Should your Growth Mindset be Fixed?
Examining the Opportunity Costs of Adopting a Growth Over a Fixed Mindset

QX Teo
A Fable:

[Image of turtle]

[Image of rabbit running]

[Image of rabbit sleeping with "zzz..."

FINISH
“Slow and Steady Wins the Race”

- Persistence as a good thing:
  - The hardworking tortoise beating the lazy hare

- Grit (Duckworth, 2007):
  - “Passion and perseverance for long-term goals”
  - Cultivating Grit: “The Hard Thing Rule”

- How do we get children to persist?
  - Growth Mindsets!
Mindset Theory (Dweck 2006)

What do people believe about intelligence?

- Fixed Mindset: Innate ability, intelligence is a fixed quantity
- Growth Mindset: Intelligence is *malleable*

How do these people react to failure?

How do these people approach problems?
Fixed or Growth Mindset?

Studies show strong support for the Growth Mindset:

- Fixed mindset children were quicker to give up when faced with failure, attributing their failures to them not being “smart enough” (Diener et al., 1978, also Dweck and Repucci, 1973)
- Students in the University of Hong Kong were asked if they were interested in taking a high-quality remedial English course (Hong et al., 1999)
  - Fixed Mindsets were not enthusiastic, while Growth Mindsets were “willing to expose a deficiency for the sake of correcting it”.
- Correlational paths from mindsets to goals & responses, predicting changes in math grades over a two year period in 7th/8th grade (Robins and Pals, 2002, Blackwell, Trzesniewski & Dweck, 2007)
Knowing that people’s notions about mindset are malleable:

Led to the focus on developing a growth mindset in interventions:

How is this knowledge used in the real world?

- Adolescents who undertook growth mindset interventions earned higher achievement test scores (Good et al., 2003), or math grades (Blackwell et al., 2007) than students in control groups.
- Refining the growth mindset intervention for schools (Y eager 2015 to 2018)
- Beyond the school system, but even parenting (Andersen & Nielsen, 2016)
- We see this even in the CMU setting!

Dr. Carol Dweck, cognitive psychologist and leading expert on “mindset,” describes growth mindset as “the understanding that we can develop our abilities and intelligence.” The

- We see this even in the CMU setting!
Is this reflected in the real world?

- Not really!
- Anecdotally: see a healthy mix of both even in academically oriented fields (faculty, university students)
- How certain are we that growth mindset is truly favorable in all scenarios?
- If growth mindset is that favorable, why aren’t more people in the world adopting it?
Fixed or Growth Mindset? (Revisited)

Are there instances where a fixed mindset may be favorable to a growth mindset?

- Tough problems: fixing a plumbing issue
- Impossible problems: Find an anagram of ‘gref’

Are there other “opportunity costs” to pursuing a growth mindset?

- Improved achievement scores, but at a cost of mental/physical health, happiness?
- Revisiting the “Hard Thing Rule”
Research Questions

1. Confirm that there is a positive correlation between the degree of growth mindset and persistence in completing a task

2. Explore if there exist tasks in which persistence is counter-productive

3. Explore whether adopting a growth mindset is always preferable to a fixed mindset, identify scenarios in which adopting a fixed mindset may ultimately benefit the individual
Theorized Pathways

- Analysis to focus on relationships between these three variables
  - Mindset: Measured by scale (Dweck, 1999)
  - Persistence: Measured through task design (e.g. how many questions were skipped)
  - Task Performance: Number of correct answers - 0.5 * Number of wrong answers
Study Design

- Conducted 3 studies, using 5 separate tasks.
  - 2 Tasks per study
- Given the COVID-19 situation, all studies were online (Qualtrics survey)
- Incentivised to do their best on the tasks (by cash performance bonus when possible)
Task 1 / 2: Listing Animals/Musicians (Todd et al., 2012)

- List as many animals/musicians as you can in 4 minutes
- Real data illustration:
  Bear, Possum, Dog, Cat, **Wolf, Leopard, Tiger, Lion, Mouse,** Rat, Shrew, Vole, Gopher, Snake, Rabbit, Sheep, Llama, Alpaca, Camel, Donkey, Horse, Goat....

- Concept: List items in a sub-category until they run out, then switch to a different sub-category
- Persistence: How often participants switched categories, how long participants spent within a category before switching
Task 3: RAT Puzzles

- Find the word associated with each of the other 3 words

- Examples:
  - Cottage / Swiss / Cake: Cheese
  - Master / Toss / Finger: Ring
  - Tooth / Potato / Heart: Sweet

- 60 questions in total, 1 per page, participants were allowed to skip at any time but can not return to previous questions

- Persistence: Number of puzzles participants skipped, time participants took before skipping
Task 4: Rebus Puzzles

- Find the popular phrase associated with this image.
- 30 questions in total, 1 per page, allowed to skip at any time but cannot return.
- Persistence: Number of puzzles participants skipped, time participants took before skipping.

Feeling on top of the world

Split second timing
Task 5: Anagrams

- Using the 9 characters shown below, find as many words of length >= 4 as you can in 4 minutes.
- 10 sets of 9 characters (6 consonants + 3 vowels), participants allowed to move on to the next set at any point in time.
- Persistence: How long participants spend on each set of characters, whether participants decide to skip a set of characters before entering a single word.
- Example: C U D S W F O E J
  - Defocus, Focused, Codes...
Results

1. Mindset x Persistence
   “Does my mindset affect my level of persistence?”

2. Persistence x Performance
   “Is persistence rewarded in this domain?”

3. Mindset x Performance
   “Does my mindset lead to better results?”

4. Supplementary findings (Additional Slides)
   a. Word2Vec Analysis of Semantic Similarity
   b. Timing Analysis
Mindset x Persistence (Skips)

- All domains show no relationship between the two, except:
  - Anagrams task: increase of 1 (out of 6) in the growth mindset scale equivalent to 0.2 decrease in number of “empty pages” ($F = 4.925$, $p = 0.0027$)
- Growth mindsets only persist in some scenarios, despite being taught that persistence is good.
- Possible explanation: discerning?
Persistence (Skips/Switches) x Performance

Tasks are split between persistence worsening and improving performance:

- Worsening: Animals, Musicians, RAT
- Improving: Rebus, Anagrams

- Persistence may not always lead to better performance in tasks, despite what the literature says
Mindset x Performance

- All domains show no relationship between the two, except:
- Animals task: increase in 1 (out of 6) on the Growth Mindset scale is equivalent to 4.3 more animals listed (F = 10.75, p < 0.01)

Reasons:

- Task homogeneity: listing farm animals similar to listing pets, or marsupials
## Summary of Results

<table>
<thead>
<tr>
<th></th>
<th>Study 1</th>
<th>Study 2</th>
<th>Study 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Animals</strong></td>
<td>0.007</td>
<td>+0.15</td>
<td>-0.094</td>
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<tr>
<td><strong>Musicians</strong></td>
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<td></td>
<td>0.043</td>
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<td><strong>RAT</strong></td>
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<td><strong>Rebus</strong></td>
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<td><strong>Anagrams</strong></td>
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<tr>
<td><strong>Mindset x Persistence (Skips)</strong></td>
<td>0.007</td>
<td>+0.15</td>
<td>-0.094</td>
</tr>
<tr>
<td><strong>Coeff.</strong></td>
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<td>3.80 ***</td>
<td>0.15 *</td>
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<td><strong>p-val</strong></td>
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<td>&lt; 10⁻¹⁶</td>
<td>0.019</td>
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<tr>
<td><strong>Persistence (Skips) x Performance</strong></td>
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<tr>
<td><strong>Coeff.</strong></td>
<td>+4.3 **</td>
<td>+1.0</td>
<td>0.027</td>
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<tr>
<td><strong>p-val</strong></td>
<td>&lt;0.01</td>
<td>0.4618</td>
<td>0.96</td>
</tr>
</tbody>
</table>

- Mindset does not always translate to persistence, even when it is beneficial.
- Persistence does not necessarily lead to improved performance.
- Mindset does not always translate to improved performance.
Discussion

● Further research on boundary conditions: When does having a growth mindset induce greater persistence?
● Lack of task diversity - giving participants incentive to switch
● Choice of task matters - can affect whether persistence is beneficial, whether mindset leads to persistence
● Possibility of better informing mindset interventions: When should we encourage students to persist?
Thank you!
Timing Analysis

- How long participants spent on a question before deciding to skip
  - Those with a growth mindset would persist for longer before skipping
- Could not find evidence indicating that mindset had an effect on whether participants persist longer ($t = 0.616, p = 0.54$)
Timing Analysis

- How long participants spent coming up with successive words (listing/anagrams) before skipping
- Participants take longer on average leading up to a skip, but no noticeable difference in behavior between growth and fixed mindset individuals.
Word2Vec Analysis

- Measured word2vec cosine similarities between adjacent entries of a list.

- Using a heuristic from the field (Lundin et. al. 2020):
  - If $S(A,B)$ is the similarity between objects $A$ and $B$, for 4 objects $A$, $B$, $C$, $D$, we say that a switch in category happened between $B$ and $C$ if:
    $$ (S(A,B) > S(B,C)) \text{ AND } (S(B,C) < S(C,D)) $$
  - Considering “Tiger, Lion, Rabbit, Hare”:
    1. Tiger + Lion are more similar than Lion + Rabbit AND
    2. Rabbit + Rat are more similar than Lion + Rabbit
Word2Vec Analysis

Participants with a growth mindset appear to switch more using the Word2Vec heuristic

- But: driven by relationship between Mindset and Performance
- Mindset had no effect on likelihood of switching
Robustness Analysis of Word2Vec Heuristics

Original: \((S(A,B) > S(B,C)) \text{ AND } (S(B,C) < S(C,D))\)

- Differences might be too minute (e.g. all \(S(x,y) < 0.2\))

Proposed alternative hypotheses:

- \(S(B,C) < k, \ k = 0.2, 0.25, 0.3\)
- \((S(A,B) > k \times S(B,C)) \text{ AND } (k \times S(B,C) < S(C,D)), \ k = 1.2, 1.3\)
- \((S(A,B) > k + S(B,C)) \text{ AND } (k + S(B,C) < S(C,D)), \ k = 0.1\)

(and combinations of the above)
Robustness Analysis of Word2Vec Heuristics

- None of the models produced significant relationship between mindset and persistence (Best model $F = 2.13$, $p = 0.15$)
- Extremely low adjusted R-squared (largest = 0.012) indicate that effect, even if present, is extremely weak