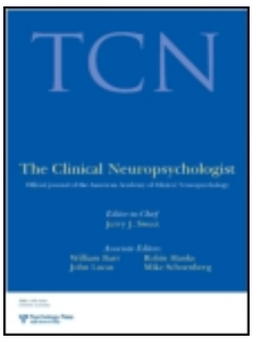

The Clinical Neuropsychologist

ISSN: 1385-4046 (Print) 1744-4144 (Online) Journal homepage: http://www.tandfonline.com/loi/ntcn20

Meta-Analysis in Neuropsychology: An Introduction

George J. Demakis

To cite this article: George J. Demakis (2006) Meta-Analysis in Neuropsychology: An Introduction, The Clinical Neuropsychologist, 20:1, 5-9, DOI: 10.1080/13854040500203266

To link to this article: http://dx.doi.org/10.1080/13854040500203266

The Clinical Neuropsychologist, 20: 5–9, 2006

ISSN: 1385-4046
DOI: 10.1080/13854040500203266

Psychology Press
Taylor & Francis Group

META-ANALYSIS IN NEUROPSYCHOLOGY: AN INTRODUCTION

George J. Demakis
Department of Psychology, University of North Carolina at Charlotte, Charlotte, NC, USA

This special issue is an introduction to meta-analytic approaches, methods, and findings in neuropsychology. The six articles that comprise this issue include a review article, one article examining the statistical power of a specific research literature, and four new meta-analyses on neuropsychological topics. Together these articles provide a user-friendly introduction to meta-analysis in neuropsychology and are designed to assist the clinician in using and applying findings from these studies to their own research and/or clinical work.

INTRODUCTION

This special issue emerged out of a symposium presented on meta-analysis in neuropsychology at the American Psychological Association's (APA) annual meeting in Toronto in 2003. At that time, a review of meta-analytic techniques and approaches within neuropsychology seemed timely given the increasing use of these techniques in psychology in general and neuropsychology in particular. Moreover, because so many of *The Clinical Neuropsychologist's* readers are, in fact, clinicians, a special issue designed to assist the clinician not only to understand meta-analytic research, but also to apply it meaningfully to his or her own clinical work, seemed beneficial. Contributing authors were thus asked (a) to describe basic meta-analytic procedures, applications, and findings in general terms; (b) to highlight the practical ways in which meta-analytic findings can be applied to daily clinical work; and (c) to write with the general clinical neuropsychologist in mind who has a basic statistical background but no specialized knowledge in meta-analysis. This special issue is thus not meant to provide all the "nuts and bolts" of how to conduct a meta-analysis nor to exhaustively review all the relevant neuropsychological or methodological literature, but rather to provide a basic, useful introduction to meta-analysis.

Since the 2003 APA symposium, meta-analytic research has been widely published in key neuropsychology journals. For instance, meta-analyses have been published on neuropsychological impairment in attention deficit/hyperactivity disorder

Address correspondence to: George J. Demakis, University of North Carolina at Charlotte, Department of Psychology, 9201 University City Blvd., Charlotte, NC 28223-0001, USA. Tel.: 704-547-4750. Fax: 704-687-3096. E-mail: gdemakis@email.uncc.edu
Accepted for publication: May 9, 2005.

(Hervey, Epstein, & Curry, 2004; Frazier, Demaree, & Youngstrom, 2004), the effects of long-term benzodiazepine use and withdrawal on cognitive functioning (Barker, Greenwood, Jackson, & Crowe, 2004), performance on executive processing measures in frontal lobe damage (Demakis, 2004), and the differences between children with attention deficit disorder and various comparison groups on the Stroop Color-Word Test (Homack & Riccio, 2004). Other meta-analyses have evaluated the relationship between neuropsychological performance and driving in dementia (Reger, Welsh, Watson, Cholerton, Baker, & Craft, 2004), as well as the relationship of hippocampal volume and memory ability in non-neurologically impaired individuals across the lifespan (Van Petten, 2004). As this brief sampling of recently published meta-analyses attests, meta-analyses are being conducted on a broad range of theoretical and clinical issues of interest to the neuropsychologist.

CONTRIBUTIONS

The first article by Demakis (2006) lays out the basic rationale for meta-analysis and why it is preferable (particularly in neuropsychology) to the traditional narrative review. This article addresses basic statistical, methodological, and conceptual issues relevant for the neuropsychologist doing meta-analysis. After these issues are addressed, the full scope of questions that meta-analytic techniques have addressed in neuropsychology are presented. Such questions include "Does neuropsychological impairment exist?," "If so, what is the nature of this impairment?," and "Are moderators important for understanding effect sizes?" The natural link between neuropsychology and meta-analysis is evident as both seek and prefer quantitative answers to such questions. The next article by Woods, Rippeth, Conover, Carey, Parson, and Troster (2006) is a power analysis of the research on neuropsychological deficits following deep brain stimulation in Parkinson's disease. Like other areas of psychology, these authors demonstrate that this research is underpowered using traditional null hypothesis statistical testing. In other words, because of a low number of participants the null hypothesis is not likely to be rejected when it actually should be rejected (e.g., a Type II error). For instance, in studies assessing cognitive decrement after deep brain stimulation, the chance of detecting a small effect was only 7% and a medium effect was only 18%. Accordingly, research on accuracy of this literature to detect minor to moderate decrements in cognitive functioning post-surgery is questionable. More broadly, this study demonstrates an advantage of meta-analysis—because effect size calculations are independent of sample size, precise relationship between variables can be determined. This can be contrasted with the binary yes–no decisions of null hypothesis testing that is dependent on sample size. Such an approach is particularly problematic in several keys areas of neuropsychological research where it is difficult to obtain a sufficient number of participants to ensure adequate power (e.g., frontal lobe dementia or circumscribed lesions).

The following four articles are new empirical meta-analyses and demonstrate how these techniques are being employed today. The first, by Gillespie, Bowen, and Foster (2006), is unique in that it includes both narrative and meta-analytic reviews of the broad literature on the effect of right hemisphere damage on various

aspects of memory functioning. While there is general overlap in the findings and conclusions using these two methods, there are intriguing differences. For instance, while the narrative review portion simply concludes that there is a difference between groups, meta-analysis quantifies that difference, providing the clinician a more precise marker of how much the left and right hemisphere individuals actually differ on each particular type of memory test (e.g., nonverbal recognition memory). As such, the narrative review found mixed evidence for verbal memory differences in right-hemisphere and left-hemisphere damaged patients (right-hemisphere participants scored higher in only 10 of the 20 studies). However, meta-analytic findings indicated that, on average, right-hemisphere-damaged individuals performed better ($d = .66$) on these verbal memory tasks than left-hemisphere-damaged individuals. While comparisons between these findings should be made cautiously given that some of the studies in the narrative review did not report enough data to be included in the meta-analysis, this comparison demonstrates how findings in meta-analysis are quantified and can presumably provide a more precise picture of the extant literature versus a narrative review.

The next article, by Stewart, Bielajew, Collins, Parkinson, and Tomiak (2006), examines the neuropsychological effects of adjuvant chemotherapy in women treated for breast cancer. This meta-analysis adds to previous research that has demonstrated small, but significant effects of such treatment on cognitive functioning. For instance, in their nine samples of chemotherapy versus comparison group, Stewart et al. found an overall weighted effects size across all cognitive domains of $d = -.26$, reflecting poorer cognitive performance in the chemotherapy group.

The final two empirical meta-analysis address the common theme of the effect of neurotoxic exposure on various aspects of functioning of interest to the neuropsychologist, including cognitive, motor, sensory-perceptual, and psychological functioning. Rohling and Demakis (2006) address the effect of mercury exposure and Lees-Haley, Rohling, and Langhinrichsen-Rohling (2006) address manganese exposure; both use traditional, well-developed meta-analytic approaches. Each of these articles demonstrates how basic meta-analytic techniques can be applied to a large body of data. Together these studies document a small, but statistically significant, effect of the respective neurotoxic on cognitive and behavioral functioning. While some analyses were not significant, a unique feature of these studies (at least within neuropsychology) is that they sought to compare the potential difference between objective and subjective self-report of symptoms, to identify dose–response effects for several biological markers of exposure (blood, urine, air), and to evaluate both time since exposure and duration of exposure. Rather than simply assessing exposed vs. non-exposed groups, these more sophisticated analyses parallel the approach and types of questions clinicians are likely to use with toxically exposed patients. In terms of clinical application, the translation of effect size to overlapping percentages and to standard deviation differences between groups demonstrates how meta-analysis can be used to judge the relative accuracy of a test (or set of tests). Finally, both meta-analyses illustrate some of the challenges for neuropsychological researchers, including how to manage missing data and the poor reporting of statistical information, and the ever present challenge of how to aggregate tests in meaningful categories. Rohling and Demakis (2006) handled this latter issue empirically by

relying on factor analysis, to the extent possible, to determine how tests should be grouped.

CONCLUSIONS AND CONTEXT

The road-weary narrative review, long a staple in psychology, is now being supplanted by, or at least integrated with, meta-analysis. The difficulties of this former approach of research synthesis and its attendant reliance on null hypothesis statistical testing are now well known. The current special issue, which seeks to educate the clinician in the basic approaches, techniques, and findings of meta-analysis, is therefore a timely addition for the readership of the *The Clinical Neuropsychologist*. Though they are not without problems and limitations, it behooves clinicians to be generally aware of and to be able to consume this increasingly used research synthesis approach to guide and inform their research and clinical work. As these articles highlight, because neuropsychologists tend to prefer quantitative approaches to comprehending patient performance, meta-analytic tools would seem at home in any neuropsychology researcher's tool box.

REFERENCES

Barker, M. J., Greenwood, K. M., Jackson, M., & Crowe, S. F. (2004). Persistence of cognitive effects after withdrawal from long-term benzodiazepine use: A meta-analysis. *Archives of Clinical Neuropsychology*, *19*, 437–454.

Demakis, G. J. (2004). Frontal lobe damage and tests of executive processing: A meta-analysis of the Category Test, Stroop Test, and Trail-Making Tests. *Journal of Clinical and Experimental Neuropsychology*, *26*, 441–450.

Demakis, G. J. (2006). Meta-analysis in neuropsychology: Basic approaches, findings, and applications. *The Clinical Neuropsychologist*.

Frazier, T. W., Demaree, H. A., & Youngstrom, E. A. (2004). Meta-analysis of intellectual and neuropsychological test performance in attention-deficit/hyperactivity disorder. *Neuropsychology*, *18*, 543–555.

Gillespie, G. C., Bowen, A., & Foster, J. K. (2006). Memory impairment following right hemisphere stroke: A comparative meta-analytic and narrative review. *The Clinical Neuropsychologist*.

Hervey, A. S., Epstein, J. N., & Curry, J. F. (2004). Neuropsychology of adults with attention-deficit/hyperactivity disorder: A meta-analytic review. *Neuropsychology*, *18*, 485–503.

Homack. S. & Riccio, C. (2004). A meta-analysis of the sensitivity and specificity of the Sroop Color and Word Test with children. *Archives of Clinical Neuropsychology*, *19*, 725–743.

Lees-Haley, P., Rohling, M. R., & Langhinrichsen-Rohling, J. (2006). A meta-analysis of the neuropsychological effects of occupational exposure to manganese. *The Clinical Neuropsychologist*.

Reger, M., Welsh, R. K., Watson, G. S., Cholerton, B., Baker, L. D., & Craft, S. (2004). The relationship between neuropsychological functioning and driving ability in dementia: A meta-analysis. *Neuropsychology*, *18*, 85–93.

Rohling, M. R. & Demakis, G. J. (2006). A meta-analysis of the neuropsychological effects of occupational exposure to mercury. *The Clinical Neuropsychologist*.

Stewart, A., Bielajew, C., Collins, B., Parkinson, M., & Tomiak, E. (2006). A meta-analysis of the neuropsychological effects of adjuvant chemotherapy treatment in women treated for breast cancer. *The Clinical Neuropsychologist*.

Van Petten, C. (2004). Relationship between hippocampal volume and memory ability in healthy individuals across the lifespan: Review and meta-analysis. *Neuropsychologia*, *42*, 1394–1413.

Woods, S. P., Rippeth, J. D., Conover, E., Carey, C. L., Parsons, T. D., & Troster, A. I. (2006). Statistical power of studies examining the cognitive effects of subthalamic nucleus deep brain stimulation in Parkinson's disease. *The Clinical Neuropsychologist*.