Adapting Tangerine to Measure Executive Function in Preschool-Aged Children

by Megan McCune for the mEducation Alliance Symposium, 2017
what is executive function?

Executive Functions (EFs) are the “air traffic control” of the brain - cognitive processes/abilities that are important for:

- Organizing information
- Planning
- Problem solving
- Ability to sustain attention
- Orchestrating thought and action in support of goal-directed behavior

EFs are key to a child’s ability to learn how to learn.
key ef cognitive skills

**Working Memory**
Holding in mind and updating information while simultaneously performing some operation or activity.

**Inhibitory Control**
The inhibition of automatized response with working to complete a task.

**Cognitive Flexibility**
The ability to adjust habitual responses or thinking and adapt to new situations or stimuli.
Original assessment mechanism:

Paper-based “flip book” approach

- Child touches/responds to stimuli on the flip book
- Required two assessors and expensive commercial scoring software
- Minimal to no control of item display speed; number of child attempts etc

First Computerized Battery:

Laptop and touchscreen monitor configuration

- Used a laptop for scoring with a connected touch screen monitor for the child; an improvement
- One assessor instead of two
- But….too cost prohibitive and bulky; difficult to deploy “assessment stations”
benefits of tangerine

- Tablets mimic the visual layout of the flip book tasks and are touch screen
- Easily modified tools using online Tangerine wizard
- Administration requires only one assessor and can be done offline
- Multiple tablets can be used at once (ie not limited to one “station”)
- Tangerine allows custom time stamps, auto-stop mechanisms and standardized delivery of test items
- Results can be uploaded immediately after data collection to a central server (rather than manual coding/entry)
EF assessment originally included a battery of six tools aimed at measuring the three key EF skills.

To adapt these tools for Tangerine, new features were developed, including:

- **Audio-visual capabilities**
- **New test progression/time-stamp capabilities**
- **Training and demo modules before all test items**
- **New skip logic** commands ("if then" statements)
- **New scoring** capabilities (ie, the ability to score if the child does *not* touch the screen)
- **Development of assessor “confidence” questionnaire** to assist in validating quality of results
ef touch pilot: is Tangerine feasible?

- EF measurement tasks further modified for Kenyan context in 2-day adaptation workshop; followed by 3-day assessor training
- Piloted with 200 children in greater Nairobi
  - First ever deployment of EF touch on a tablet device
- Mostly administered in Kiswahili (76%)
- 51% female; aged 3-6 years but predominantly 4-6
- Data collected using 7” Android tablets on tablet stands
pilot tool example: bubbles

Introductory tool measuring reaction time; child taps images of a bubble to “pop it” as it moves around the screen. Child scored based on response time; zero score applied to an item if the child does not touch the bubble.
Stroop-like task measuring inhibitory control. Each screen presents a photo of a dog and a cat, and either a woof or a meow sound is played. The child is instructed to touch the cat if they hear a “woof” and the dog if they hear a “meow”. Zero score if child touches wrong animal.
Measures working memory; children are presented with an array of pictures and are asked to pick a different picture within that set on each screen so that “all the pictures get a turn.” Pictures are re-ordered in each screen.
Something’s the Same
Measures attention shifting and mental flexibility. Children are presented with two pictures that are the same in some way (ie, both are cats, but one is red and one is blue). A third picture is introduced (ie, a red flower), and the child is asked to select which of the original pictures are similar to the new picture in some way (ie, the red cat as both are red).

Animal Go / No Go
Measures inhibitory control; children are instructed to touch a green button every time an animal that is not a pig is presented.

Spatial Conflict Arrows
Measures inhibitory control and cognitive flexibility. Two buttons appear on the left and right sides; children are instructed to touch the button where the arrow is pointing.
challenges

- **Tool adaptation**: translations and illustrations appropriate?
- **Small screen size** of tablet
- **Small assessment space** / distracting sounds
- **Training issues**: Assessors following directions and the script
- **Modifying back end** to produce cleaner data
- **Loading more than one apk** (ie, *EF Touch* with “regular” Tangerine)
- **Creating new skip logics** and back-end programming – requires a new codebook
Data “behaved” similarly to data collected using the original flipbook/laptop methods

- Age, individual reaction time and attentive-related behaviors all uniquely associated with the EF composite scores, as hoped/expected

- Children completed an avg of 64-82% of the test items correctly; children overall observed to be highly engaged

- Some tools ran a little long and/or tested the same EF and can be reduced or eliminated

- Some AV adjustment needed (sounds/illustrations)

- Assessors rated high data confidence in 90% of the tasks
Overall, the pilot successfully demonstrated the feasibility of using Tangerine™ *EF Touch* to measure EF skills in young children in a developing country context.
Larger deployment in Kenya – data collection with 1,300 children currently in process

Further back-end modifications to improve ease of analysis

Development of additional EF assessment tools and *EF touch* capabilities in Tangerine

Identify new partners to assist in systematic studies/deployments of *EF touch* in Tangerine in the interest of early education policy
questions?