Pushing the limit: A further investigation into the exceptional ability to break Miller's processing capacity

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Doctor of Philosophy in Science (Psychology)

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Statement of Originality

I hereby certify that the work embodied in the thesis is my own work, conducted under normal supervision.

The thesis contains no material which has been accepted, or is being examined, for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to the final version of my thesis being made available worldwide when deposited in the University’s Digital Repository, subject to the provisions of the Copyright Act 1968 and any approved embargo.
Statement of Collaboration

I hereby certify that some of the work embodied in this thesis has been done in collaboration with other researchers. I have included below, as part of the thesis, a statement clearly outlining the extent of collaboration, with whom and under what auspices.

Some of the information in Chapter 1 of this thesis was similar to the work included in a chapter of which I am a co-author:


The content of Chapter 2 was published in a paper of which I am a co-author:


The initial inspiration for the work in Chapter 3 was discussed with Professor Roger Dean from the MARCS Institute for Brain, Behaviour, and Development (University of Western Sydney). Professor Dean created the tones used in this experiment and also collaborated with Professors Brown, Professor Heathcote, and I in the experimental design of this project.

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Publications during Candidature

During my candidature, I contributed to published work, listed below, some of which were not directly related to the content in this thesis.


* These publications are directly related to the work in this thesis.

** This publication is cited in Chapter 6 of this thesis in the section *Future Research Directions*
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Abstract

Absolute identification (AI) is a paradigm in which participants identify stimuli varying on one physical dimension, such as line length. Stimuli are presented during a practice phase with a unique label, and during a test phase the participant is required to report labels based on the stimulus alone. Miller’s (1956) processing capacity limit of $7\pm2$ was long thought to be the ceiling for the number of uni-dimensional stimuli participants could learn to identify in an AI task. Recent research, however, has proven this limit to be breakable by some exceptional participants. This thesis contains four experimental chapters that aimed to answer three central questions that relate to the ability to exceed Miller’s processing capacity limit. Firstly, to what extent is this ability learned? Secondly, what quality do people have who can learn beyond this limit? And finally, how far beyond this limit is it possible to go? Following the introduction in Chapter 1, Chapter 2 describes a Structural Forms algorithm (Kemp & Tenenbaum, 2008) to investigate participants’ psychological representation of stimuli across several modalities in various AI learning tasks. The examination of whether the multi-dimensional nature of musical tones contribute to an increased accuracy, and whether the frequencies aligning with the current Western musical scale are better identified, particularly for musicians, is presented in Chapter 3. Chapter 4 describes an experiment conducted in China investigating whether native tonal-language speakers have an AI advantage with pitch compared to Western populations. Chapter 5 reports about a long term learning experiment with tones of varying frequency and lines of varying length. Together, these results confirm findings that breaking Miller’s limit in identifying uni-dimensional stimuli is possible through learning, and that it is correlated with having a complex psychological representation of the stimuli. It is suggested that future
research directions focus on disentangling these two factors, as well as collaborating with other psychological research areas such as neuro- and bio-psychology.