

**Validating the online measurement of cognitive load in multimodal and multilingual educational settings**

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The benefits of instructional design have been well-documented in many areas of multimedia learning (Mayer, 2009). However, there is comparably less evidence of these benefits in dynamic audio-visual stimuli, including subtitled video, and for those with diverse language proficiencies, e.g., students studying in a second language and students with language impairments. These are particularly pressing issues in contemporary educational settings in which complex multimodality and linguistic diversity are the norm.

It has been widely acknowledged that learning through a second language poses a significant barrier to academic success (e.g., see Berman & Cheng, 2010). Educators have been trying to find innovative ways to engage these students in a variety of teaching and learning activities to provide optimal language support. Central to this has been the incorporation of video, although little empirical evidence exists as to the optimal online processing of dynamic audio-visual stimuli amongst linguistically diverse groups (e.g., Gernsbacher, 2005). Such knowledge is particularly relevant in the context of the multiple redundancies present in subtitled educational content. Knowing how different sources of information in educational video contribute to cognitive load will enable us to optimise subtitles to meet the needs of students with diverse language needs. The incorporation of online measures provides greater granularity than previously possible and enables the exploration of real-time interventions, e.g., dynamic subtitle presentation adapting to the needs of the viewer during a video lecture.

This paper will present the findings of a study that was designed to validate the multimodal measurement of cognitive load in the context of educational subtitles (based on Kruger & Doherty, 2016). This methodology contains a novel combination of electroencephalography (alpha, delta and theta power), eye tracking (pupil diameter, blinks, and fixations), self-reported cognitive load, and task performance measures. Although these measures have previously been used in isolation, or in combination for texts that do not combine video and text and audio, this suite has provided an unprecedented validation of the multimodal measurement of cognitive load. Our findings include results from a study involving the presentation of short videos at different levels of linguistic complexity, where greater linguistic complexity resulted in high cognitive load scores across the range of measures and with the inclusion of known linguistic and cognitive co-variables. From this, we contend that the initial validation of this methodology holds promise in establishing online measures that will help us to shape the future of research and applications of cognitive load in multimodal and multilingual educational settings.