  | Step 3 <br> $\Delta R^{2}=.08$ |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\beta$ | $p$ | $\mathrm{sr}^{2}$ | $\beta$ | $p$ | $\mathrm{sr}^{2}$ | $\beta$ | $p$ | $\mathrm{sr}^{2}$ |
| Line | -.020 | .873 | .000 | .014 | .911 | .000 | .082 | .497 | .006 |
| Circle | .135 | .274 | .017 | .088 | .498 | .006 | .045 | .723 | .002 |
| Dot | -.048 | .693 | .002 | -.057 | .653 | .003 | -.051 | .676 | .002 |
| Inhibition | -.065 | .588 | .004 | -.046 | .695 | .002 | .007 | .948 | .000 |
| Line Ratio |  |  |  | -.364 | $.007^{*}$ | .100 | -.289 | $.029^{*}$ | .060 |
| Circle |  |  |  | .076 | .628 | .003 | .123 | .416 | .008 |
| Ratio |  |  |  | .177 | .163 | .026 | .118 | .337 | .011 |
| Dot Ratio |  |  |  |  |  |  | .316 | $.013^{*}$ | .079 |
| Raven |  |  |  |  |  |  |  |  |  |
| $p<.01^{* *}, p<.05^{*} ;$ | Line $=$ Line acuity, Circle $=$ Circle acuity, Dot = Dot acuity, Line Ratio = Line ratio acuity, |  |  |  |  |  |  |  |  |

[^0]| c. Algebra |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{aligned} & \text { Step } 1 \\ & R^{2}=.05 \end{aligned}$ |  |  | $\begin{gathered} \text { Step } 2 \\ \Delta R^{2}=.08 \end{gathered}$ |  |  | $\begin{gathered} \text { Step } 3 \\ \Delta R^{2}=.13 \end{gathered}$ |  |  |
|  | $\beta$ | $p$ | $\mathrm{sr}^{2}$ | $\beta$ | $p$ | $\mathrm{sr}^{2}$ | $\beta$ | $p$ | $\mathrm{sr}^{2}$ |
| Line | -. 078 | . 526 | . 006 | -. 040 | . 746 | . 001 | . 047 | . 689 | . 002 |
| Circle | . 063 | . 601 | . 004 | . 013 | . 923 | . 000 | -. 042 | . 728 | . 001 |
| Dot | -. 200 | . 100 | . 038 | -. 232 | . 072 | . 044 | -. 224 | . 062 | . 041 |
| Inhibition | . 011 | . 927 | . 000 | . 012 | . 916 | . 000 | . 079 | . 472 | . 006 |
| Line Ratio |  |  |  | -. 265 | .048* | . 053 | -. 170 | . 181 | . 021 |
| Circle Ratio |  |  |  | . 073 | . 641 | . 003 | . 133 | . 365 | . 009 |
| Dot Ratio |  |  |  | . 237 | . 063 | . 047 | . 163 | . 174 | . 021 |
| Raven |  |  |  |  |  |  | . 400 | .001** | . 126 |

d. Math Fundamentals

|  | $\begin{aligned} & \text { Step 1 } \\ & R^{2}=.03 \\ & \hline \end{aligned}$ |  |  | $\begin{gathered} \text { Step } 2 \\ \Delta R^{2}=.13 \end{gathered}$ |  |  | $\begin{gathered} \text { Step 3 } \\ \Delta R^{2}=.08 \end{gathered}$ |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\beta$ | $p$ | sr ${ }^{2}$ | $\beta$ | $p$ | $\mathrm{sr}^{2}$ | $\beta$ | p | $\mathrm{sr}^{2}$ |
| Line | -. 063 | . 611 | . 004 | . 006 | . 959 | . 000 | . 074 | . 533 | . 005 |
| Circle | . 105 | . 393 | . 010 | . 121 | . 346 | . 012 | . 078 | . 530 | . 005 |
| Dot | -. 097 | . 427 | . 009 | -. 066 | . 602 | . 003 | -. 059 | . 622 | . 003 |
| Inhibition | -. 096 | . 420 | . 009 | -. 095 | . 408 | . 009 | -. 043 | . 704 | . 002 |
| Line Ratio |  |  |  | -. 264 | .046* | . 052 | -. 189 | . 145 | . 026 |
| Circle <br> Ratio |  |  |  | -. 140 | . 366 | . 011 | -. 092 | . 536 | . 005 |
| Dot Ratio |  |  |  | . 291 | .022* | . 071 | . 233 | . 058 | . 044 |
| Raven |  |  |  |  |  |  | . 314 | .012* | . 078 |

$p<.01^{* *}, p<.05^{*}$; Line = Line acuity, Circle = Circle acuity, Dot = Dot acuity, Line Ratio = Line ratio acuity, Circle Ratio $=$ Circle ratio acuity, Dot Ratio $=$ Dot ratio acuity.

| e. Trigonometry |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{aligned} & \text { Step } 1 \\ & R^{2}=.02 \end{aligned}$ |  |  | Step 2$\Delta R^{2}=.09$ |  |  | $\begin{gathered} \hline \text { Step } 3 \\ \Delta R^{2}=.05 \\ \hline \end{gathered}$ |  |  |
|  | $\beta$ | $p$ | $\mathrm{sr}^{2}$ | $\beta$ | $p$ | $\mathrm{sr}^{2}$ | $\beta$ | $p$ | sr ${ }^{2}$ |
| Line | -. 059 | . 635 | . 003 | -. 016 | . 896 | . 000 | . 038 | . 759 | . 001 |
| Circle | . 033 | . 788 | . 001 | -. 003 | . 984 | . 000 | -. 037 | . 775 | . 001 |
| Dot | -. 108 | . 379 | . 011 | -. 120 | . 352 | . 012 | -. 116 | . 362 | . 011 |
| Inhibition | -. 050 | . 676 | . 002 | -. 044 | . 709 | . 002 | -. 002 | . 989 | . 000 |
| Line Ratio |  |  |  | -. 288 | .035* | . 063 | -. 228 | . 094 | . 037 |
| Circle Ratio |  |  |  | . 029 | . 852 | . 000 | . 068 | . 666 | . 002 |
| Dot Ratio |  |  |  | . 230 | . 075 | . 044 | . 183 | . 152 | . 027 |
| Raven |  |  |  |  |  |  | . 252 | .053 ${ }^{+}$ | . 050 |

Table S5. Results from the hierarchical regression analyses predicting scores on Symbolic fraction comparison without including Raven.

| Symbolic Fraction Comparison (with acc, n=84) |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Step 1 <br> $R^{2}=.02$ |  |  |  |  |  |
|  | $\beta$ | $p$ | $\mathrm{sr}^{2}$ | $\beta$ | Step 2 <br> $\Delta R^{2}=.09$ |  |
| Line | .028 | .831 | .001 | -.066 | .635 | .003 |
| Circle | .124 | .337 | .012 | .078 | .568 | .004 |
| Dot | -.118 | .329 | .012 | -.188 | .136 | .027 |
| Inhibition | -.036 | .750 | .001 | -.028 | .799 | .001 |
| Line Ratio |  |  |  | .168 | .194 | .020 |
| Circle Ratio |  |  |  | -.139 | .297 | .013 |
| Dot Ratio |  |  |  | .252 | .125 | .029 |


[^0]:    Circle Ratio $=$ Circle ratio acuity, Dot Ratio $=$ Dot ratio acuity.

