The effect of text simplification techniques on cognitive load across languages and modes: Insights from human and machine-based evaluations

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Text simplification is the process of reducing the linguistic complexity of a text while retaining the original content and meaning. Text simplification techniques can be carried out manually as part of the creation of a text, or automatically by systems trained to simplify existing texts. These techniques can be applied to different levels of a text and across a range of domains including technical documents and medical texts (Doherty, 2012; Siddharthan, 2014). Typical examples of these interventions are the usage of restricted vocabulary and grammar, and the limitation of sentences to 25 words with a maximum of two clauses. While a number of studies have shown that such text simplification techniques have resulted in increased readability and comprehension in monolingual and multilingual applications (Doherty, 2012), inconsistencies between human and machine-based evaluations have been widely reported (Doherty, 2017). These inconsistencies are arguably due to the limited interface between the prognostic computational algorithms that predict readability and empirical evidence from actual human performance data.

This paper presents results from a series of experiments from a project that aims to test the efficacy of text simplification techniques across languages and modes. Using a novel cross-disciplinary eye tracking methodology based on Cognitive Load Theory that triangulates online and post-hoc human and machine-based metrics (Doherty, O'Brien & Carl, 2010), I show how text simplification techniques are indeed effective across languages and modes and identify a point of divergence between human (n = 121) and machine evaluators, where the former is more sensitive to the effects of text simplification techniques at the syntactic level and the latter at the lexical level. I account for the replicated benefits of text simplification in this manner by drawing upon findings from multimedia learning (see Mayer, 2009) which show how the reduction of extraneous load maximises the cognitive capacity to be assigned to germane load to facilitate schema formation—in this case for comprehension.

The findings and methodological development of this project help to address a long-standing inconsistency between human and machine-based linguistic evaluation methods in several areas of language processing, particularly text simplification and machine translation. In closing, I describe a prototype system developed from this project which incorporates real-time eye tracking data into machine translation systems to improve reading and comprehension across languages and modes. I contend that the integration of Cognitive Load Theory into language performance tasks can be illuminating to researchers and valuable to applications of language technologies.