

# Progress Report

## Colourful-Calculations: An International App-Based Trial, Investigating The Potential Of Therapeutic Tools For Synaesthesia

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### What is Synaesthesia and why do we study it?

Synaesthesia is characterized by the coupling of a triggering percept, the ‘inducer’, to an additional percept, the ‘concurrent’<sup>2</sup>. There is an infinitude of potential combinations with the most famous variant, seeing-sound, being ingrained in both music and art culture (*Viz.* Messiaen, Marilyn Monroe, David Hockney, Joan Mitchel, Billy Joel, Lady GaGa, Lorde etc.) In the most widely studied variant, Grapheme-Colour Synaesthesia (GCS), viewing numbers and letters triggers a colour experience.

"When I see equations, I see the letters in colors - I don't know why. As I'm talking, I see vague pictures of Bessel functions from Jahnke and Emde's book, with light-tan j's, slightly violet-bluish n's, and dark brown x's flying around. And I wonder what the hell it must look like to the students."

— *From Richard Feynman, p. 59*

Despite the common occurrence of synaesthesia, prevalent at perhaps greater than 4% of the general population, it is often under-reported and under-recognised<sup>1</sup>. This is unsurprising for two primary reasons: first, due to the practical inaccessibility of others’ brain circuitry and phenomenological experience *cf* an externally visible trait like eye-colour, and second due to the fear of being labelled as, “faking it, on drugs, or just plain crazy”. Historically, the focus of synaesthesia research has been on its validation as a phenomenon and inquiring into its potential benefits for memory, learning, and recognition. Despite ubiquitous reporting and allusions in the literature to an inherent cost - interference from these additional perceptions - it has largely been overlooked as a potential area of positive intervention.

After serendipitously recognising a friend’s synaesthesia may be interfering with her numeracy, the Chief Investigator suggested a colourful-calculator that reflected her number-digit associations may be helpful. After receiving an unexpectedly positive response to prototype version (Figure one) he deferred his medical studies to undertake this line of research in the hope that the simple change could affect others similarly.

## **Hypothesis vs Findings**

We hypothesised that there will be a general effect of reduced interference, that translates to an improved function and affect (i.e. emotions), when interacting with tools that mirror a synaesthete's 'concurrent'. Our preliminary results are promising, with 40/54 of the GSC participants reporting increased ease, and a sub-group of participants being objectively faster, when performing numeracy tasks on a tablet device using a 'colourful calculator'. On a 7-point scale, twenty-four of the participants rated 7/7 in agreement that analogous devices (e.g. colour-keyboards) would be useful and fourteen participants rated 7/7 that a 'colourful-calculator' would have helped as a child.

## **Unanswered questions**

For the moment, we are focused on upscaling and generalising the pilot study to an app based study that may be performed remotely to increase the power of our analysis. We aim to answer the following questions:

- Is there a general objective facilitatory effect over a larger population?
- Is there a general effect on people's affect over a larger population? [We measure facial micro-expressions, captured by the forward-facing camera of the device, as a proxy for affect]
- Are there subpopulations who may benefit especially? [There is an increased prevalence of Synaesthesia in Autism Spectrum Disorder]

Further down the track, we envisage a longitudinal study examining the potential impact on children's development and learning.

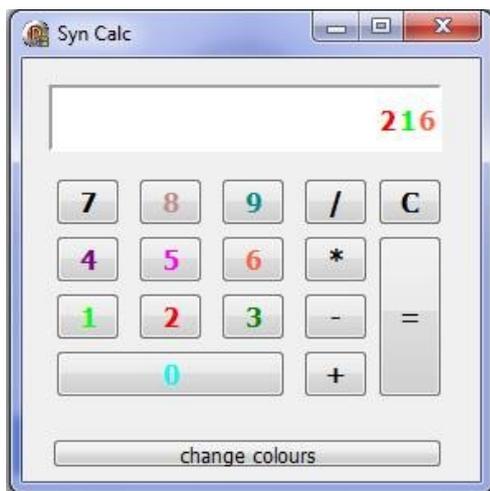
## **What these results outcomes mean.**

Our results demonstrate that by aligning feed-forward sensory data with the synesthetic concurrent we can improve both function and affect. We envisage our 'colourful-calculator' to be the starting point of uniquely targeted therapeutic tools in this previously untreated population. Importantly, these tools would not be aimed at removing, but at complementing synaesthesia, a trait that has the potential to endow advantages in memory, perception, and cognition.

## Did you know?

'The doctor who feels your pain', Harvard Neurologist Dr Joel Salinas, has Mirror-Touch synaesthesia, whereby viewing someone being touched elicits a similar perception on his body.

Figure 1



*“I cried the first time I used it... Everything made sense. It was actually quite life changing.”*