Revisiting Miller's Limit:

Studies in Absolute Identification

Pennie Dodds – BPsych (Hons)

Thesis Submitted for Doctorate of Philosophy, September 2011

Statement of Originality

This thesis contains no material which has been accepted 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 this copy of my thesis, when deposited in the University Library, being made available for loan and photocopying subject to the provisions of the Copyright Act 1968.

Acknowledgment of Collaboration

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

Thesis by Publication

I hereby certify that this thesis is in the form of a series of published papers of which I am a joint author. I have included as part of the thesis a written statement from each co-author, endorsed by the Faculty Assistant Dean (Research Training), attesting to my contribution to the joint publications.

Pennie Dodds

Publications Included in Thesis

In order of reference:

Dodds, P., Donkin, C., Brown, S. D. & Heathcote, A. (2011) Increasing Capacity: Practice Effects in Absolute Identification *Journal of Experimental Psychology: Learning, Memory & Cognition, 37(2), 477-492.*

Dodds, P., Donkin, C., Brown, S. D., Heathcote, A., & Marley, A. A. J. (2011) Stimulus-Specific Learning: Disrupting the Bow Effect in Absolute Identification. *Attention, Perception & Psychophysics*

Brown, S.D., Marley, A.A.J., **Dodds, P**., & Heathcote, A. (2009) Purely relative models cannot provide a general account of absolute identification. *Psychonomic Bulletin & Review, 16, p.583-593*

Dodds, P., Brown, S. D., Zotov, V., Shaki, S., Marley, A. A. J. & Heathcote, A. (2011). *Absolute production and absolute identification.* Manuscript submitted for publication

Dodds, P., Donkin, D., Brown, S.D., Heathcote, A. (2010) Multidimensional scaling methods for absolute identification data *In S. Ohlsson & R. Catrambone (Eds.), Proceedings of the 32nd Annual Conference of the Cognitive Science Society. Portland, OR: Cognitive Science Society*

Dodds, P., Rae, B. & Brown, S. D. (2011). *Perhaps Unidimensional is not Unidimensional.* Manuscript submitted for publication

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

19th September 2011

To whom it may concern,

This letter outlines Pennie Dodds' contribution to the series of papers that are submitted as a part of her PhD. All papers that are contributing to her thesis are listed below, with a statement of her contribution for each.

Regards,

Associate Professor
Scott Brown

Professor
Andrew Heathcote

Emeritus Professor
A. A. J. Marley

Babette Rae
PhD Candidate

Doctor
Chris Donkin

Doctor
Samuel Shaki

Doctor
Vladimir Zotov

Endorsed By

Dodds, P., Brown, S. D., Zotov, V., Shaki, S., Marley, A. A. J. & Heathcote, A. Reconciling absolute identification and absolute production: a method of examining internal magnitude representation. *Submitted*

> *This project was led by Pennie, 50% contribution. Pennie coordinated and supervised data collection, completed all data analyses, and took the lead role in manuscript preparation. Other authors contributed as follows: S. Brown (10%), V. Zotov (10%), S. Shaki (10%), A. A. J. Marley (10%), A. Heathcote (10%).*

Dodds, P., Rae, B. & Brown, S. D. When unidimensional is not unidimensional. *Submitted*

> *This project was led by Pennie, 40% contribution. Pennie completed all data analyses, took the lead role in manuscript preparation, and collected most of the data that were analysed. The other PhD student on the project (Babette Rae) contributed 40%, Associate Professor Brown contributed 20%.*

Dodds, P., Donkin, C., Brown, S. D., Heathcote, A., Marley, A. A. J. (2011) Stimulus-Specific Learning: Disrupting the Bow Effect in Absolute Identification. *Attention, Perception & Psychophysics, 73*(6), 1977-1986

> *This project was led by Pennie. She conducted all data collection and all analyses, and was primarily responsible for manuscript preparation. Numerically, the contributions from the authors were: Pennie Dodds, 50%; Chris Donkin, 20%; Scott Brown, Andrew Heathcote & A.A.J. Marley, 10% each.*

Dodds, P., Donkin, C., Brown, S. D. & Heathcote, A. (2011) Increasing Capacity: Practice Effects in Absolute Identification. *Journal of Experimental Psychology: Learning, Memory & Cognition*, *37*(2), 477-492

> *This project was very large (many experiments, over several years) and was jointly led by Pennie Dodds and Scott Brown. Pennie was responsible for*

almost all of the extensive data collection, all of the data analyses and most of the manuscript preparation. Numerically: Pennie Dodds 50%, Chris Donkin 30%, Scott Brown 10%, Andrew Heathcote 10%.

Dodds, P., Donkin, D., Brown, S.D., Heathcote, A. (2010) *Multidimensional scaling methods for absolute identification data* In S. Ohlsson & R. Catrambone (Eds.), Proceedings of the 32nd Annual Conference of the Cognitive Science Society. Portland, OR: Cognitive Science Society.

Pennie was responsible for all data collection, analyses and manuscript preparation, with little except advice and feedback provided by the other authors. This equated to approximately a 90% contribution.

Brown, S.D., Marley, A.A.J., **Dodds, P**., & Heathcote, A.J. (2009) Purely relative models cannot provide a general account of absolute identification. *Psychonomic Bulletin & Review, 16*, p.583-593

Pennie was responsible for experiment design, data collection and manuscript review. Approximately a 30% contribution, with Brown and Marley contributing 25% each and Heathcote 20%.

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Abstract

Absolute Identification is a seemingly simple cognitive task that provides researchers with a number of interesting and complex phenomena. The task provides evidence towards an information processing capacity, which Miller (1956) popularised with his magical number 7±2 – a number of which he suggested is reminiscent of the number of unidimensional items (or chunks in short term memory) that an individual should be able to learn to perfectly identify. This limit has long since been accepted as a truism of absolute identification research, with much further model development accepting this as a known intrinsic "quirk" of absolute identification performance. This thesis begins with results that are in stark contrast to Miller's findings – we find that given moderate practice, participants are able to improve their performance significantly. The following chapters describe further investigation into this contrary result, and provide an overview of current models of AI performance. Through a series of published and submitted papers, we investigate the possibility that rather than disproving Miller's theory of an information processing capacity, we might have further refined the absolute identification paradigm. Close examination of common stimuli used in absolute identification tasks reveals that while common stimuli such as line lengths and dot separation are physically unidimensional, the psychological representation of these stimuli may be multidimensional. Interestingly, the sole stimulus modality that did *not* exhibit learning effects – tone loudness - did *not* appear to be represented on multiple dimensions. Without the assumption of uni-dimensionality, we cannot suggest the results are due to some difference in information processing capacity, but are rather more likely an artefact of stimulus perception. These results have significant consequences for the future of absolute identification research: it would appear that

absolute identification researchers should restrict their use of stimulus modalities to only tones varying in loudness.