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CLINICAL BULLETIN
of the
DEVELOPMENTAL DISABILITIES DIVISION

THE C. KINGSLEY ALLISON Research Award Winners for 2011

*We are pleased to announce the funding of two research projects submitted to the University of Western Ontario, Developmental Disabilities Division (DDD), for **Dr. Gavin Rhys Price**, for a UWO postdoctoral fellowship project, and a faculty grant to **Dr. Robert Sandieson**, Associate Professor in the Faculty of Education at UWO.*

The C. Kingsley Allison Research Award in Intellectual and Developmental Disabilities will fund graduate student level awards (masters or doctoral) and students can either apply directly to the DDD or be nominated by the DDD Research Division.

The award can also fund a Postdoctoral Fellowship which researchers and clinicians working in the developmental disabilities field apply for funding to recruit a postdoctoral fellow.

As well, there is a faculty grant to support a graduate research assistant. Researchers and clinicians in developmental disabilities would apply for funding with the intention to use the funds to hire a graduate student from Western as a research assistant.

We provide a brief biography of Mr. Allison at the end of the Bulletin.

Gavin Rhys Price, PhD & Postdoctoral Fellow, Department of Psychology
University of Western Ontario

Dr. Price's project '**Understanding Developmental Dyscalculia: The Neural Correlates of Calculation Learning**' was funded to examine Developmental dyscalculia (DD) - a specific developmental disability affecting the acquisition of numerical and arithmetic skills.

Historically, DD has been chronically understudied relative to equivalently prevalent learning disorders such as dyslexia. Recent years have seen a growth in research attempting to understand the root causes of the disorder, and although such studies remain scarce, behavioral and neuroimaging studies suggest that DD is associated with a developmental impairment of brain mechanisms responsible for representing and processing numerical quantity or magnitude information. In order to develop effective interventions for DD, a greater understanding of the phenotypic presentation, as well as core deficits, is required. No studies to date have investigated the neural mechanisms which support calculation in DD children. Thus, the current project aims to examine the functioning of these mechanisms in DD children, and the extent to which their function can be improved through focused training. Using functional magnetic resonance imaging (fMRI) both prior to and following a tailored calculation training program, the current project will develop our understanding of which neurocognitive mechanisms function atypically when children with DD perform calculations, and whether those mechanisms are amenable to learning related changes to the same degree as in typically developing children.

Dr. Price works in the laboratory of Daniel Ansari, PhD; Associate Professor & Canada Research Chair, The University of Western Ontario - Faculty of Social Science, Department of Psychology.

Butterworth (1999) proposes that DD is caused by a developmental impairment of the brain regions responsible for representing numerical information in typically developing children and adults, namely, the intraparietal sulcus (IPS) (Ansari, 2008; Dehaene, Piazza, Pinel, & Cohen, 2003). However, only a handful of studies have thus far empirically investigated the neural correlates of DD. This is surprising given that cognitive neuroscience research into dyslexia has led to a greater understanding of the root causes of the disorder, and has led to significant advances in the efficacy of evidence-based remediation programs (Shaywitz, Lyon, & Shaywitz, 2006). The first neuroimaging study to reveal significant differences in brain function between children with DD and their typically developing peers found atypical brain activation patterns in children with DD. Specifically, when children with and without DD were asked to decide which of two sets of squares contained the larger number of squares, typically developing children exhibited an increased level of activation in the right intraparietal sulcus as the difficulty of the comparison increased, while the same was not true for the DD children (Price, Holloway, Räsänen, Vesterinen, & Ansari, 2007). That study, and those which followed (Mussolin et al., 2009; Soltesz, Szucs, Dekany, Markus, & Csepe, 2007), provided empirical support for the 'Number Module hypothesis'.

Thus, neuroimaging research has made some progress in understanding brain level deficits in core cognitive abilities in DD children. However, DD is characterised at the behavioural level by impaired mental calculation, and to date, no neuroimaging study has directly investigated the integrity of neural mechanisms underlying calculation in DD children. In view of this fact, the proposed research program aims to develop our understanding of the neural correlates of calculation in children with DD, and by investigating the impact of arithmetic training on these neural correlates, we aim to establish the extent to which atypical brain function can be changed through intervention in children with DD. This project will provide significant scientific insights that form an evidence-based foundation for the design and evaluation of educational remediation programs. Such success in translating research into practice has already been seen in the field of reading disabilities, and it is the goal of the

proposed project to begin to match those developments within the field of numerical learning disabilities. Against this background, the proposed research project will consist of a two part functional magnetic resonance imaging (fMRI) study with a cohort of children with developmental dyscalculia and a group of matched, typically developing controls.

Research Description

The primary goal of the proposed research project is to take the first step in empirically determining whether the brain circuits underlying mental arithmetic can be changed through training in DD and TD children. In other words, this project will investigate the neuronal correlates of learning mental arithmetic through training in children with and without DD. The most commonly observed behavioural deficit in DD is an impairment of the ability to retrieve arithmetic facts from memory (Geary, 2004). However, surprisingly little is known about the neural mechanisms which underlie this deficit. Before effective interventions can be developed, it is essential to better understand the brain mechanisms which support arithmetic learning, and their integrity in children with DD. Functional neuroimaging studies have consistently revealed that the left angular gyrus (IAG) plays a critical role in mental arithmetic. Individuals with higher activation of the IAG during calculation also show higher scores on standardised arithmetic tests (Grabner, Ansari et al., 2007), and activation of this brain region is greater for calculation problems solved by memory versus effortful calculation strategies (Grabner, Ansari et al., 2009). Importantly, work with typically developing adults has revealed that the activation of the IAG changes as a function of arithmetic training. Specifically, in fMRI training studies, it has been shown that the activation of the IAG is greater for trained compared to untrained arithmetic problems, suggesting that calculation related activation of the IAG can be modulated by training. Essentially, the brain networks supporting calculation are subject to functional plasticity (Grabner et al., 2009; Ischebeck et al., 2006).

The evidence for neuro-plastic changes in IAG function, discussed above, raises the question of whether individuals with DD exhibit similar training-related modulation of activation in the IAG as do their typically developing peers. Answering this question will help to determine the extent of functional plasticity in the dyscalculic brain and, therefore, the prospect for normalization of atypical brain function in individuals with DD. Thus, in this project, children with and without DD will be systematically trained on arithmetic problems and fMRI will be used to visualize training effects and how they differ between the groups. Both before and after training, DD and TD children will participate in a short fMRI scanning session during which they will be presented with trained and untrained (novel) single and double digit arithmetic problems and will be asked to verify the correctness of the presented solution.

The proposed research will begin to lay the foundation for the development of evidence based educational interventions which address not only what DD children need to learn, but also the extent to which their brains are equipped to acquire that information. If indeed these neural correlates of mental arithmetic in children with DD are altered and normalized through customized training, then future interventions may focus on strategies which enhance the performance of these neuroplastic systems. If not, however, then future interventions may instead focus on employing compensatory mechanisms in order to bolster arithmetic learning in DD children.

The proposed project will provide novel and detailed insights into the neurocognitive basis of developmental dyscalculia. They will lay the foundations for research based interventions for children with DD by addressing the function of neural mechanisms responsible for successful arithmetic performance. Moreover, they will also elucidate the extent to which atypical functioning of these brain circuits can be changed through training to help children with DD to become fully numerate participants of our society.

Robert Sandieson, Associate Professor, Educational Psychology & Special Education
Faculty of Education, University of Western Ontario (UWO)
Adjunct Professor, UWO Department of Psychiatry

Abstract

This investigation will test a recently developed information retrieval system to the area of Intellectual and Developmental Disabilities in health sciences databases. Evidence indicates that searching for specific information in the research databases is difficult for researchers as well as students and practitioners. Although a number of information search strategies are commonly used, these strategies lack a combination of sensitivity (or comprehensiveness) and precision. The Pearl Harvesting Information Retrieval System was developed to overcome these limitations and has been validated in education and psychology databases (Sandieson, 2006; Sandieson, Kirkpatrick, Sandieson, & Zimmerman, 2009). This system relies on gathering a wide range of relevant search terms, a feature other retrieval systems lack. Initial investigation has shown that health science databases lack consistency and completeness when it comes to use of identifying search terms. The present work will analyze each of the terms in a set developed by Sandieson et al. for the population of Intellectual and Developmental Disabilities in health science databases. The validation procedure will verify which terms are necessary within these databases and give those wishing to find research in the health sciences a quick and efficient system of doing so.

Each research assistant (RA) will be assigned 3 databases. Their task will be to search for research studies on the topic of Intellectual and Developmental Disabilities using each of the keywords developed by Sandieson et al., 2009. They will document the number of research studies produced by each term (i.e., sensitivity of search) and review the articles (or a large sample of articles depending on the number of citations produced) for relevance to the topic IDD (i.e., precision of search). While analyzing articles for precision, they will also look for possible terms denoting IDD that may not have been found previously. Since precision can be a subjective decision in some cases, each RA will review the other person's results regarding precision to ensure agreement on whether the study is relevant to the field. The research assistants will then work co-operatively to validate the string of search keywords produced by Pearl Harvesting in comparison to a recently published meta-analysis in the field: Heyvaert, Maes, and Onghena (2010) (*see method section*).

Project Description

Validating a new information retrieval system for accessing evidence-based knowledge on Developmental and Intellectual Disabilities in the health sciences

Today's emphasis on evidence-based policy and practice necessitates those working with individuals with Intellectual and Developmental Disabilities (IDD) to effectively access the research literature. A difficulty, however, resides with knowing how to conduct comprehensive (i.e., sensitive) and precise literature searches. The present proposal is for funds to further the development of a new information retrieval system, initially developed specifically for IDD. This system, referred to as Pearl Harvesting (Sandieson, 2006; Sandieson, Kirkpatrick, Sandieson, & Zimmerman, 2009), was successfully validated in psychology and education databases. The purpose here is to apply and validate this information retrieval system in various databases used in the health sciences.

The field of IDD has seen many claims regarding etiologies, treatments, and policies. Scientific research has clearly discredited some claims and substantiated others (Kavale, 2001). Also, research evidence can only guide decision-making particularly when the available evidence is limited or contradictory. It is, therefore, in the best interest of all concerned to be aware of what scientific evidence is available in order to keep informed about current issues and their contextual backgrounds.

One of the major problems to successfully using research information involves locating it. Today, there is so much information available that finding relevant research information amidst the vastness of studies located on multiple databases can be a daunting task (Curan & Adams, 1999; Grayson & Gomersall, 2003). Existing methods of literature searching suggested by White (1994; 2009) and organizations, such as the Cochrane and Campbell Collaborations, include reference tracking, keyword searching, and hand searching indexes of multiple journals. Although somewhat effective, each of these is both time consuming and limited in terms of finding all the research available (Sandieson, et al., 2009).

Evidence suggests that researchers and academics in many fields have difficulties retrieving research information (Ivanitskaya, O'Boyle, & Casey, 2006; Rudner, 2000; Wessel, Tannery, & Epstein, 2006) which may be why academics appear to be citing less studies and using a restricted range of journals, contrary to what might be expected in this digital age (Evans, 2008). For example, Minor and Raju (2004) reanalyzed a previously published meta-analysis. Based on locating more relevant studies on the same topic than the original source meta-analysis, their reinterpreted results contradicted the original study's conclusions. Arendt (2007) reviewed all the meta-analyses done with American Psychological Association journals in 2004. She found 78% of the studies, which reported the details of their search strategies, did not include keywords listed in the database thesauri. She also found 54% of the studies had keywords not listed in the database thesauri. Sandieson (2006) and Sandieson et al. (2009) in two instances located over 40% more applicable studies than current published reviews of the literature. Valentine, Cooper, Patall, Tyson, and Robinson (2010) recently published a study illustrating the alarming disparity of search keywords used across meta-analyses covering the same topic. These studies together indicate that researchers involved in meta-analyses, considered the pinnacle of providing confidence to the evidence-based enterprise, struggle to find all the relevant information on their topics.

In the context of IDD, the field is particularly prone to confusions with terminology and therefore it becomes problematic to know which terms to use as search keywords in a literature search. Sandieson (1998) illustrated this by uncovering a list of 66 different terms

denoting IDD that could be used to locate research studies in the databases ERIC, PsycINFO, and MEDLINE.

Sandieson proposed a new information retrieval system referred to as Pearl Harvesting with an awareness of the important role of keywords and the range of possible terms available to denote IDD (Sandieson, 2006; Sandieson et al., 2009). The premise of this approach is that often ideas or topics are represented linguistically by numerous terms; by those in different professions, different geographical regions, or across time. If the complete range of terms for a specific idea or topic can be tracked down and tested for their usefulness as search keywords, either in subject heading searches or free text searches, then the resulting combined set of search keywords may prove to be a powerful literature search strategy.

The first two studies using the Pearl Harvesting information retrieval system proved to be very successful (Sandieson, 2006; Sandieson et al., 2009). Original source studies found in a broad range of existing meta-analyses were used as a representational sample of articles on a topic. Within that sample, it was hypothesized, was a representational sample of terms that could denote the search topic. The bibliographic information (title, abstract, descriptors/subject headings) of each article was analyzed for such potential search terms. The relevant terms located were then tested as search keywords to retrieve relevant citations. Comparisons were done contrasting the Pearl Harvested lists with reviews of the literature with the finding that the Pearl Harvesting approach included a far broader range of search terms. Over 40% more relevant citations were gathered.

Already, the Pearl Harvesting system has been referenced and recommended nationally and internationally as a general system of searching the research literature. Examples include: the University of British Columbia Health library; Social Care Institute for Excellence, UK; The National Centre for Universal Design for Learning, Massachusetts; Institute for Applied Psychometrics, Minnesota; Council for Exceptional Children Division on Autism and Developmental Disabilities, Virginia; and even the Net-Gold listserv for Medieval History, Temple University.

As of this time, the Pearl Harvesting system has only been validated in the educational and psychology databases and only with a limited number of topics, one of which included the topic of IDD. The goal of the present proposal is to extend the validation of the Pearl Harvested list of search keywords on IDD to the databases used by the health sciences communities. There are a number of reasons for doing this. First, the various health sciences are actively involved in supporting IDD, e.g., medical, psychiatric, speech and language disorders, nursing, physical therapy and pharmacology. The commitment to the evidence-based approach in the health sciences is leading edge, perhaps epitomized by the Cochrane Collaboration, which is noted for its high quality meta-analyses resources. Strong efforts are being made to assist practitioners across the health science areas to gather and use evidence for their practices (e.g., Morrissey & DeBourgh, 2001).

However, health science databases appear to be as prone to the problem of terminology differentiation and confusion in their subject headings as the social science databases. This can be seen in the area of IDD. For example in MEDLINE, many studies on IDD can be retrieved using the term *mental retardation*. Yet, a preliminary analysis showed

that a large number of studies can also be found independent of the use of *mental retardation*, e.g., using terms such as *intellectual disabilities* and *developmental disabilities*. Since there is a wide range of possible search terms that can be used to retrieve information on IDD as located in the social science databases (Sandieson et al., 2009), it follows that these terms denoting IDD need to be analyzed for their usefulness in retrieving research in the health sciences databases. It is hypothesized, then, that Pearl Harvesting will provide a better system of information retrieval for IDD in the health sciences.

Method

The method for this proposed study will involve validation of the set of search keywords pertaining to Intellectual and Developmental Disabilities as previously found by Sandieson et al. (2009) in social science databases; only in this investigation the keywords will be validated in health science databases. Each of the 29 terms that were found to be essential will be entered into the search fields of the following health science databases: Medline, Embase, AMEd, ISI Web of Science, Cochrane Methodology Register, CINAHL. These databases were chosen as ones used in a number of meta-analyses on IDD in the health science field. Each keyword will be checked for sensitivity (number of citations produced) and precision (per cent of citation that are relevant to Intellectual and Developmental Disabilities). Precision will be established through inter-rater reliability of two researchers determining if the retrieved articles pertain to IDD.

Further validation of the use of the terms will then be done through comparison with a recent meta-analysis in the field: Heyvaert, Maes, and Onghena (2010), "A meta-analysis of intervention effects on challenging behaviour among persons with intellectual disabilities". These authors used a limited number of search terms, i.e., mental retardation, intellectual disability, learning difficulty, high/complex support needs. The question to be asked is whether the Pearl Harvested list of search keywords of population terms is able to retrieve all the studies referenced by this meta-analysis. Should citations be missed using the Pearl Harvested search keywords, those citations will be analyzed to understand the keywords that would have retrieved them. Should the Pearl Harvested list of search keywords find more relevant citations according to the inclusion criteria of the meta-analysis, this would provide further validation for use of the Pearl Harvesting information retrieval system.

On a wider dissemination scale the purpose of this research endeavour is to support people in finding evidence-based knowledge about Intellectual and Developmental Disabilities. Once the population aspect of literature searching is established, further effort will be necessary to specify the range of search terms for individual content areas, e.g., behavioural, pharmacological, communication. To accomplish this task a public Wiki for search keywords has just been constructed and the community will be invited to participate. Wikis allow for community members to make contributions to the overall database (the same way it is done in Wikipedia). In this case others doing work in specific content areas can enter the search terms they use. The larger international community of people working in the field of IDD therefore can contribute to a broad base of keywords of relevant terms to be shared with everyone. This will provide more comprehensive searching for reviews of the literature, such as meta-analyses, and also provide the tools for anyone interested in quick and efficient access to research information on IDD.

A Brief Biography of **C. Kingsley Allison 1905 -1995**

In February 1951 there was a meeting of five London, Ontario parents wanting to organize to help their 'retarded' children (mental retardation was the terminology used in those days). The following month thirty parents met, one of them, C. Kingsley Allison, an executive with O-Pee-Chee Candy Company of London, Ontario, was elected V.P. of the new group. His only child, Mary Beth aged six, was one of the first eight students at the class established by these parents. In the early days, Mrs. Allison volunteered along with two other parents as teachers for this class.

In 1953 "King" Allison was elected President of the parents' group called "The London Association for Help of Retarded Children." There were now thirty students, so they were looking for a move from the church basement where they had been housed for almost two years. Mr.Allison announced to the media that "the first real school for retarded children would be opened in London in the near future". He went to various Boards of Education in the London area, and finally obtained a vacant school on Gore Rd. Through Mr. Allison, the O-Pee-Chee company donated to the school regularly.

That same year local associations in Ontario banded together to form a Provincial Association and Mr. Allison was appointed to represent London on the slate of officers of the new provincial group.

Mr. and Mrs. Allison and Mary Beth lived in the Sherwood Forest neighbourhood all their lives. After his wife died in 1985 Mr. Allison continued to live there with Mary Beth. Aand after his death in 1995, Mary Beth was still cared for in her home until she moved to a group home operated by Community Living London in 2003.

Mr. Allison's will stated that his estate was to provide care for his daughter so that she would never be a burden on the taxpayer. It was not until May 2008 when Mary Beth died at the age of sixty-four that the other provisions of the Mr. Allison's will came into play, including the bequest of money to the Developmental Disabilities Division at the University of Western Ontario for a research scholarship in intellectual and developmental disabilities (IDD).

C. Kingsley Allison was a pioneer for services for people with intellectual and developmental disabilities in London. He was active at the very beginning when there were no services, no educational resources, or anything else for children with IDD. And he supported opportunities for these children all his life, financially, with his activities and with his influence. O-Pee Chee Company contracts were a mainstay of Community Living London workshop contracts for years. Even after his death, his legacy of interest and service continue.

Please note that the DDD website has many resources and other information available at: www.ddd.uwo.ca