

III

西オーストラリア
大学（心理学）

11/11～13/2008

University of
Western Australia
(Psychology)

International Symposium with University of Western Australia
Trans-cultural Psychology

～西オーストラリア大学との国際シンポジウム～

多文化の中の心理学

【主旨】 自己と組織の形成、対人関係の特徴、心理、発達における臨床課題について、アジア圏心理学の将来像を見据えながら議論する。

【招聘者】 Dr. David Morrison Professor Mike Anderson
(School of Psychology, University of Western Australia)
金井壽宏教授 (神戸大学大学院経営学研究科) / Professor Toshihiro Kanai
(Graduate School of Business Administration, Kobe University)

【訪問者】 UWA 生命自然科学部学部長 Professor George Stewart
(Dean, Faculty of Life and Physical Sciences, University of Western Australia)

【対象】 教員, 院生, 学部生, 研究者

【日程】

11月10日 (月)

Dr. Morrison と Professor Anderson 来日

11月11日 (火)

午前 大学院生による学内案内

午後 西オーストラリア大学紹介 Professor George Stewart

基調講演 Dr. Morrison

企画対談 Dr. Morrison x Professor Kanai

夜 学術 WEEKS 合同レセプション

11月12日 (水)

午前 学術講演 Professor Anderson

午後 研究発表 中村和夫 教授 (神戸大学大学院人間発達環境学研究科)

中出知恵 (神戸大学大学院人間発達環境学研究科博士課程前期)

夜 心理発達論コース主催の懇親会

11月13日 (木)

フィールドワーク

11月14日 (金)

Dr. Morrison と Professor Anderson ご帰国

<活動の詳細>

2008年11月11日(月)

学内案内

心身発達論の大学院生2名と西オーストラリア大学の先生方3名，人間環境論の大学院生1名とオース大学(University of Otago)の先生1名と合同で学内案内

国際交流会館からの六甲の町並みの展望，自然科学系の図書館などの施設案内，
六甲台キャンパスの案内

その後，森岡先生，金井先生，大学院生2名も合流し，六甲台キャンパスの和風レストラン「さくら」で昼食

昼食後，発達科学部キャンパスへ。

UWA 紹介

13:30～13:45

発達科学部 F256

UWA 生命自然科学部長 Professor George Stewart

西オーストラリア大学の所在地である，パース市の
特徴などとともに，西オーストラリア大学の説明を
していただく。



基調講演

13:45～15:30

発達科学部 F264

Individual differences in safety behaviour and cognitive error

MORRISON, D. L. (University of Western Australia)

講演者：Dr. David Morrison (University of Western Australia)

司会者：森岡正芳教授(神戸大学大学院人間発達環境学研究所)

【講演要旨】

Identifying individual differences in safety related behaviours and error has long been a topic of interest in organisational psychology. The relationship between personality and safety related behaviours was examined across three studies using self and

supervisor ratings of safety behaviour and self reported cognitive errors. The studies had dual aims. First, to test the hypothesis that lower order personality facets were better predictors of unsafe work behaviours and error than super ordinate global personality factors. Second, using cognitive resources theory as a guiding framework, the indirect effects of cognitive ability and personality on safety behaviours and outcomes were assessed using a measure of cognitive failure as a mediating variable. The data revealed different facets of emotionality and conscientiousness predicted self reported errors and safety behaviours. No main or interaction effects of cognitive ability and personality were found. The effects of anxiety, a facet of emotionality, were partially mediated by cognitive failures whereas those of prudence and organisation (facets of conscientiousness) were fully mediated. Finally, results showed that conscientiousness and emotionality are antagonistic to each other with respect to cognitive failures, and thus a more complex picture of the relationship between personality and safety is presented than has hitherto been the case.

【講評】

ヒューマンエラーについてのモリソン先生の研究をパワーポイントを用いて発表していただいた。

認知能力とパーソナリティとの関連からヒューマンエラーの検討を行うことにより、実際の社会的場面においてヒューマンエラーをより少なくすることが可能となったり、あるいは、働く人の特質に応じて適材適所に配置することにより、雇用者と被雇用者にとって相互に働きやすい環境になることなどの興味深い発表だった。ゆっくりとより平易な英語で話してくださり、学生も理解をすることができた

モリソン先生の発表後、神戸大学大学院経営学研究科の金井先生も参加いただき、組織文化の視点からの話題提供や、大学院生からの質問などを交えながら、和やかな雰囲気の中、有意義な意見交換をする場となった。



企画対談

16:00～17:30

発達科学部 F264

「国際文化・組織文化とキャリア形成」

対談者：Dr. David Morrison (University of Western Australia)

金井壽宏 教授 (神戸大学大学院経営学研究科)

司会者：森岡正芳 教授 (神戸大学大学院人間発達環境学研究科)

【講評】

金井先生が日本語と英語の挨拶の仕方の違いという具体的な例から、文化差についての話を展開された。そうした差異が、日本における個人・個性の概念の独自性と深く関わっており、また、組織と個人の関係という面においても特徴的に見出されることに話題が及び、各先生方が文化差および、ご自分の研究領域の立場から、それぞれの考えを述べられた。心理学の豊富な知見を背景に、経営学の分野で人間を中心に据えた研究を積み重ねておられる金井先生と、組織心理学を専門とされるモリソン先生との議論は活発に展開された。

金井先生が、英語での発言内容を逐次日本語に訳して解説して下さったので、聴衆も理解ができ、本大学院研究科では日頃触れることの少ない、この領域の先端の理論にナマで接するという、得がたい経験をすることができた。



学術 WEEKS 合同レセプション

18:00～

発達科学部大会議室

学術 WEEKS に参加された先生方との立食パーティで、心理学分野で来ていただいた、モリソン先生、アンダーソン先生、スチュワート先生と日本における臨床心理士取得の制度や、オーストラリアでの臨床心理士の仕事などの話、文化の違いに関する日常的な話などを交えながら談笑し、交流を深めた。また、他の分野の先生方とも話すことができ、楽しい時間を過ごした。

2008年11月12日(火)

学術講演

10:00～12:00

発達科学部大会議室

The Cognitive Neuroscience of General Intelligence

講演者：Professor Mike Anderson (University of Western Australia)

司会者：原田 新 (神戸大学大学院人間発達環境学研究科博士課程後期)

金 季実 (神戸大学大学院人間発達環境学研究科博士課程前期)

【講演要旨】

In this talk I will look at two different suggestions for the information processing basis of Spearman's *g* (or general intelligence). One is speed of information processing and the other is the integrity of "frontal" or executive functions. Data from patients with fronto-temporal dementia and children born prematurely will be used to support my claim that speed of processing and executive functions represent two different dimensions to Spearman's *g* – one related to individual differences in intelligence (or IQ) and the other to developmental change. I will also discuss a project that is examining the role of cortical maturation in the development of cognitive abilities.

【講評】

神経心理学を専門とされるアンダーソン先生が、幼児の知能の発達についての講演をされた。研究方法は実験が主体で、仮説と検証の過程を説明しながら非常にたくさんの研究結果を発表して下さった。実験で実際に子どもたちに実施されたテストを体験できるような動画や、映像なども盛り込まれたパワーポイントを使用して、とてもわかりやすく説明して下さった。神経心理学は本学研究科ではあまり学ぶことができない内容であり、最初はその実験的な手法に少しとまどいも感じたが、「知能とは何か」という深い問題を根本に持っているのは同じだと感じた。同じ問題に対してこのようなアプローチも可能であることを知ることができ、学生らにとっても新しい興味をかきたててくれる発表であったと思われる。

本講演では、司会も大学院生が担当し、フロアの学生からの質問もあり、学生主体の時間となった。学生に合わせながら、柔軟にアンダーソン先生が対応して下さり、英語での質疑応答の仕方を体験できる機会としても、貴重な時間となった。



研究発表

13:30～17:00

発達科学部大会議室

コメンテータ : Dr. Morrison Professor Anderson ・
Professor Stewart

司会者 : 王 松 (神戸大学大学院人間発達環境学研究科博士課程後期)

① Rough-and-tumble play and expressive aggressive behavior

— How do they occur and develop in late childhood? —

発表者：中出千恵（神戸大学大学院人間発達環境学研究科博士課程前期1年）

【発表要旨】

児童期における男児の攻撃行動は仲間関係の中で強化されやすいことが指摘されている（八島，2002）。攻撃行動の多い子どもは周りから拒否されやすいなどの問題があるが（前田，2001），攻撃性の高い個人は認知的な歪みが生じているとして，攻撃性と社会的情報処理との関係を見る研究が多くなされている（濱口，1992 坂井・山崎，2004）。しかしそれらの研究では自己認知



による攻撃行動を把握しているにすぎないため，日常場面における仲間同士の相互作用の中での攻撃行動とらえる必要がある（尹・広田，1996）。さらに児童における攻撃性を考える場合には，遊びという観点を無視してはならない。児童期においては攻撃のように見える行為の中に遊びが加熱したけんかごっこのようなものが含まれている可能性も十分にある。子どもらの攻撃と乱暴遊びとがどのように展開しているかを把握することで，それらのより包括的な姿をとらえることが可能であると考えられる。そこで本研究では，児童期の男児に多く見られる乱暴遊びと表出性攻撃について観察研究を行い，それらがどのように展開しているのかのモデルを作成することを目的とした。その結果，攻撃のようにみえる行為の中には<乱暴遊び>，<意図にずれのある攻撃>，<本気同士の攻撃>の3種類があることがわかった。終息には<平和的終息>，<片側怒り型終息>，<両側怒り型終息>の3種類があることが示された。さらに力の強さ，行為の意図，関与者の不満感が展開を動かす重要なファクターであることが見出された。また，男児の表出性攻撃行動が遊びときわめて密接に結びついていることが改めて確認されたとともに，遊びと攻撃との枠組みの変わりやすさを把握することができた。

【講評】

英語のパワーポイントを作成し，それを解説する形で進められた。発表者が自分の意図を伝えるために，わかりやすい英語を使って説明されたため，聴衆にも研究内容がよくわかった。また，同時に英語で発表する際に，どのような点に注意すればよいのかという点も感じることができ，今後の対外的な活動におけるスキルを学べる時間となった。

質疑応答においても，すべて英語でなされ，発表者が懸命に応える姿勢には感動した。また，それに対して，わからない場合はコメンテータの先生方がうまくエスコートをしてくださり，より発表者の研究の論点が明らかとなり，発表者，コメンテータ，フロアーの3

者が相互に理解を深めることができたと思われる。発表者のがんばりに、さらに大学院生も力をもらった。

② On the mechanism of the genesis of representation in L. S. Vygotsky's psychological theory (「ヴィゴーツキーの心理学理論における表象の発生のメカニズムについて」)

発表者：中村和夫 教授 (神戸大学大学院人間発達環境学研究科)

【発表要旨】

表象によって、人間は現実世界から離れ、現実とは独立した精神的世界を手に入れることができる。人間を他の動物と最も本質的に区別するものが精神世界であるならば、表象の発生の問題は、子どもの発達心理学において最重要な課題である。本報告では、ヴィゴーツキーの発達理論において、表象発生のメカニズムがどのように考えられているのかについて考察をする。表象発生のメカニズムについて、ヴィゴーツキー自身



は明示的な回答を与えているわけではない。しかし、子どもの発達について述べられたヴィゴーツキーの論述を分析していくと、そこに、表象発生のメカニズムに関するヴィゴーツキーの考えが垣間見えてくる。本報告では、特に、モノグラフ『児童(発達)心理学の諸問題』の中の乳児期の記述を分析している。その分析からは、ヴィゴーツキーが表象発生の基本原因を、乳児と大人の間で成立する「本源的われわれ(Ur-wir)」意識に見ているのではないか、ということが明らかにされた。乳児と大人のこの心理的一致を媒介にして初めて、乳児は離れたところにある対象を、その距離を克服して、自分に関与させることができるようになるからである。乳児と大人の社会的な関係に表象発生の契機を見るこのような考え方は、ワロンに近く、感覚運動的行為の内面化から表象発生を捉えるピアジェとは異なっている。

懇親会(人間発達論コース主催)

18:30 ~ 酒心館にて

UWAの先生方のご希望により、酒蔵のある、日本情緒あふれる「酒心館」にて、懇親会を行った。日本酒や日本料理を堪能しながら、オーストリアの国歌やオーストリアの歌を一緒に歌うなど、無礼講で文化交流を楽しんだ。



【招聘者紹介】

● Dr David Morrison

Dr David Morrison is the Head of School of Psychology at University of Western Australia. David has been an active researcher and research consultant for 20 years. He is the founder of PersonAbility; a psychometric assessment and development company. Through his business David has consulted and provided training services to a wide variety of government and private sector organisations.

David began his career as in human factors and engineering design concerned with how humans solve complex problems in ever more complex industrial systems and how personnel may be selected and trained for work in “high-tech” environments. David has publishing extensively in this area making contributions to mainstream human factors journals such as International Journal of Man-Machine Systems, Behaviour and Information technology, IEEE Systems Man and Cybernetics, International Journal of Computer Integrated Manufacturing and the Journal of Human Factors and Ergonomics in Manufacturing. He has been on the editorial board of the International Journal of Cognitive Ergonomics and the International Journal of Human Factors and Ergonomics in Manufacturing.

● Professor Mike Anderson

Professor Mike Anderson is Director of the Neurocognitive Development Unit in the School of Psychology at the University of Western Australia. He took his undergraduate degree in psychology at the University of Edinburgh and his PhD at Oxford under the supervision of Professor Patrick Rabbitt. He was a Lecturer at the University of Edinburgh and a Senior Scientist at the Medical Research Council’s Cognitive Development Unit in London before moving to Western Australia in 1990. His research interests are in developmental psychology, particularly in understanding the mechanisms underlying individual differences and developmental changes in intelligence. He currently holds an ARC discovery grant (with Dr Allison Fox, Dr Corinne Reid (Murdoch University) and Professor Dorothy Bishop (University of Oxford)) investigating the maturation of cognitive functions and the development of intellectual abilities in primary-school aged children. In collaboration with Dr Reid, he has run Project K.I.D.S a research study that has investigated both the intellectual and the social and emotional development of children. The project has tested more than two thousand children since 1995.

● 金井 壽宏先生

神戸大学大学院経営学研究科教授

専攻

経営管理・経営行動科学

研究テーマ

リーダーシップ、モチベーション、クリエイティブなマネジメント、ネットワーキング、キャリア・ダイナミクスなどのテーマを中心に、創造や連帯になじむニューウェーブの組織や管理のあり方を探求。

2008年11月13日(水)

—— フィールドワーク ——

モリソン先生とアンダーソン先生とともに、大学院生6名と京都へ

10:00 京都駅に集合

10:30 東寺へ

11:30 四条通りを散策

良い天気めぐまれ、暖かい日差しの中、日本最古の五重塔がある東寺へ。両先生は、禅や修業などに興味をもたれている様子であった。紅葉した木々の風景を楽しみなが



12:00 昼食

京都の古い町家を改装したお店で昼食。西オーストラリア大学の話や、各学生が自分の研究テーマを説明し、両先生がそれについての感想やさらに話をふくらましてくださり、それぞれが自分の研究に対しての視野を広げることができる有意義な昼食のひとときを過ごした。



14:00～ 清水寺へ

修学旅行の学生や、観光客のにぎわう中、清水寺を訪問。先生方は紅葉に感動され、時折、立ち止まりながら、紅葉した木々をゆっくりと眺められていた。学生は清水寺の歴史や、先生方が疑問に思われることなどに対して、知っている英語を駆使しながら、代わる代わる先生方とお話をした。先生たちは帰りに、お子さん方へ着物などのお土産を購入され、日本文化を楽しまれていた。



17:30 京都駅にて解散

＜学術ウィークス活動へ参加した院生の声＞

- 今回の学術ウィークを通して海外での研究の動向を肌で感じる事が出来、とても学ぶことが多かったと思います。心理学とは考え方、アプローチの仕方の1つに過ぎず、自分の研究する分野や内容というのはもっと広く考えていいのだなということが一番大きな収穫でした。そして研究結果もより数値など、明確に分かる形にすることでより説得力を持たせることができるのだと感じました。英語でのコミュニケーションは少し大変でしたが、良い勉強になったと思います。
- 学術ウィークは、内向きになりがちな日頃の学生生活にあって、外の世界に目を向ける良い機会となったと思います。狭い学問領域に留まらず、近いけれど普段あまりなじみの無い分野の最新の理論に、言葉の壁を越えて触れることが出来たのは有意義であったと思います。ただGPの活動全体については趣旨が浸透しているとはいえ、学術ウィ

ークについても、決定されていたことを実行するために意味がよく分からないまま参加し何とか乗り越えたという実感が残ります。

- 自分の馴染みのある研究分野とは違いますが、それと近い分野の研究に触れることが出来、興味が広がると共に、自分の研究をよりひろい視点から捉えなおすことができ刺激を受けました。でも私は英語が苦手なので、内容についていきにくかったことが残念でした。
- 学術ウィークでは、外国の先生の話聞くことができとてもよかったです。普段なかなか聞くことが出来ないのので良い勉強になりました。講演が全て英語で、通訳がほとんどなかったの理解するのが難しかったのが残念でした。
- 学術ウィークでは日程の関係からコース内の発表しか聞きに行くことが出来ず、残念でした。また質疑応答もすべて英語だったため、英語能力がないとついていけないことが残念だったし、疑問に思いました。
- 院に入ってようやく自分の専門分野の勉強をはじめた初心者であるのに、他分野との協力というのは取り組みにくいと思いました。このような活動が学部生にも開かれていれば、専門分野に入る前に様々な選択肢を得ることが出来、自分の目指す道を考えることが出来るように思いました。
- 西オーストラリア大学の先生方との交流は、なかなか出来ない貴重な体験だったと思います。英語があまり得意ではないので発表内容を理解するのは難しく、改めて英語を学ぶ必要性を感じました。「心理学」という学問の研究を、世界中の色々な研究者が色々な立場から研究を行っているという事実を肌で感じ、当たり前なのだけれど少し不思議な感覚を持ちました。
- 西オーストラリア大学との学術交流は、普段の学校生活では知ることのできない研究について触れることができ、とても興味深いものでした。しかし、通訳無しの発表では同分野の学生にとっても理解が難しく、まして他分野の学生たちにとっては気軽に参加することが難しかったのではないかと思います。当日の参加だけでなく、それまでも準備が多くあり、負担が大きかった人もいたようです。院生主体といえども、少しサポート体制が必要だと思いました。

西オーストラリア大学との国際シンポジウム「多文化の中の心理学」講評

森岡正芳（神戸大学大学院人間発達環境学研究科教授）

西オーストラリア大学（以下UWAと略記）を2008年3月末に訪問したとき、この大学の心理学部門の規模には驚いた。基礎から応用、実験から臨床にいたるすべての心理学領域をカバーできるアカデミックスタッフの充実ぶり、設備のすばらしさ。このたびUWAよりモリソンおよびアンダーソン博士が初来日されたが、私たちの学部、研究科が学術協定校として対等に交流できるのか正直言って不安があった。心理学部門にかぎっていうと、私たちの研究科は発達、人格、臨床という心理学のごく一部をカバーするにすぎず、設備の貧弱さについては目を覆うばかりである。しかし、学術ウィーク当日は天候にも恵まれ、講師の方々も思いのほか神戸の地を気に入られたようであった。

両博士は最先端の心理学の話題を、その水準を落とすことなく学生に伝わるようかみくだいてお話しされ、こちらの不安は杞憂にすぎなかった。講義の合間にも学部長の博士とともに学生たちにも気さくに接触され、一日たつごとにうちとけた雰囲気になったことがうれしかった。講義および、シンポジウムの内容については博士後期課程院生日湯淳子さんの報告に十分にまとめられているが、以下簡単に感想を述べておきたい。

モリソン博士は組織心理学の立場から、きわめて現代的なテーマである安全と危機管理の問題についてご自身の研究の一端を紹介された。労働環境とパーソナリティの関係という大きな問題圏を背景におきながら、人の安全に関わる行動と誤りが生じる要因を科学的に根拠づけていく。認知的なリソースだけでなく、仕事への不安や誠実性という情動面の要因が絡んでいることを明確に提示された。このテーマは引き続き経営学研究科金井壽宏教授との対談において直接つながり、実りのある討論となった。金井先生の英語での講演、プレゼンテーションと討論のしかたなど、本場仕込みの作法は磨きがかかっていて、説得力のあるもので、若い院生たちに模範を示され大いに刺激となった。会場には経営学研究科の院生学生ほかもつめかけ、質疑も盛んにかわされ熱のこもった討論会となった。

翌日のアンダーソン博士の講演は、知能研究の最先端のお話であった。知能の概念は心理学の歴史でも、もっとも由緒のあるテーマであるといつてよい。しかし研究史の中で知能の概念はより多義的になってきている。アンダーソン博士は知能の神経科学的根拠づけを行い、**Big Q**という知能の構築的モデルを提示した。このモデルは学会でもすでに定評があり、知的障害、発達障害の臨床領域でもこのモデルを基盤にした援助法が試みられている。会場には院生だけでなく、教員も多数つめかけ活発な議論がかわされた。二日目の午後は、コースより博士前期課程院生の中出千恵さん、そして中村和夫教授の研究発表があった。お二人の英語による発表はよく準備されたみごとなものであり、予定の時間を大幅にこえる活発な議論がかわされた。司会、コメント、その他会場の手配など院生たち中心にてぎわよく運営され、正規外の教育研究活動としてもよい体験であった。午後の会場は心理発達論コースの学部生たちの顔も多く見かけうれしく思った。

今回のプロジェクトは、モリソン博士を中心とするUWAから「トランスカルチュラル心理学」の共同研究の要請があり、その端緒を切り開くものである。異文化間の単なる比較研究にはとどまらない多文化間心理学の構築をめざし、東アジア圏の新たな心理学を作り交流していく第一歩となった。UWAからの発信は、英国本流、まさに正統の科学的心理学の流れをくむもので、学生たちとともにその一端に触れえたことは私たちの教育研究姿勢を問い直すよい機会となった。

あらためて超ご多忙の時間を割いて駆けつけてくださった金井壽宏先生、中村和夫先生をはじめとする神大の先生方、日瀨淳子さんをチーフとする院生の方々の多大なご苦勞に感謝したいと思う。

「多文化の中の心理学」スタッフ院生（*はスタッフ院生代表）

王松(D)、原田新、森口竜平、日瀨淳子*（以上 D2）、田仲由佳、山根隆宏、田淵和歌子（以上 D1）、井手良徳、上田亜弥、川嶋陽菜、金季実*、竹内美佐子、竹中美穂子、多田幸子、谷本拓郎、中野友美子、野角淑江、平井正博、畑野快、松川千尋（以上 M2）、磯邊真美、今村実由紀、岡田恭子、近堂香奈、高谷奈々恵、武佐和子、豊島花恵、中谷友香、中出千恵*、吉田朝香、吉田明日香、北口和希（以上 M1）

Workplace Safety Performance: The problem with facet aggregation and the implied mediational role of cognitive failure

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Abstract

In this paper the relationship between personality and safety behaviour and different error categories is examined. Using the five factor model of personality as a framework, the hypothesis that previously inconsistent relationships between individual personality factors and safety can be resolved through the disaggregation of individual facets from superordinate factors is tested and supported. Using the concept of psychological arousal as a guiding framework, the relationship between specific facets of Emotionality (e.g., Anxiety) and facets of Conscientiousness (e.g, prudence) are examined for their relationship with different aspects of safety related behaviour (unsafe acts and skill/rule based errors) was also examined. The combined effects of facets from the Conscientiousness and Emotionality factors is also examined for their impact on self reported cognitive failures which is hypothesised to act as a mediator of personality on error. Results showed that Conscientiousness and Emotionality are antagonistic to each other with respect to cognitive failures and that self reported cognitive failures mediate the impact of personality on self-reported skill/rule based errors..

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Introduction

Human involvement plays a major role in the occurrence of everyday accidents (Reason, 1988, 1990). Wagenaar and Groenweg (1987) estimated that 70 to 80 percent of workplace accidents can be attributed to human error, that is, a deviation from an individual's preliminary intention to reach a targeted outcome (Heckhausen & Beckmann, 1990). It has been proposed that the analysis of human error provides the basis for safety recommendations and thus has a crucial, albeit indirect impact on system design and the prevention of future accidents (Rasmussen, 1986).

The research reported here seeks to expand on the personality-safety research by investigating links between personality and safety outcome variables. Initially we follow the five factor model but later argue that a more fine grained analysis of personality, utilising cognitive theory, should lead to more consistent results. The present study sought to consider, as criterion variables, three likely antecedents to workplace accidents. The first, unsafe workplace behaviour (UWB), represents intentional violations of safety protocols, such as taking 'short cuts' (Hofmann & Stetzer, 1996). The second, is the propensity to be involved in slips and lapses of attention resulting in what have been called skill and rule based errors (SBE). These errors represent unintentional errors that occur, in part, due to poor equipment design (signal confusability) and "attentional intrusion", lack of attention or distractibility (Reason, 1984). The third criterion is what are referred to as Knowledge Based Errors (KBE). This type of error results from errors in cognitive that occur on tasks that require conscious and deliberate effort (e.g. mental arithmetic).

Direct Links between Personality and Safety Outcomes

In recent years, the convergence of personality research has led to the emergence of the Five-Factor Model (FFM) of personality which has served as a conceptual framework to conduct systematic research on personality and various criteria (Costa & McCrae, 1992; Goldberg, 1992; Barrick and Mount, 1992). According to this model personality can be parsimoniously but fairly comprehensively defined within the space of five broad factors: Openness to Experience, Conscientiousness, Extraversion, Agreeableness and Emotionality.

The most robust links to accidents and other safety-related outcomes is Conscientiousness (Arthur & Graziano, 1996; Cellar et al., 2001). Indeed Conscientiousness seems also to be the most consistent predictor of a range of work performance measures. The implied relationship is one whereby individuals low on conscientiousness are less organised, careful, and systematic and as such will be more prone to accidents due to poor planning, and procedural omissions (Tziner, Murphy, & Cleveland, 2002). Wallace and Vodanovich (2003b) found that Conscientiousness was a significant predictor of both workplace accidents and unsafe work behaviours, in a sample of 219 production workers.

Clarke and Robertson (2005) suggested that links between Emotional Stability and accidents would be expected to emerge due to those low on Emotional Stability being more prone to distraction, and vulnerability to distress due to environmental factors. Briefly, this hypothesis was based on previous studies demonstrating links between Neuroticism (i.e. low Emotional Stability) and experiences of driver stress (Mattheyys, Dorn, & Glendon, 1991) and quality of coping strategies (Parkes, 1990), combined with negative links observed between self-reported stress levels and cognitive performance (e.g. Steffy, Jones, Murphy, & Kunz, 1986). Essentially, this argument suggests that individuals low on Emotional Stability will be more easily distracted (see Norman, 1981), and thus more prone to making particular types of errors of the sort associated with lapses of attention. Individuals low in emotional stability might also be expected to experience a diminution of cognitive resources in high stress environments making them prone,

not only to be (i) distractable, (ii) overly focussed on a narrow set of environmental data but (iii) to also making errors on tasks requiring conscious processing effort.

Hitherto, research has been inconsistent in showing the link between personality and accidents. We believe that there are a number of reasons for this. One of these is the level of aggregation at which personality is described. While models such as the FFM are useful, an analysis based on a model of personality at this level of granularity ignore the facets said to underpin each factor and as such represent a crude depiction of personality. Arguably, the most popular measure of the FFM, the NEO (Cost and McCrae, 1992) contains up to six individual facets representing super ordinate factors. The consequence is that measures of personality may under perform as criterion predictors. The second, but perhaps related, error is to treat all accidents as if they had the same underlying cause or the same psychological roots.

The question, then, is what behavioural and psychological styles make us believe that some people more than others are accidents waiting to happen? People who are more emotionally volatile than others may be involved in more accidents but the question is why? We can, for example, measure emotional volatility, but how does this volatility affect cognition, behaviour and the probability that a safety violation and accident will occur.

The present study is one in a series that we have conducted where the above issues are beginning to be addressed. Our central thesis is that it is the level of aggregation at which the personality-safety/accidents linkages are being sought that obscures the nature of the relationships in terms of form and magnitude. We also argue that, based on psychological theory, that there are specific relationships at the facet level that should correlate with specific types of unsafe acts and behaviours. For the moment the context in which the individuals act is ignored but this simply reflects lack of opportunity to examine the potential moderating effects of context rather than a lack of acknowledgement of their importance.

Narrow versus Broad Personality Traits

Most studies examining the links between personality and safety outcomes such as accidents, have tended to focus on broad measures of personality, such as the Big-Five personality factors. For example, Conscientiousness can be thought of as an ‘umbrella’ factor for a cluster of more specific traits such as diligence, forethought and planning, prudence, and perfectionism. It is possible, then, that links observed between broad personality factors and criteria such as accidents are attributable to direct links between these criteria and the narrower subordinated personality facets. Wherever a relationship exists for some narrow facets within a single factor but not for others, any relationship observed between a broad personality factor and the criterion variable will be ‘diluted’ by those narrow facets that are not relevant (see Ashton, 1998). Focussed predictors should make better predictions when they closely relate to a tightly specified criterion. A problem with much research in this area is that the criteria are often poorly specified (ie all accidents and their are treated the same) and the predictors of these criteria are poorly defined.

A General Model of Cognitive Processes and their Relationship to Human Error

Rasmussen (1986) argues that human behaviour is largely under the control of three modes of cognitive control. When activated each level of control handles incoming information in different ways and the types of errors made when operating in the different modes are quite different. The levels of cognitive control have been labelled as: knowledge based processing, rule based processing and skill based processing. Knowledge based processing is concerned with analytical problem solving based on symbolic representation, whereas rule and skill based behaviour are concerned with perception and action and tend to be less under volitional control

and conscious processing resources.

The general prediction, with respect to personality, for knowledge based errors is less clear as it may result from wilful violations or limited attentional or resource capacity. Nevertheless it is possible to suggest that those who have little regard for convention and rules (a facets of some measures of Conscientiousness), may be involved in safety violations. The Emotionality facets, such as anxiety, may also play a role at this level since general arousal is also known to impact on the availability of cognitive resources (Kahneman, 1983) and therefore decision making capacity. One might predict that in stress inducing environments those prone to suffer anxiety may well perform less well when the task requires cognitive resources to be optimally available.

Hitherto, the argument has been that some personality characteristics predispose people to a general psychological and physiological (arousal) states. In particular we have argued for a link between Emotionality and Skill/Rule based errors and Emotionality and knowledge based errors under conditions of hyper arousal. But there is a missing link in the causal chain. Prior to the error being observed we might expect that general arousal will lead to a susceptibility to mental slips and lapses that go unnoticed to most except the person him or herself. If true, then it is the general propensity to suffer slips and lapses due to personality that predisposes people to be involved in rule/skill based errors in particular. This suggests that there may be an intervening variable between the general personality and the observed safety violation and it is the propensity to suffer a cognitive failure. Cognitive failure, is defined as a mistake or 'failure' in the performance of an action that a person is normally capable of completing, and, as it happens, has been demonstrated to be an important antecedent of safety performance (Wallace and Vodanovich, 2003a, 2003b). Cognitive failures, are often associated with slips trips and fall or errors where an intended action is somehow interrupted.

Cognitive failures appear to result from a deficit in an individual's ability to sustain attention to an ongoing task, particularly when one is faced with concurrent demands on attention. McKenna (1982) proposed that the degree to which an individual's attention is prone to capture by extraneous environmental cues is, to an extent, implicitly driven by personality.

While hyper aroused individuals will suffer from the inability to attend to a wide range of stimuli, Wallace and Vodanovich (2003b) suggested that conscientious employees, who are task-oriented and organized, will repeatedly make attentional checks when performing work duties. These activities would be expected to reduce the individual's propensity for cognitive failure, and hence skill errors. Following this line of reasoning, anxiety and conscientiousness may well be antagonistic to each other in some situations. If so then the relationship between personality and error is somewhat more complex than simple correlations would suggest and that different components of personality will, under some circumstances, promote error while in others they will mitigate each other.

From the above descriptions it is possible to argue that individuals will vary in their susceptibility to commit errors and that different mechanisms will apply in each case. On the one hand highly emotional individuals would be expected to be more susceptible whereas highly conscientious individuals less so. A fatal combination may be found in someone who is high in emotionality and low in conscientiousness.

Thus we generally hypothesise that personality, at least in part, influences one's ability to sustain attention to an ongoing task, which in turn causes certain individuals to have a higher propensity for erroneous behaviour than others. Thus, although personality may not directly predict accident involvement, cognitive failure seems to serve as a generative mechanism (mediator) through which certain personality variables, namely facets of Conscientiousness (such

as organisation and prudence) and Emotional Stability (such as anxiety), indirectly influence accident-related outcomes, such as rule and skill-based errors. This hypothesised mediational model is depicted in Figure 1 and the present study sought to provide an empirical test of this mediator model.

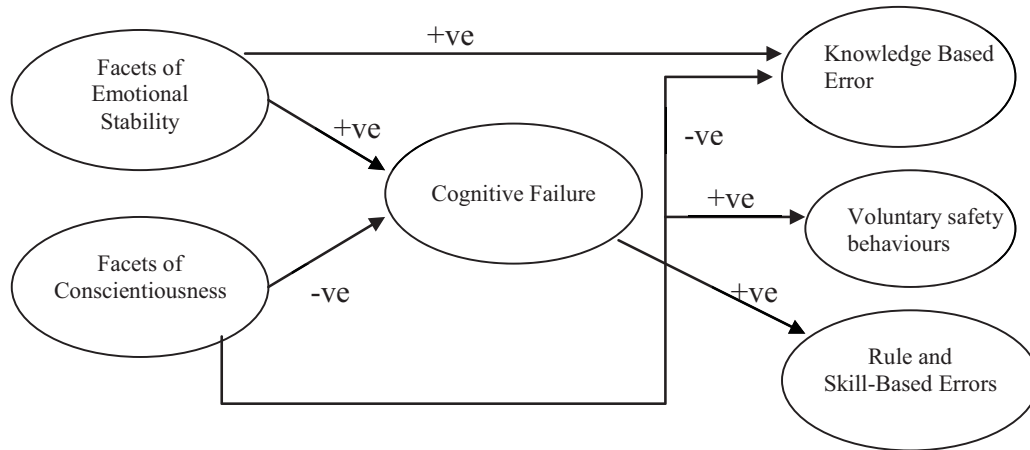


Figure 1.

From the above it is possible to formulate a number of hypotheses:
From the above arguments we are able to formulate two hypotheses.

Hypothesis 1: Only The general Emotionality and Conscientiousness personality factors will predict different safety related outcome variables.

Hypothesis 2: The predictions will reflect an antagonistic relationship between these two personality factors Emotionality and Conscientiousness

Hypothesis 3: Only Conscientiousness will predict (inversely) volitional unsafe work practices.

Hypothesis 4: Individual facets of personality will be better predictors of error than the general super ordinate personality factors.

Hypothesis 5: The relationship between personality and Rule and Skill based error is mediated by the propensity to suffer cognitive failures. Cognitive failures are the results of personality characteristics which influence psychological arousal (e.g. facets of Emotionality positively relate to cognitive error) and are mitigated by characteristics which promote vigilance (e.g. facets of Conscientiousness relate negatively to cognitive error).

The present study sought to investigate a moderating role personality factors on each other. We ask, for example, how personality factors interact to influence behavioural outcomes. As noted above we have conducted several studies which test the propositions outlined above. The data from one such study are presented and summarised in what follows.

Method

Measures

Unsafe Work Behaviour. Unsafe work behaviour (UWB) was measured using the short-form version of the Workplace Safety Questionnaire (WSQ; Hofmann & Stetzer, 1996). This shortened measure comprises six items. When completing the measure, respondents are requested

to indicate how frequently they engage in each UWB, on a 4-point response scale (1 = 'Never', 4 = 'More than once a week'). Sample items include 'Generally rushing through a job due to time pressure thereby increasing risk to yourself' and 'Generally neglecting to use or clean equipment correctly'. Cronbach's alpha for this scale was observed to be .70.

Knowledge based Errors (KBE): This measure was a simple numerical calculations test comprising 60 questions answered under timed conditions. Simple arithmetic calculations performed without a calculator were performed where speed and accuracy are emphasised. For the present study, the number correct was taken as the dependent measure.

Accident Likelihood Scale: The Accident Likelihood Scale (Roberts, 2004) comprises 10 items that examines how likely a person is to injure themselves or make a mistake whilst performing a specific task. The measure consists of two sub-scales. Roberts (2004) argued that five survey items correspond to knowledge-based errors that occur at the conscious level of cognitive processing (e.g. performing a task without having read the instructions or procedures first), while the remaining five items pertain to skill and rule based errors. For the purposes of the present study the distinction was ignored and the data were collapsed into a single measure henceforth referred to as SBE, or errors at the inattentive, unconscious level (e.g. a lapse in concentration whilst performing a repetitive task). The response format is a 5-point Likert scale (1 = never, 5 = very often) and items are positively worded. That is, high scores on the each of the sub-scales represent a higher propensity for experiencing errors at the rule-based or skill-based level of cognitive processing.

Cognitive Failure. Broadbent et al.'s (1982) Cognitive Failures (CF) Questionnaire comprises 25 items that inquire about a person's general propensity to minor mistakes or cognitive failures over the past six months. Responses to these items were made on a 5-point scale (0 = 'Never', 4 = 'Very Often'). The items pertain to physical blunders (e.g. "Do you bump into things?") memory lapses (e.g. "Do you forget people's names?") and distractibility (e.g. "Do you start doing one thing and then get distracted into doing something else?"). Previous test-retest reliability results support the stability of the construct (e.g. $r = .82$ over a 2-month time period; Vom-Hofe et al., 1998). Cronbach's alpha for this scale was observed to be .88.

Personality. The 192-item version of the HEXACO Personality Inventory was administered to the job applicants. This questionnaire measures 24 facet scales which fall under the six higher-order factors (see Appendix A). All items on the HEXACO Personality Inventory are short descriptive statements, and participants were asked to indicate the extent to which they agreed that each statement described them, using a 5-point scale (1 = *strongly disagree*; 5 = *strongly agree*). Cronbach's alphas for the 24 facet scales ranged from ($\alpha=.67$) to ($\alpha=.82$).

Participants and Procedure

The participants of this study were a sample of 367 applicants to position within the Fire and Emergency Services Authority of Western Australia. The mean age of the participants was 28.5 years (sd = 6.49 years), and most participants were male (95.9%).

As part of the applicant process, all participants completed the HEXACO Personality Inventory, along with four cognitive ability tests. After completing these assessments, participants were informed that research into personality and safety was being conducted, and should they be willing to participate, they could remain in the testing room to complete some additional questionnaires. All participants were informed that completion of these questionnaires was voluntary and their responses would not affect the selection decisions in any way, nor would the questionnaires be presented to the hiring organisation. Data were gathered from participants in large groups of 70-80

Results

Hypothesis Testing

The first component to the present study involved examining the direct relationship between personality and UWB and SBE. The purpose of the first analyses was to compare the predictive strengths of narrow traits to that of the corresponding parent factors. For each of the HEXACO factors, the corresponding facet variables were regressed on the three dependent measures, UWB KBE and SBE and the R^2 of this model was compared to the squared correlation between the corresponding parent factor and the dependent variables. In most cases, using narrow facet personality measures rather than broad factorial personality measures provides a more accurate estimation of UWB. The results are broadly summarised in Table 1

General Factor	Good Overall Predictor for		Strong Facet Predictors with directional effect for SBE			Prediction Improvement Over Factor		
	SBE	UWB	SBE	UWB	KBE	SBE	UWB	KBE
Honesty	✗	✗						
Emotion	+✓	+✓	+ Anxious	+ Anxious	+Anxious	67.7%	19.7%	23.7%
Extravers	✗	+✓	None	- Social Boldness - Liveliness			104.6%	
Agreeab	✗	✗						
Conscient	-✓	-✓	- Organised - Prudence	- Organised - Diligence + Perfection - Prudence		39.5%	42.5%	
Openness	✗	✗						

Table 1. Summary results showing general effects of factors and facets for each error type (SBE & UWB)

As seen in Table 1, Emotionality and Conscientiousness were found to be significant predictors of both SBE and UWB whereas KBE was only predicted by the Emotionality factor. Agreeableness, Honesty and Openness to Experience general factors were not significant predictors of any of the dependent variables as expected.. Unexpectedly Extraversion was found to predict UWB and thus Hypothesis 1 was largely supported. The direction of the relationships (ie that Emotionality would promote error and Conscientiousness would mitigate it) was as anticipated by Hypothesis 2.

At the facet level, predictions of the dependent variables improved for all of the general factors when they predicted a dependent variable. The increasing the variance accounted for at the facet level as can be seen by the prediction improvement results highlighted in the columns to the far right of the Table 1. In addition the direction of the results suggests that Emotionality increases errors Thus, both hypothese 1 and two have been supported.

Hypothesis 3 was not supported as both Emotionality and Conscientiousness predicted Unsafe Work Behaviours (UWB).

Hypothesis 4 was supported in that when a facet level analysis was undertaken the amount of variance in the dependent variable that was explained increased for individual facets.

Mediational Analysis

The second hypothesis was that Cognitive Failures (CF) would mediate the relationship between the outcome measures tapping inattention and distractability (SBE) but not knowledge based errors (KBE) or deliberate conscious unsafe behaviours (UWB). Following the procedure outlined by Barron and Kenny, 1986; Judd and Kenny, 1991), the results of this analysis can be seen in figures 2 and 3 for the general factors and facet level analyses respectively.

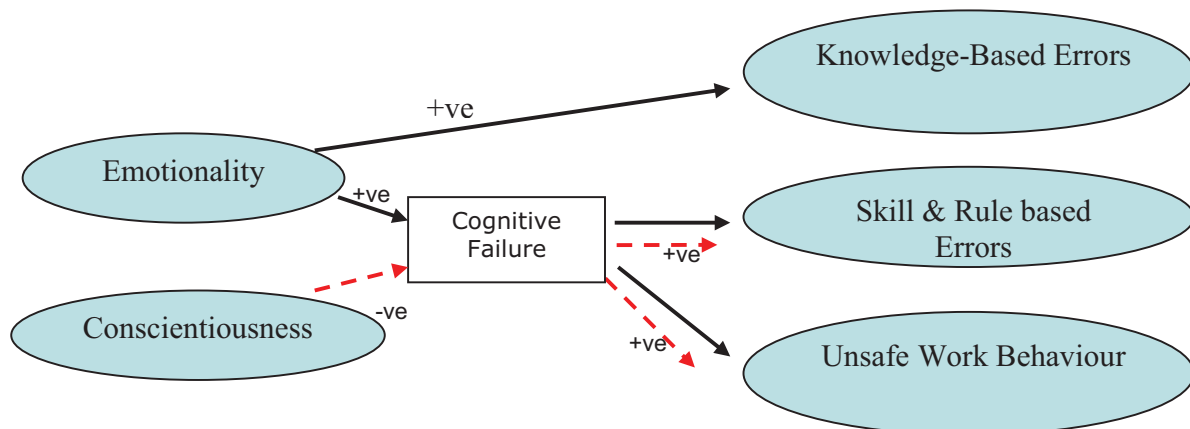


Figure 2. Mediation effect of cognitive failure at the general factor level

The first point of note in Figure 2 is that both Conscientiousness and Emotionality are mediated by Cognitive Failures and in a way that was anticipated. Secondly, Emotionality and not Conscientiousness was linked to Knowledge Based errors which was unexpected. This result might be peculiar to the context of the present study in that it was a “high stakes” selection situation. The third point of note was that the link between personality and deliberate unsafe acts (UWB) was mediated by Cognitive Failure. This was also an unexpected result. Perhaps participants prone to cognitive failure seek to reduce the burden on their information processing system by taking shortcuts that compromise safety. Thus only partial support for Hypothesis 5 was found although arguably the most important components of it were supported: (i) Conscientiousness and Emotionality are mediated by Cognitive Failure; (ii) Emotionality and Conscientiousness act antagonistically on behavioural outcomes.

A further mediation test was undertaken, this time using the facets rather than the general factors the results of which are summarised in Figure3. The additional variance explained by the facet level model aside, the general pattern of results is as reported for the general factor level analysis: (i) The facets of from the Emotionality and Conscientiousness factors are antagonistic to each other with respect to Cognitive Failures; (ii) Cognitive Failures mediates the effect of personality albeit for the Anxiety facet this is done only partially. Anxiety has both a direct and indirect effect on Skill & Rule Based Error as well as volitional unsafe work behaviours. Additionally, Anxiety has only a direct effect on Knowledge Based Error. As before the general thrust of our hypotheses has been supported

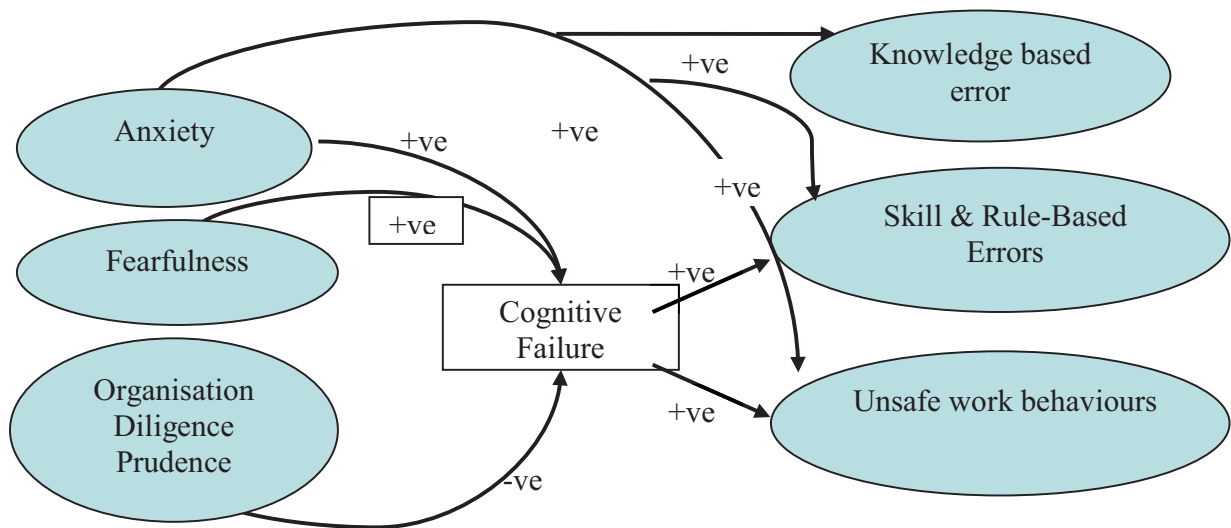


Figure 3. Mediation effect of Cognitive failure at the facet level.

Discussion

The first aim of the research presented here was to explore the direct links between both broad and narrow personality facets and behaviours that ultimately, in some cases, will have serious consequences (i.e. slips, trips and lapses of attention that could potentially lead to accidents), and unsafe work behaviour (i.e. deliberate violations of safety protocol). The data have by an large supported the hypotheses with some unexpected results.

Collectively, the results suggest that individuals higher on Emotionality, and more specifically those that are more Anxious, are more likely to process task relevant data superficially (ie a failure to monitor) or from a failure to consider relevant data more broadly (ie a narrowed focus of attention). Consequently they are more prone to distraction (a failure to attend) or a narrowing of focus (also a failure to attend) leading to higher rule based and skill based errors.

The results for the Conscientiousness factor, both at the super ordinate level and the facet level suggest an antagonistic relationship between different aspects of personality. In other words, highly conscientious individuals are less susceptible to error because their mind set is more towards careful deliberation and depth of processing. Put together the antagonistic relationship between Conscientiousness and Emotionality offers some clues at to why the correlation between personality factors and safety outcome variables is often quite low (see Cooper and Robertson, 2005).

The weak relationships alluded to above might also be explained, in part, by the fact that super ordinate personality factors contain “noise” due to facet conflation into a single factor score. Evidence in support of this argument is found for the facet level analyses where, in every case, the variance explained by individual facets was greater than the generic factor scores. Collectively, the results of this study suggest that there is merit in considering narrow facets rather than broad factorial traits in the prediction of workplace safety outcomes.

A further goal of the present research was to investigate the role of cognitive failure as a mediator in the personality - error relationship. Wallace and Vodanovich (2003a, b) found, across two studies, that cognitive failure was a significant predictor of workplace accidents and unsafe work behaviour. Given that the causes of accidents are typically faulty cognitive/attentional

processes including mental errors, poor selective attention, and distractibility (Arthur et al., 1991; Mihal & Barrett, 1976) it is not surprising that reports of accident correlate highly with scores on the CFQ. It is therefore important to identify any personality information that may predict propensity to cognitive failures.

In the present study, those low on Conscientious reported a higher susceptibility for cognitive errors. This can be attributed to the notion that the two constructs largely reflect opposing regulatory styles (Wallace et al., 2003b). That is, employees prone to cognitive failure tend to exhibit off-task processes and behaviours (e.g. absentmindedness, forgetful, easily distracted), while highly conscientious individuals are hard-working, organized and disciplined, behaviours that reflect on-task processes (Barrick, Stewart, & Piotrowski, 2002). Such on-task behaviours have been attributed to the reason why such individuals report being involved in few accidents and generally do not engage in unsafe acts (Tziner et al., 2002).

Empirical support was found for the mediating role of cognitive failure in the relationship between facets of Conscientiousness (Organised, Diligence, Perfectionistic, and Prudence – all fully mediated) and proneness to rule and skill based errors. That is, cognitive failures occur (partly) because of a combination of a lack of cognitive organisation (low on Organised), willingness to work hard (low on Diligence), willingness to pay attention to detail (low on Perfectionism), and ability to control impulses (low on Prudence), and these cognitive failures lead to unintentional skill errors.

The partial mediation of the relationship between Anxious and rule and skill based errors suggests that individuals with a greater propensity to worry or experience anxiety are more likely than those that are less anxious or worrisome, to experience cognitive failures, and thus commit skill errors. This finding also supports a ‘limited cognitive resources’ model, which suggests that cognitive errors are more likely to occur as individual’s cognitive resources are being taxed. Empirical studies have consistently shown that trait-anxious individuals display an attentional preference for distracting stimuli, especially in environments perceived to be threatening (Kindt & Van Den Hout, 2001). Within anxious individuals, cognitive resources are being allocated to distractors such as perceived threats and negative emotions (e.g. Matthews and Wells, 1988). Such individuals can therefore allocate less cognitive resources to tasks, and hence more cognitive failures *and* more errors will emerge.

Two sets of results remained unexpected in the present study. One of these was that Extraversion (and Social Boldness and Liveliness at the facet level) was inversely related to self reported unsafe workplace behaviours. The second was that Emotionality (and Anxiety at the facet level) predicted all three categories of dependent variable. Especially surprising was the effect of Anxiety on Knowledge Based Errors when Conscientiousness (or its facets) did not. In the first instance, we speculate that these results may reflect two things. First is the common method effect where data coming from the same source (ie self report) has a tendency to show correlation as a function of response bias. For Unsafe Work Behaviours this explanation seems possible but is less likely to be the case for the other variables that had an enduring and direct relationship with Anxiety in particular. Knowledge based errors were determined from an objective and independent test, ruling out the common method explanation. For the Skill and Rule based measure, the common method explanation is a possibility, but as we have found the same effects when the Skill and Rule Based error assessment comes from a different source, it also seems unlikely. The second possible explanation for the observed effects is that they are theoretically meaningful. For example, the description of Social Boldness contains elements of self efficacy. Individuals high in self efficacy may not see certain behaviours as unsafe or if they do they may believe they can “fix” the problem when it occurs. The relationship of self efficacy

to reality seems a worthwhile avenue for further research since although it is trait like it can be modified (Bandura 1996).

The anxiety effect on Knowledge Based Errors may be explained by recourse to resource theory once more. Those who are more anxious are often found to under perform in stressful situations and this is said to reflect a reduction in cognitive resource availability. The context in which the present research was conducted, by its very nature, might be thought of as stress inducing. Recall, the respondents in this study were part of a high stakes job selection process. The mitigating effect of conscientiousness would not be found with the Knowledge Based Error measure used here since as it was operationalised the scores simply reflected total correct and ignored number attempted or errors committed. The interesting question is whether the effects of Conscientiousness would be found with a more refined or sensitive measure of Knowledge based Error.

Implications for Organisations

The findings from the current study have a number of practical implications for organisations. First and foremost, the results indicate that personality measures can offer valid means to predict one's propensity for cognitive failure, skill errors, and unsafe work behaviours, and therefore should be used in the selection of 'safe' personnel. This is especially important for screening job applicants for safety-critical organisations. Moreover, however, such measures should aim to be specific as possible, focusing on traits such as anxiety, and those that fit under the Conscientious family.

The finding that the CFQ is a strong predictor of safety outcomes is also of practical importance. Indeed, the high correlation found between scores on the CFQ and skill-based errors, suggests that the CFQ is a solid predictor of accidents when task components have the potential to be automatic and performed in a more automatic mode. Future studies assessing the cognitive failure-accident relationship will hopefully further encourage the addition of the CFQ into a test battery, designed to screen job applicants on the basis of future safety performance. Before this could eventuate, however, it might be important to develop a version that is less open to social desirability or faking.

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Appendix A

HEXACO Factors, Facets and Brief Descriptions

Factor	Facet	Description
Honesty	Sincerity	tendency to be genuine in interpersonal relations
	Fairness	tendency to avoid fraud and corruption
	Greed Avoidant	tendency to be uninterested in possessing lavish wealth, luxury goods, and signs of high social status
	Modesty	tendency to be modest and unassuming
Emotionality	Fearfulness	tendency to experience fear
	Anxiety	tendency to worry in a variety of contexts
	Dependence	one's need for emotional support from others
	Sentimentality	tendency to feel strong emotional bonds with others
Extraversion	Expressiveness	tendency to be excitable and dramatic in one's interpersonal style
	Social Boldness	one's comfort or confidence within a variety of social situations
	Sociability	tendency to enjoy conversation, social interaction, and parties
	Liveliness	typical enthusiasm and energy
Agreeableness	Forgiving	willingness to feel trust and liking toward those who may have caused one harm
	Gentleness	tendency to be mild and lenient in dealings with other people
	Flexibility	one's willingness to compromise and cooperate with others
	Patience	tendency to remain calm rather than to become angry
Conscientiousness	Organisation	tendency to seek order, particularly in one's physical surroundings
	Diligence	tendency to work hard
	Perfectionism	tendency to be thorough and concerned with details
	Prudence	tendency to deliberate carefully and to inhibit impulses
Openness	Aesthetic Appreciation	one's enjoyment of beauty in art and in nature
	Inquisitiveness	tendency to seek information about, and experience with, the natural and human world
	Creativity	one's preference for innovation and experiment
	Unconventionality	tendency to accept the unusual

The Cognitive Neuroscience of General intelligence

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In my paper I will review some research that says something interesting and new about the nature of individual differences in intelligence and developmental change. Specifically, that individual differences normally measured as IQ, are largely caused by differences in speed of information processing but developmental change is caused by changes in an orthogonal dimension of psychological functioning. This dimension is largely known as executive functioning and executive functions are supported by the development of the frontal lobes of the brain. In persuading you of this view I will introduce you to some of our recent work on cortical maturation and the development of specific cognitive functions which is supported by a current grant from the Australian Research Council to myself and co-workers¹.

IQ and intelligence

As is well-known, the concept of IQ was born out of early psychometric work by Binet who constructed the first “mental scale” (Anderson, 1992). Binet conceptualised intelligence in terms of mental age or how intelligence grew with the developing child. Mental age was taken to be the chronological age of children who could pass a problem of a given difficulty. Thus a child could have a mental age of eight if they could pass items that the typical eight year old passed but the typical seven-year old failed. However it was Wilhelm Stern who noted that if we divide a child’s mental age by their own chronological age (and multiplied by 100) we could derive a measure of individual differences in ability standardized by the age of the child. Thus a child aged eight who has a mental age of eight will have an IQ of 100 (or the average IQ). A child of 9 with the same mental age would have a lower IQ and a child of 7 would have a higher IQ. While the concept of IQ has a long and acrimonious history in psychology (see Anderson, 2006), that is not our concern today. Rather, I want to focus on a central concept related to IQ and that is the nature of general intelligence or *g* (Spearman, 1904). Spearman considered all mental activities to involve two components: one common to all and he called that *g*, and the other specific to the specific cognitive task at hand. Spearman thought of *g* as being some kind of mental energy (in modern psychology we would call this a general resource or capacity) and attributed individual differences in *g* to some biological property of the central nervous system. This view of Spearman has not been popular in modern psychology, with many preferring the idea that the intellect is composed of a number of multiple intelligences (Gardner, 1983). Again, that is a debate for another day and instead I want to focus on two alternative accounts of the cognitive basis of *g*.

Speed of processing and *g*

Jensen (1998) and many others have argued that there is overwhelming evidence that general intelligence can be attributed to variation in a single global factor, speed of information processing. The impetus for the speed of processing hypothesis is the finding that elementary cognitive tasks (Jensen, 1982) with little or no knowledge content, such as reaction time and

¹ Discovery grant DP0665616 awarded to M.Anderson, A. Fox, C. Reid & D.Bishop.

inspection time tasks (Nettelbeck, 1987), are nevertheless correlated with knowledge-rich intelligence test performance (Anderson, 1992). Reaction time measures show a regular decrease with development (Keating & Bobbitt, 1978) and inspection time (see below) also has been shown to decrease with age during development (Nettelbeck & Wilson, 1985), although not as strongly as reaction time (Anderson, 1988). This has led some to suppose that not only does speed underlie differences in *g* in adults but also developmental changes in *g*. Anderson (1992, 1988, 1989, 1992) has challenged this and argued, instead, that while speed may underlie individual differences in *g*, what underlies developmental change are developing executive functions. Recently this idea has received some support from a body of work that attributes *g* not to speed of information processing but to properties of the frontal lobes of the brain.

Frontal/Executive functions as a specific function and/or an alternative basis of *g*?

A radically different formulation of the basis of general intelligence has been proposed by Duncan (Duncan, 1995; Duncan et al., 1996). It has been known for some time that substantial injury can be inflicted on the frontal lobes of the brain with little or no effect on measured intelligence or IQ. This is paradoxical because such patients also present with considerable difficulties in everyday problem solving. However, Duncan showed that when frontal patients are given tests of *crystallized g*, such as the heavily knowledge-based tests such as the Wechsler scales (WAIS), their IQs are normal. On the other hand, when they are given a test of fluid intelligence, such as the Cattell Culture Fair, they are significantly impaired (Duncan et al., 1996). An fMRI study (Duncan et al., 2000) has shown that when participants perform a highly *g*-loaded task the frontal lobes of the brain show heavy activation. Thus it is possible that the functions subserving frontal functions (and their relationship to *g*) are different from those that typically underlie individual differences in IQ. I will present data from a patient study (in preparation for publication) that argues that speed of processing is related to individual differences in *g* but is unrelated to frontal functioning. The mechanisms supported by the frontal lobes of the brain represent another (developmental dimension) to *g*. Before this I will explain my theory of intelligence.

The theory of the minimal cognitive architecture underlying intelligence and development

Anderson's (1992) theory of the **Minimal Cognitive Architecture** underlying intelligence and development argues that intelligence tests measure intelligence through assessing knowledge, but that knowledge itself is acquired through two different routes proposed by Fodor (1983). The major proposition is that these two processing routes are related to the two different dimensions of intelligence – one related to individual differences and the other to cognitive development.

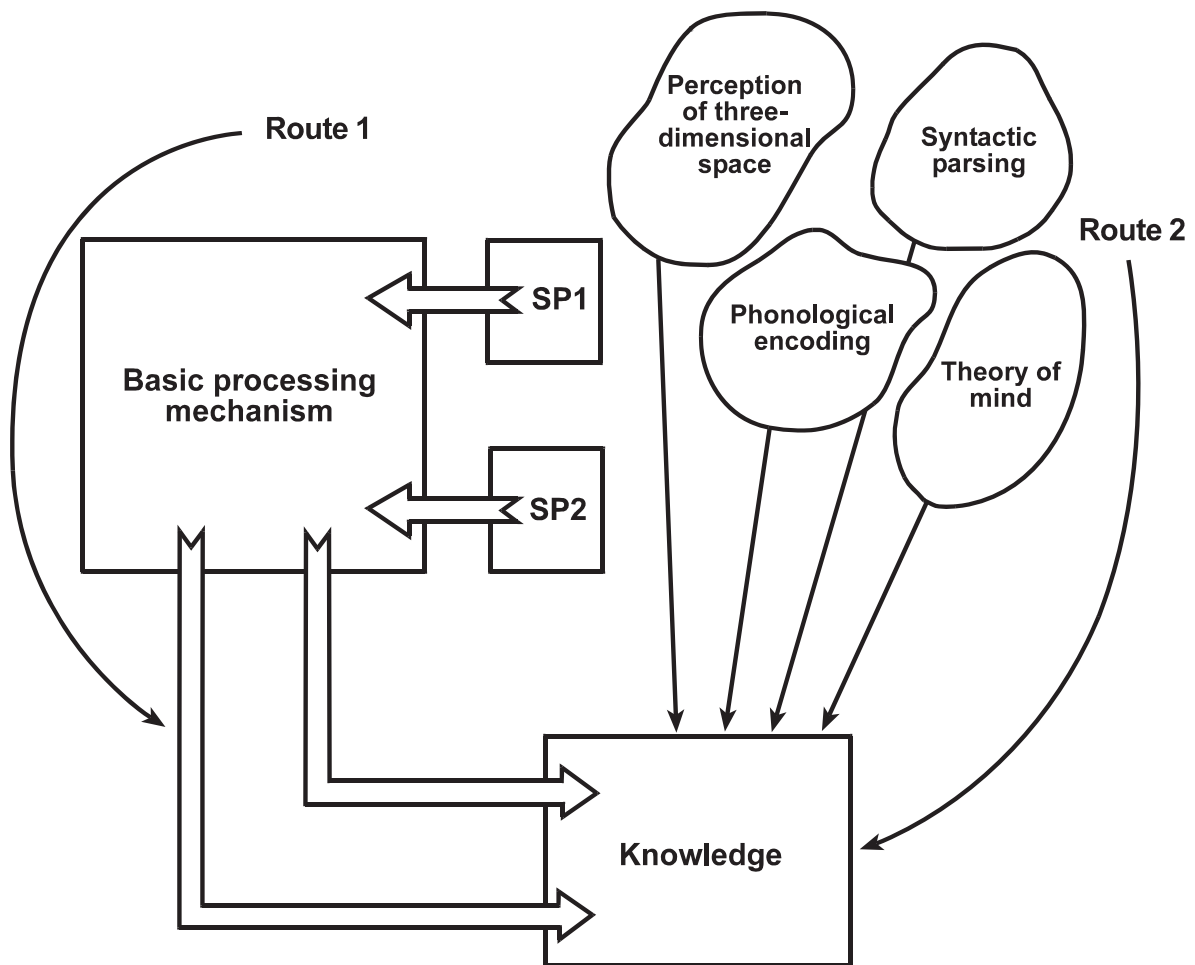


Figure 1: Anderson's theory of the minimal cognitive architecture underlying intelligence and development

In the theory the first route to knowledge (depicted in figure 1) is through thought and this is the route that is related to differences in IQ. Thoughtful problem solving can be done either by verbalising a problem (using language-like propositions to think) or by visualising it (using visuo-spatial representations to think). In the theory this is accomplished by having two different kinds of knowledge acquisition routines, each generated by one of two specific processors. The specific processors are the source of *individual differences in specific abilities*. However, the observed specific ability is constrained by the speed of a basic processing mechanism – at slow speed only the simplest kinds of thoughts of either kind can be implemented (the speed of the basic processing mechanism can be measured using tasks such as inspection time and reaction time). It is this constraint that is the basis of *individual differences in general intelligence* and the reason why manifest specific abilities are correlated (giving rise to the *g* factor).

The second route for acquiring the knowledge that will influence intelligence test performance (depicted in figure 1) is through dedicated information processing modules, and it

is this route that is related to *cognitive development*. Modules have evolved to provide information about the environment that could not be provided by central processes of thought (route-1 knowledge acquisition) in an ecologically useful time frame. For example, if we had to ‘think through’ all the perceptual information presented to us in order to construct a 3-dimensional view of the world we would be literally lost in thought. Because this activity is so important to us and requires great computational power and speed, evolution has created special modular devices to allow us to do this automatically. In the theory this is catered for by the ‘Perception of 3D space’ module illustrated in figure 1. The maturation and acquisition of modules is the prime cause of developmental change. Because modules function independently of variations in the speed of the basic processing mechanism their operation is independent of differences in IQ. *This means that individual differences and cognitive development represent two independent dimensions of intelligence.* It also means that these complex modular attributes are available to non brain-damaged individuals with intellectual disabilities. It is my contention that the general class of processes that we call “executive functions” and that are supported by the frontal lobes of the brain are modular in this sense.

I will now describe two tasks we have used to differentiate the contributions that both speed of processing and executive functions make to differences in g. In the first case I will describe an inspection time measure of speed of processing and in the second Duncan et al.’s (1996) goal-neglect task.

Inspection time and speed of processing

Over the years we have conducted many studies using a particular measure of speed of processing – inspection time or IT (see figure 2). In an IT task a participant must make a simple perceptual discrimination – in this case whether a “space invader” has antennae that are the same or different length. The exposure duration of the stimulus is controlled using a procedure that prevents further processing of the stimulus information by presenting a masking stimulus. By varying the stimulus onset of the mask relative to the stimulus the exposure duration can be controlled. A staircase method (PEST) can be employed to change the exposure duration according to the whether the participant correctly identifies the stimulus as same or different. In this way the exposure duration for a required level of accuracy can be estimated and this is known as the participant’s inspection time.

Standard Inspection Time

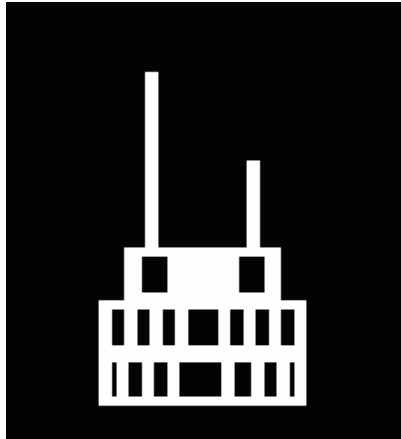


Figure 2: A typical inspection time stimulus

Inspection time has been shown to correlate at about -0.5 with intelligence in adults (Nettelbeck, 1987; Kranzler and Jensen, 1989). I have shown that inspection time is related to intelligence in children (Anderson refs) and have used it to measure speed of processing in a number to difficult to test groups, such as including autistic children (Anderson et al., 1998; Schueffgen et al., 2000), groups with general mental retardation (Moore et al., 1995; Anderson & Miller, 1998), schizophrenics (Badcock et al., 2004), and children at risk of Developmental Coordination Disorder (Piek et al., 2004).

Goal Neglect

Duncan and colleagues believe that the frontal lobes of the brain are the areas responsible for instantiating cognitive routines for problem solving. These routines involve the establishing of hierarchies of task goals, maintaining those goals and monitoring ongoing information processing in service of those goals – the core functions of what others call executive functioning. In a task designed to measure these functions, the goal-neglect task, Duncan not only showed that patients with frontal damage performed very poorly but that performance on this task in individuals with no known brain damage is predicted by their levels of fluid *g*.

The Standard Goal Neglect (GN) Task

WATCH LEFT or WATCH RIGHT

X	F	(Call out aloud)
2	3	(ignore)
B	C	
7	2	
4	4	
H	A	
L	Q	
5	9	
3	8	
T	M	
	+	(means watch right)
	-	(means watch left)
5	8	
N	F	
R	Y	

Figure 3: Stimulus sequence in the Goal Neglect Task. Letter or number pairs are presented sequentially as described in the text

Figure 3 shows how the goal neglect task works. Participants are presented with a Rapid Serial Visual Processing task (RSVP), where pairs of either letter or digit pairs are presented (sequentially) in the centre of a computer screen. Each pair is presented for 200ms with an inter-stimulus interval of 200ms. Participants must maintain three goals during the task. The first is either to report the stimulus that appears on the left or on the right of the pair. The second is to report letters and not numbers. The third is to report letters from the side indicated by a cue that appears after 10 pairs of digits are presented and is followed by a further 3 pairs. Goal neglect is manifest in an inability to correctly report the appropriate letters that appear after the cue.

Study with patients

This research was conducted with Simon Davies at Murdoch University, Western Australia, John Hodges, formerly of Cambridge and now the University of New South Wales, and Sinclair Lough a clinical neuropsychologist in Dorchester, England. The data are being prepared for publication and first appeared as part of Dr Davies' PhD. We measured inspection time and goal neglect in patients with frontal temporal dementia (FTD), their typical clinical controls, patients with Alzheimer's disease and elderly subjects with no known brain injury but with fluid intelligence test scores that were matched with the FTD group.

Figure 4 presents the data for both inspection time and goal neglect, calculated as z-scores over the groups as a whole (this allows us to compare the tasks which have radically different scales). What we see is that the Alzheimer's group are very poor on both tasks. The FTD group is much worse on goal neglect than the clinical control group and, in fact, is better on inspection time (they have faster speed of processing). The critical comparison is with the "low-g" group. These are the older participants who have been matched with the FTD group on their fluid intelligence test score (g). Importantly we now see a *double dissociation* between speed of processing and goal neglect. The low g group is much better on the goal neglect task but much worse on inspection time. Put another way, it is likely that the elderly participants have lower g scores because of slow speed of processing, whereas the FTD group have lower g because the damage to their frontal systems has led to an executive functioning deficit. In turn this provides evidence for the hypothesis that there are two dimensions to g .

Inspection time and Goal Neglect standard scores as a function of group

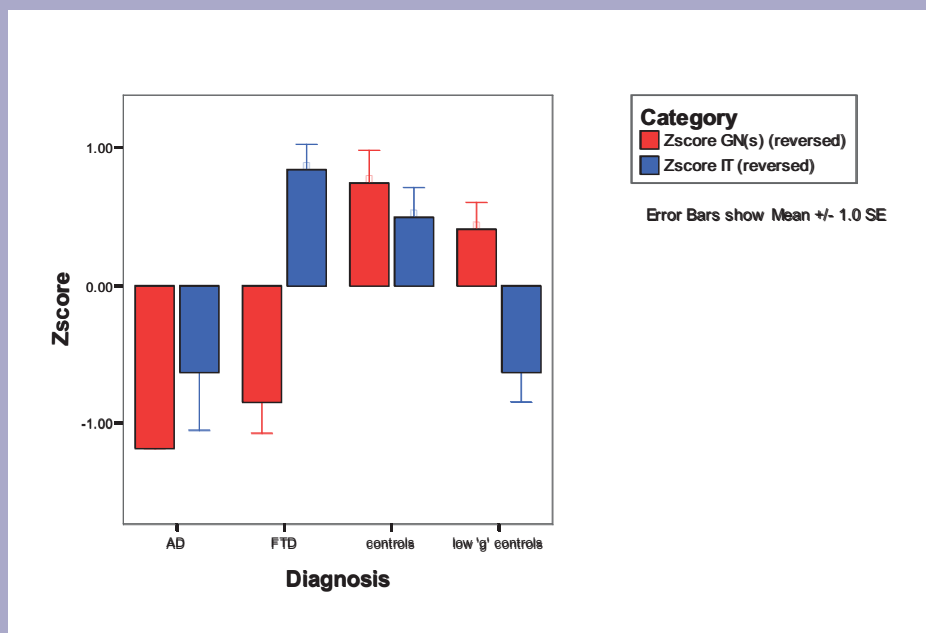


Figure 4: inspection time (blue) and goal neglect (red) scores.

Conclusion

There is a great deal of contemporary interest from cognitive neuroscience in the nature of general (fluid) intelligence or *g*. I have presented some data from patients that suggest that there may be two distinct dimensions to *g*, one related to individual differences in speed of information processing and the other related to executive/frontal functions. Our current project at the University of Western Australia is examining similar questions developmentally by measuring cortical maturity in typically developing children. We collect these data in Project KIDS where children come to the university to be measured on a whole range of psychometric measures as well as information processing and psychophysiological measures. We measure cortical maturity through innovative techniques using evoked related potentials. Our questions are relatively straightforward: Does cortical maturity in the frontal lobes proceed on the same or different path to that in language areas of the brain? Does maturity in each area predict separately behavioural tests thought to reflect the activity of these areas (executive functions and language)? Alternatively, is there a global cortical developmental function that is related to fluid intelligence and is that mediated through speed of processing or executive functioning. All being well we will have the answers in about two years.

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On the mechanism of the genesis of representation in L. S. Vygotsky's psychological theory

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<abstract>¹

The function of perception is seeing, hearing or smelling the features of the object that exists here and now. Therefore, perception cannot come free from the real world that exists at hand now. Perception binds its own subject to the actual present world. On the other hand, with the help of representation, we can reproduce in the mind the object that doesn't exist here and now. Thanks to representation, we are able to separate the object from the real world both temporally and spatially, and beside that hold it in the mind. The most essential function of representation is to replace the actual object by something else mental. In such a replacement relation, the replacing one (representation = signifier) is separated from the replaced one (the actual world = signified) and comes to be able to behave independently. That is, we can become the possessor of the mental world independent of the real one by representation. Representation liberates its own subject from the perceptual bondage of the real world. Therefore, we can say that representation is the most important factor in human mental development.

Well, how does the representation bringing about the mental world that most definitely distinguishes human being from other animals germinate in the process of child development? It must be important for every psychological theory to elucidate this problem. In this report, we try to research what L. S. Vygotsky thinks about the mechanism of the genesis of representation in child development. Vygotsky himself does not necessarily describe the mechanism of the genesis of representation explicitly. However, we are able to find out Vygotsky's own idea about the mechanism of the genesis of representation by analyzing the infant's developmental features described by him. As a result of the analysis, we could find that Vygotsky seemed to regard the consciousness of "Ur-wir" as a root cause which prepares the genesis of representation. The consciousness of "Ur-wir" means the initially appearing psychological commonality of the infant and his mother which serves as the starting point for further development of consciousness. According to Vygotsky, the very consciousness of "Ur-wir" makes it possible for the infant to assimilate the distant object into his psychological inside and deal with it in psychological plane. Based on the psychological commonality of the infant and his mother, the infant for the first time is able to bridge

the distance between him and the object, and retain the psychological set (attitude) to the distant object.

¹ The full version of this paper will be published in *Bulletin of Graduate School of Human Development & Environment* Vol.2. No.2 (March, 2009). If you are interested, please refer to the forthcoming Bulletin.

Rough-and-tumble play and expressive aggressive behavior

— How do they occur and develop in late childhood ? —

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Introduction

Peer relationships in childhood are important for their social development. Nevertheless, it is pointed out that problems in peer relationships such as “being attacked directly” and “the existence of troublemakers” (Koishi, 1995) are major stressors to children (Nakazawa, 1997). Moreover, as in childhood, children are often occupied with peer relationships, and we should notice that children rejected by their peers are in great distress. Maeda (1995, 2001) claims that children with salient aggressive behaviors strongly feel loneliness and are often rejected by their peers. It is pointed out that the expressive aggression is often seen in boys’ play and that aggressive behaviors among boys tend to be reinforced in their relationships with peers (Yashima, 2002). This means that there is a complexity of boys’ relationships. On the one hand, aggression tends to be reinforced by peers but at the same time they reject high-aggressive children.

Many researchers have investigated the relationships between aggression and social information processing (e.g. Hamaguchi, 1992; Sakai & Yamazaki, 2004) because the high aggressiveness is thought to be related with cognitive distortion. These studies, however, only consider aggressive behaviors recognized by children themselves or their friends. Therefore, it is necessary to grasp aggressive behaviors caused by an interaction of children (In & Hirota, 1996).

We also have to think about children’s aggression from a perspective of play. Aggression is defined as “a behavior which has an intention of hurting someone”, but as far as childhood is concerned, there is something like a play-fighting which has a look of aggression. As physical activity play, there are ‘locomotor play’, ‘exercise play’ and ‘rough-and-tumble play(R&T)’. R&T refers to vigorous behaviors such as wrestling, grappling, kicking, and tumbling that would appear to be aggressive except for the playful context. It peaks between 8 and 10 years, and boys exceed girls in frequency. In his study, Smith reports the existence of play which looks like aggression. Most children start R&T with making a physical move on other children (such as patting a shoulder),

and attacked children sometimes react aggressively. Smith focuses on how sociometric status influences children's R&T. However it must be useful to comprehend the process of aggressive behavior and R&T from a view point of the interaction with others, and inclusively understand how aggressive behavior and R&T occur, and what problems and dangers are.

So, this study aims to observe and make a model of how boys in late childhood show and develop their behaviors of expressive aggression and R&T in their relationships. In this study, expressive aggression is defined as physically and verbally aggressive behaviors, while R&T is defined as a vigorous behavior which seems to be behaviors of expressive aggression but in the playful context.

Method

- The subject of this study was 20 boys who attended an after-school care program. 15 were in 4th grade, and 5 were in 6th grade.
- I observed them once a week from 3 pm to 6 pm. The observation was carried out 7times in all from May to July 2007.
- Sitting in a corner of the room, I kept taking a not of what they did. When aggressive behavior or R&T occurred, I took meticulous notes on the process of their behaviors including their looks, reactions and voices. If most children played outside, I also went out for observation.
- I made a transcription from the note and after every observation. This data was then analyzed by Grounded Theory Approach. First of all, the data was broken down into separate units. Then they were labeled by the type and intent of behaviors. By property and dimension I figured out how a given unit goes to another unit, and constituted a model.

Result

I don't include "admonition" into aggression because it has more constructive intentions than aggressive behavior. And I separate aggressive behavior and R&T into two groups: "first behavior" and "non-first behavior", because first behavior has a big influence on the subsequent development. An attached handout shows the model I have constituted but today I would like to focus on several points.

(a) There are 2 types of first behaviors: first R&T and first aggression

“First R&T” occurs in play or arise suddenly as teasing or meddling. When it occurs in play or when its “strength” is low or middle, “playful reaction” happens. But as the “strength” becomes higher, attacked children tend to react aversely. “First aggressive behavior” occurs after a physical warning or an unsatisfactory end of former aggressive behavior. In this case, the victim is not necessarily a participant of former aggressive behavior or warning. When children suffer “first aggressive behavior”, children who already feel discontent react aggressively like intimidation or fighting back, and children who hardly feel discontent just try to avoid the aggression or show passivity.

(b) There were three types of non-first aggressive behaviors: “R&T”, “aggressive behavior with both seriousness”, “aggressive behavior with a gap of intentions”.

There are secure R&T and precarious R&T. Secure “R&T” is characterized by a dual-direction and a low or middle strength. Meanwhile precarious “R&T” is characterized by one-way and a high strength. But the stability changes often. Secure R&T occasionally changes into other 2 types of behaviors, and precarious R&T changed into a secure one. This means that the strength and direction of behaviors change the stability and their category.

“Aggressive behavior with both seriousness” means a situation where both children seriously show their expressive aggressions. We can find two patterns here. First, with increasing “strength”, a fighting back as R&T gradually turns into “aggressive behavior with both seriousness”. Secondly, a child who feels dissatisfied with the admonition or the end of former aggressive behavior shows “first aggressive behavior”, and another child reacts aggressively. This instantly turns into “aggressive behavior with both seriousness”. Thus there are different processes to get to “aggressive behavior with both seriousness”.

“Aggressive behavior with a gap of intentions” means a situation where one child attacks as play but the other child attacks seriously. When “strength” of “R&T” grows stronger, one participant becomes serious. And the “R&T” turns into “aggressive behavior with a gap of intentions”.

(c) There are three types of ends: the “peaceful end”, the “end with one-side anger” and the “end with both-side anger”.

The “peaceful end” means an end with enjoyable atmosphere. Only “R&T” gets it. Two types of causes lead to this end. One is a clear cause such as paper-rock-scissors, admonishment by other children or daily routines like leavers assembly and going-home time. Another cause is that as “R&T” progressively weakens, both children step away from each other, and then end R&T with smile. After “peaceful end”, children are jolly-looking. And what is more some of them seem to feel regret at ending the R&T.

The “end with one-side anger” means an end with a situation where one child is angry or surely in a bad mood but the other is happy. It mainly arises from “aggressive behavior with a gap of intentions”, but sometimes from “first R&T” having a high strength. There are 3 causes leading to this end: one child’s resignation, a third-person’s admonishment and one-sided stop of attack for unknown reasons.

The “end with both-side anger” means an end with anger or discontent on both sides. It arises from “aggressive behavior with both seriousness”. There are 2 causes leading to this end: either a third-person admonishes the participants, or both children gradually step away from each other.

(d) It is therefore concluded that “strength”, “intent of behavior” and “discontent of participants” are the major factors that develop the process of this model of aggressive behavior and R&T.

As the degree of “strength” becomes higher in “R&T”, children becomes more seriously. So the R&T changes into “aggressive behavior with a gap of intentions” or “aggressive behavior with both seriousness”. Furthermore, children react aversively to “R&T” in case it has a high degree of “strength”. These results suggest the importance of “strength”. When the levels of “strength” are the same, “first R&T” causes obliging reactions, while “first aggressive behavior” causes aversive reactions. And when the “intent of behavior” was ungraspable, a victim reacts after observing the look of the performer. These facts indicate the importance of “intent of behaviors”. Moreover if behaviors end with children’s anger or discontent, they tend to show “first aggressive behavior” to the participant of the former aggression or to another child who has nothing to do with it. There are some cases that a child who receives a tough reprimand from other children shows “first aggressive behavior” to them. They suggest that “discontent of participants” functions as a trigger for aggression and that children get out from the discontent in the form of aggression, and show the circularity of

aggression.

Conclusion

First and most importantly, this study reveals that, among boys, “aggressive behavior with both seriousness”, ‘R&T’ and “aggressive behavior with a gap of intentions” are very close to each other and one gradually changes into another. Smith’s research also reports a case that R&T gradually changes into aggression. But he does not treat it thoroughly because he considers it is caused only by rejected children. In my study, however, there are some cases that “R&T” change into other types of aggression and it does not always happen to certain children. So there is a possibility that the change of behaviors is not unusual for children. In & Hirota (1996) observe that there is a give-and-take of low aggressive behaviors. They indicate that such aggressive behaviors maintain the relationships between children. Accordingly we cannot easily split boys’ behaviors, which seem aggression, into “play” and “serious aggression”. We have to consider how we should treat R&T, which is included in aggression-like behaviors.

There are 3 major factors, which conduce to the change from play to aggression: “strength”, “intent of performer” and “discontent of participants”. A frame of behavior seems to be judged by the “intent of performer”, which is figured out by “strength” as an external condition and “discontent of participants” as an internal condition. This may be an “encoding” part in social information processing of Dodge. And the circularity of aggression is also suggested from the fact that discontent as the end of aggression leads to another aggressive behavior.

And finally, the striking fact is the existence of “aggressive behavior with a gap of intention”. “R&T” and “aggressive behavior with both seriousness” are well formed because the participants are in the same frame (“This is play fighting”. “This is real fighting”). But regarding “aggressive behavior with a gap of intention”, the participants are in the different frames, so the situation is fragile. Nevertheless it occurs occasionally and lasts long. In the meantime, some behaviors change into “aggressive behavior with both seriousness”, or end with a gap of intention. Yano(1989) finds out the same 3 types of frame, from his observation of kindergarteners. Using “frame” concept of Bateson, Yano says that “aggressive behavior with a gap of intention” means a discrepancy of the frames. And he also argues that this discrepancy is similar to “Ijime (bullying)”.

This time I could not examine the instability of frame, so I would like to continue to

consider it in the future.

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