**How does tracing reduce extraneous cognitive load? A Think Aloud approach.**

Michael Tang - University of Sydney
Michael Jacobson - University of Sydney
Paul Ginns - University of Sydney

Cognitive load theorists have been inspired by Geary's (2008) evolutionary perspective and incorporated an evolutionary view of human cognitive architecture. Based on this perspective, new concepts to distinguish categories of knowledge have been introduced as biologically primary knowledge (B1K) and biologically secondary knowledge (B2K) (Sweller, 2008). Humans have evolved to acquire B1K without much effort, e.g. listening; and B2K are those required socially yet acquiring such knowledge requires extended effort, e.g. writing and reading (Sweller, 2011). Paas and Sweller (2012) argue that there are potentials for B1K to support teaching and learning of B2K without imposing a substantial additional working memory load on learners. Gesturing, as a source of B1K, has been argued to be able to facilitate acquiring B2K (Paas & Sweller, 2012). Inspired by Montessori's (1912) sandpaper letters, a series of studies (Aghostino et al., 2015; Hu et al., 2015; Ginns et al., 2015) have found explicit instructions to point and trace with the index finger enhances learning from worked examples across a range of mathematics topics. The current study extends research on tracing gestures through a series of experiments to examine how tracing gestures affect cognitive processing and learning from expository text and diagrams drawn from the science curriculum. The results of Experiment 1 (n=44) have demonstrated the effectiveness of tracing over reading on knowledge retention (U=139, p=.008, d=.75), knowledge explanation (U=172, p=.050[one-tailed], d=.55), and on transfer knowledge (U=105, p=.001, d=1.05), showing that tracing gesture may have involved reducing search and match processes, as indicated by less extraneous cognitive load reported by the tracing condition than the non-tracing condition (U=344.5, p=.016, d=.84). However, the lack of an effect on intrinsic cognitive load is at odds with Hu et al.'s (2015) hypothesis that information is better "packaged" (cf. Alibali et al., 2000) during learning in the tracing condition than the non-tracing condition. In order to understand this inconsistency, Experiment 2 aimed to elucidate the underlying cognitive processes activated by tracing via verbal protocol (Ericsson & Simon, 1993). In Experiment 2, ten primary school students were randomly and evenly separated into tracing and non-tracing conditions and were instructed to think aloud while studying. Verbal protocol analysis and video analysis (currently being performed) will be used to cross-compare self-reported cognitive rating with displayed learning behaviour to elucidate the effects of tracing while studying. Results and possible relation between gesturing and cognitive load rating will be presented at the conference.