

THE UNIVERSITY OF HULL

Deployment of Social Cognition for Communication and Moral Judgement in Traumatic Brain
Injury

Being a dissertation submitted in partial fulfilment of the requirements for the degree of Doctor
of Clinical Psychology, in the University of Hull

By

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June 2016

Acknowledgements

There are a great many people to whom I owe a debt in relation to this thesis, but a few names must be mentioned specifically. Dr Miles Rogish first stimulated my interest in a project of this kind, in a conversation that I still remember now, almost three years on. I recall that our initial ideas were much simpler than the project reported within these pages. Perhaps therein lies a lesson for next time.

Dr Kevin Riggs' support and guidance has also been invaluable. My interest in the issues explored in this thesis have in no small part been inspired by his tutelage, and this project would be unambiguously lesser were it not for those long and meandering discussions in Fenner.

Special thanks also to Dr Tim Alexander, for trusting me to go off and explore this niche and emerge with something coherent, and for always being on the end of a telephone during the bumps in the road.

The people close to me have tolerated my distractedness, exhaustion, despair, incessant complaining and outright unhappiness during the past three years. Those who are closest to me may be glad that I can now return to their arms. This thesis is dedicated to a few of these people:

To my Mum, for her support and her secretarial services. But more than that, for her absolute and unwavering confidence in me, for as long as I can remember.

To my Dad, for teaching me about determination.

And to Daisy, for her enduring love and her patience.

*To swing on the spiral, to swing on the spiral,
To swing on the spiral of our divinity and still be a human.*

Tool, "Lateralus"

Overview

This portfolio comprises three parts. Part one is a systematic meta-analytic review of the relationship between cognition, including social cognition, and the pragmatic aspects of language comprehension and production following traumatic brain injury. Part two is an empirical paper which presents novel data pertaining to the characterisation of moral judgement disturbance following traumatic brain injury, and the relationship of these disturbances to social cognition. Part three comprises the appendices, which contain information supplementary to parts one and two, in addition to an epistemological and reflective statement.

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Part one: Systematic Literature Review

Written for submission to *Brain and Language*

See Appendix A for submission guidelines

Word Count (excluding tables, figures and references): 5,961

**The Relationship between Language-In-Use and Cognition following Adult Traumatic
Brain Injury: A Systematic Review and Meta-Analyses.**

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Abstract

Effective pragmatic comprehension and discourse production are both critical in enabling complex human interaction using language. Both are routinely impaired following Traumatic Brain Injury (TBI), along with a host of cognitive functions (Douglas, 2010; Martin & McDonald, 2003). Individual studies have investigated the cognitive mechanisms which contribute to impaired pragmatic comprehension and discourse production, but there remains little understanding of the relative importance of different cognitive processes in contributing to pragmatic comprehension and discourse production impairment following TBI. A systematic review of the literature pertaining to the relationship between these communicative abilities and cognitive processes following TBI was conducted in order to populate meta-analyses of correlative data. Ten meta-analyses were computed, comparing the relationship between pragmatic comprehension and five key cognitive constructs (declarative memory; working memory; attention; executive functions; social cognition), and between discourse production and these constructs. Significant moderate to strong correlations were found between all cognitive measures and pragmatic comprehension, where declarative memory was the strongest correlate. Significant but weak correlations were found between discourse production and all cognitive measures with the exception of social cognition, where executive functions showed the strongest correlation. Thus, our findings indicate that pragmatic comprehension in TBI is associated with an array of domain general cognitive processes, and as such deficits in these cognitive domains may underlie pragmatic comprehension difficulties following TBI. In contrast, discourse production was largely independent of cognitive processes following TBI, indicating that discourse production difficulties may not be a product of cognitive impairment following TBI. Competing accounts of this observation are discussed.

To what extent is cognition recruited in aid of human language? Questions regarding the interface between language and cognition are fraught with difficulty, traversing multiple academic boundaries and running parallel to entrenched philosophical and empirical controversies relating to the nature of language and the extent of its domain specificity (Myachykov, Scheepers & Shtyrov, 2013).

Pragmatic Language Comprehension

In human communication, listeners are able to derive far more meaning from language than is contained in the linguistic propositions alone. Any given spoken discourse is interpreted by a listener in the context of their prior knowledge, belief, competency and values (Wilson, 2005). As a result the meaning of the same set of linguistic propositions can have entirely unrelated, or indeed conflictual meanings, dependent upon the context of the communication. The ability to comprehend these contextual aspects of communication is then profoundly important in enabling humans to develop effective communicative relationships with others. The ability to comprehend the implied and contextually dependent meanings within communication has been termed “pragmatic language”.

Pragmatics have been called “the skills underlying competence in contextually determined, functional language use” (Turkstra, McDonald & Kaufmann, 1996, p. 329). One view (Wilson, 2005) is that pragmatic comprehension is itself one module of a broader system which enables us to draw inferences about the beliefs, desires and intentions of conspecifics (Theory of Mind; ToM). Wilson writes:

“Understanding an utterance involves constructing a hypothesis about the speaker’s meaning [...]. Recognising a speaker’s meaning amounts to recognising the intention behind the speaker’s communicative behaviour, and this is a special case of the more general problem of explaining an individual’s behaviour in terms of attributed mental states”.

Clearly then, there are theoretical links between the capacity for comprehension of the implied meaning of conversational remarks and social cognition, particularly mental state reasoning.

Nonetheless, more basic cognitive processes may be more parsimoniously related to comprehension of language implicature. Indeed, there is fierce debate regarding the extent to which social cognition, in particular ToM, represents a modular function, versus one task of a domain general executive system (Abouafia-Brakha, Christe, Martory & Annoni, 2011; Apperly, Samson & Humphreys, 2005; Hartwright, Apperly & Hansen, 2012). As such, general executive resources may be deployed in order to support pragmatic comprehension, for example by inhibition of inappropriate interpretations (Faust & Gernsbacher, 1996; Gernsbacher, Keysar, Robertson & Werner, 2001) and for general inferential reasoning (Martin & McDonald, 2005). In addition, due to the theoretically limitless amount of contextual information that can be drawn upon in order to inform pragmatic interpretation of any given remark (Wilson, 2005), declarative and working memory, as well as attentional and processing resources, are likely to play some kind of supportive role in pragmatics. Indeed, neuroimaging studies have provided emerging evidence that inferential language comprehension relies on a distributed frontal-parietal network typically associated with multiple cognitive functions, including the lateral frontopolar, anterior prefrontal, dorsolateral prefrontal and anterior cingulate cortices, as well as the inferior and superior parietal cortices (See Barbey et al., 2013, for a review).

Discourse Production

In an authoritative paper, Linguists Youse and Coelho (2005) state that the term ‘discourse’ refers to any unit of language, typically longer than a single sentence, *which conveys meaning*. As such, although other uses of the term are prevalent in the social sciences, in a linguistic sense (which will be the one used herein) the term discourse refers only to the conveyance of meaningful information via the creative use of language by a speaker. Production of intelligible discourse thus requires linguistic ability, that is, the ability to produce grammatically and syntactically correct propositions. However it also requires a *macrolinguistic* skill set. Marini and colleagues (2011) define macrolinguistic aspects as the “pragmatic and discourse-level aspects of language processing, i.e. those recruited in establishing cohesive and conceptual links among contiguous (cohesion or local coherence) or long-distance sentences/utterances (global coherence) and in formulating a mental model or gist of a story or procedure” (p. 2904).

The structure building framework (SBF; Gernsbacher, 1990; Gernsbacher, Tallent & Bollinger, 1999) provides an account of discourse production at the language-cognition interface. It suggests that discourse production is supported by a process of constructing mental structures onto which information is mapped for production. SBF posits that memory nodes are crucial to the development and maintenance of these structures, onto which subsequent discourse can be conceptualised and planned. Two other general cognitive processes support the structure building process: suppression (inhibition) of irrelevant associations, and enhancement of relevant activations. Breakdown in these core processes can lead to impairment in discourse, as observed in schizophrenia (see Gernsbacher, Tallent & Bollinger, 1999, for a review). According to the SBF then, discourse production is supported by a diverse cognitive network consisting (at least) of executive functions, (for suppression and enhancement of appropriate responses from the behavioural repertoire), declarative memory (for recall of previously built discourse structures), and working memory (for the planning and organisation of discourse). In addition, one can certainly envisage a supporting role for sustained, selective and divided attentional resources in this cognitive-linguistic task (see Peach, 2013). A role for ToM is less certain, although in many cases a discourse must be tailored to its audience; taking account of their prior knowledge, experience and level of linguistic or technical competence. In some circumstances then, it seems plausible that ToM may play a supportive role in enabling the production of informative discourse.

TBI

Traumatic brain injury (TBI) has been characterised as “alteration in brain function, or other evidence of brain pathology, caused by an external force” (Menon, Schwab, Wright & Maas, 2010, p. 1637). Neuropathological consequences of non-penetrating TBI typically include traumatic axonal injury, which is the acute functional impairment of neural axons, which can lead to cell necrosis, particularly in white matter and transcallosal tracts. In non-penetrating TBI, the frontal cortex is affected in the majority of cases, as part of a diffuse pattern of cortical lesion and degradation to the structure and integrity of axons (Adams, Graham, Scott, Parker & Doyle, 1980; Lezak, Howieson, Bigler & Tranel, 2012; Smith, Meaney & Shull, 2003).

TBI leads to significant impairments in both pragmatic comprehension and the production of effective discourse. When given novel metaphors, TBI participants take longer to interpret their meaning, and make more errors in doing so than non-injured controls (Yang, Fuller, Khodararast & Krawczyk, 2010). Similarly, sarcastic remarks are often misunderstood; those with TBI often accept the literal meaning of the statement or interpret it in a non-literal but nevertheless inappropriate way (Channon, Pellijeff & Rule, 2005). The ability to detect humour is also attenuated (Braun, Lussier, Baribeau & Ethier, 1989), and although TBI participants perform similarly to non-injured controls when making basic and automatic inferences in real-world conversation, they are poorer than controls when required to employ a conscious reasoning process to analyse the context of the statement in order to arrive at an inference (Johnson & Turkstra, 2012). Finally, TBI participants are less able to comprehend indirect requests than non-injured controls (Evans & Hux, 2011), and demonstrate an impaired ability to comprehend the “gist” of story narratives, despite intact ability to follow the microstructural aspects of the story (Holliday, Hamilton, Luthra, Oddy & Weekes, 2005).

Analysis of language at the level of discourse in TBI populations is important as discourse represents the employment of language in service of communicating within real social interactions. This approach has provided a wealth of evidence that although TBI rarely causes chronic disruption of the core language faculty (Hagen, 1984; Holland, 1982; Yang et al., 2010), the recruitment of language to convey meaning (i.e. macrolinguistic ability) is frequently impaired.

In discourse production, TBI participants produce shorter sentences, provide less elaboration (Coelho, 2002), and are less time efficient in conveying information (Matsuoka, Kotani & Yamasato, 2012). They commit more errors of cohesion and coherence due to frequent derailments, interruptions and extraneous utterances (Marini et al., 2011). They find it more difficult to plan sentences (Peach, 2013), and tell stories in a way that makes clear the causal and temporal relationships between events (story grammar; Mozeiko, Lê, Coelho, Krueger & Grafman, 2011). Unsurprisingly then, the discourse of TBI survivors has been described as

“incoherent and impoverished” (Marini, Zettin & Galetto, 2014, p. 282). Partners of TBI survivors in marital dyads give similar summaries (Bracy & Douglas, 2005), and these communicative difficulties remain stagnant even over the very long term (Ponsford et al., 2014).

In addition to communicative impairment, chronic cognitive impairments in the domains of declarative memory (encoding, storage and retrieval; Fork et al., 2005; Scheid, Walther, Guthke, Preul & von Cramon, 2006), working memory (McDowell, Whyte & D'Esposito, 1997), executive functions (Fork et al., 2005; Milders, Fuchs & Crawford, 2003; Scheid, Walther, Guthke, Preul & von Cramon, 2006; Stuss, 2011), attention (Mathias & Wheaton, 2007; Rios, Perianez & Munoz-Cespedes, 2004) and processing speed (Madigan, DeLuca, Diamond, Tramontano & Averill, 2000) have been documented after TBI, reflecting the diffuse nature of TBI pathophysiology. Diffuse axonal injury in TBI is associated particularly with processing speed (Felmingham, Baguley & Green, 2004; Niogi et al., 2008) and executive functioning impairments (Lipton et al., 2009; Wallesch et al., 2001), and even mild TBI results in acute cognitive impairments (Binder, 1997; Binder, Rohling & Larrabee, 1997; Erez, Rothschild, Katz, Tuchner & Hartman-Maeir, 2009) which extend to the chronic stage in a proportion of patients (Carroll et al., 2004).

TBI also results in significant difficulties in social cognition. Specifically, impairments have been documented in the low level processes enabling recognition of emotion in faces and vocal prosody (Milders, Fuchs & Crawford, 2003; Spikman, Timmerman, Milders, Veenstra & van der Naalt, 2012), as well as in the reflexive mimicry of facial emotion (McDonald et al., 2011). Higher order processes of social cognition, including the representation of the intentions and emotional state of others (Havet-Thomassin, Allain, Etcharry-Bouyx & Le Gall, 2006), and second order belief reasoning (Muller et al., 2010) are also impaired.

Need for this review

A decade ago, Youse and Coelho (2005) commented that despite an array of research into the classically observed communication deficits in absence of aphasia following TBI, a clear understanding of the relationship between cognition and communication disorder had not been established. Given the literature reviewed above it is arguable that this remains the case.

Individual studies have implicated a core group of cognitive processes in both discourse production and pragmatic comprehension; declarative and working memory, attention, executive functions and social cognition in the context of acquired brain injury. However, rarely has any individual study taken a comprehensive measure of all of these cognitive functions, and as a result it is difficult to draw conclusions about the *relative* importance of each in the process of comprehension or production. An estimate of this relative importance is a crucial step towards the development of a model of dysfunction in pragmatic comprehension and discourse production following TBI. This will allow future research to further investigate those cognitive constructs which are not only of theoretical relevance, but also empirically implicated. There is then a need to synthesise and integrate the work done in this area.

Finally, findings from the literature in this area may not filter easily into clinical knowledge and practice, despite clear relevance to neurorehabilitative settings. The literature sits on the academic and professional boundary between Neuropsychology and Linguistics, and as a result may not be readily accessible to professionals from each discipline. However the relationship between cognition and communication has implications clinically and may allow clinicians to understand risk factors for pragmatic difficulties based on particular cognitive impairments, and *vice versa*.

The present study thus attempts to address these issues by systematically drawing together published studies which report data on the cognitive correlates of both pragmatic comprehension and discourse production following TBI, and quantifying the extent of each of these relationships.

Method

Search Strategy

The EBSCOhost search engine was used to conduct an extensive literature search of the Medline, PsycInfo and CINAHL databases. This search was undertaken in January 2016 and yielded no systematic or meta-analytic reviews of the relationship between cognition and pragmatic language comprehension or discourse production.

Search Terms

Search terms were as follows:

(“communicati* OR conversation* OR (language N2 comprehension) OR (expressi* N2 language) OR (language N2 producti*) OR (recepti* N2 language) OR discourse OR figurative OR humo#r OR idiom OR irony OR linguistic* OR metaphor* OR narrative OR (persua* N3 discourse) OR pragmatic* OR proverb OR sarcasm OR psycholinguistic* OR sociolinguistic*) AND (Amnesi* OR attention* OR “belief reason*” OR cogniti* OR “desire reason*” OR “executive function*” OR “executive dysfunction” OR “dysexecutive syndrome” OR “false belief” OR fMRI OR frontal OR prefrontal OR “functional magnetic resonance imaging” OR (intention N3 reason*) OR memory OR mentali* OR mindread* OR neuroimag* OR “sally-ann*” OR “social cognition” OR “theory of mind” OR (intention N3 infer*) OR (processing N2 speed)) AND (“Traumatic brain injur*” OR “head injur*” OR “head trauma” ”)

Search Limits

These search terms were applied to article titles, abstracts and key words. In order to ensure a comprehensive search of the published literature, limiters were employed in EBSCOhost to ensure that peer reviewed papers published between January 1975 and December 2015 and written in the English language were returned. None of the included papers predated 1991.

Criteria for inclusion

The following criteria were applied to the returned articles in order to determine eligibility.

Inclusion criteria

- i. The study includes a measure of pragmatic language comprehension or the macrolinguistic aspects of discourse production, either by:
 - a. Formal standardised measure
 - b. Rating a sample of discourse
 - c. Novel experimental tasks
- ii. The study includes a measure of any of the following cognitive processes:
 - a. Declarative memory
 - b. Working memory

- c. Attention / processing speed
 - d. Executive functioning
 - e. Social cognition
- iii. The study includes a defined group of participants who have sustained a TBI of at least mild severity in adulthood (18+)
 - iv. The study reports correlation of the relationship between I) and II) in the TBI group, OR
 - v. The authors make this data available via personal correspondence

Results of the Systematic Search Strategy

Figure 1 outlines the search procedure in diagrammatic form. A total of 1,544 papers were returned using the search procedure outlined. Further investigation revealed 476 of these records were duplicates, leaving 1068 papers for screening.

In the first instance abstracts were compared against the inclusion criteria. 1009 papers were excluded at this stage, leaving 59 for full-text review. Of these, 22 papers were ultimately identified as eligible for inclusion. Appropriate correlation data was not directly available in five papers and authors provided this for review via personal communication (LeBlanc et al., 2014; Marini et al., 2011; Martin & McDonald, 2005; McDonald & Flanagan, 2004; McDonald et al., 2014). Two papers were treated as a single study as the data indicated that these papers reported different observations from the same experimental session on the same sample (Lê, Coelho, Mozeiko, Krueger & Grafman, 2014; Mozeiko, et al., 2011).

As such a total of 21 studies were included in the review. The reference lists of all included papers were scrutinised for additional relevant papers. None were found using this method.

Assessment of methodological quality

Papers included in the present review were assessed for methodological quality (see appendix B) using checklist adapted from Downs and Black (1998), which was developed in order to assess the methodological quality of healthcare papers. The adapted measure comprised 17 items covering the conceptual integrity of the studies, their methodology (including participant characteristics), reporting of the results, and the internal and external validity of

conclusions drawn. Items were given one point if the condition of the checklist was met, zero points if it was not, and the item was not scored if it did not apply to that particular study. Checklist scores were converted to percentages, where 100% indicated an exceptionally high quality study in which all relevant conditions of the checklist were met.

Quality ratings were conducted by the first author and a random sample of five papers were selected for quality review by a researcher independent to the study. Inter-rater reliability was high (mean = 92.9%; range = 85% – 100%) and as such, the ratings of the first author were taken as reliable and employed as the measure of quality for the 21 included studies.

Data extraction

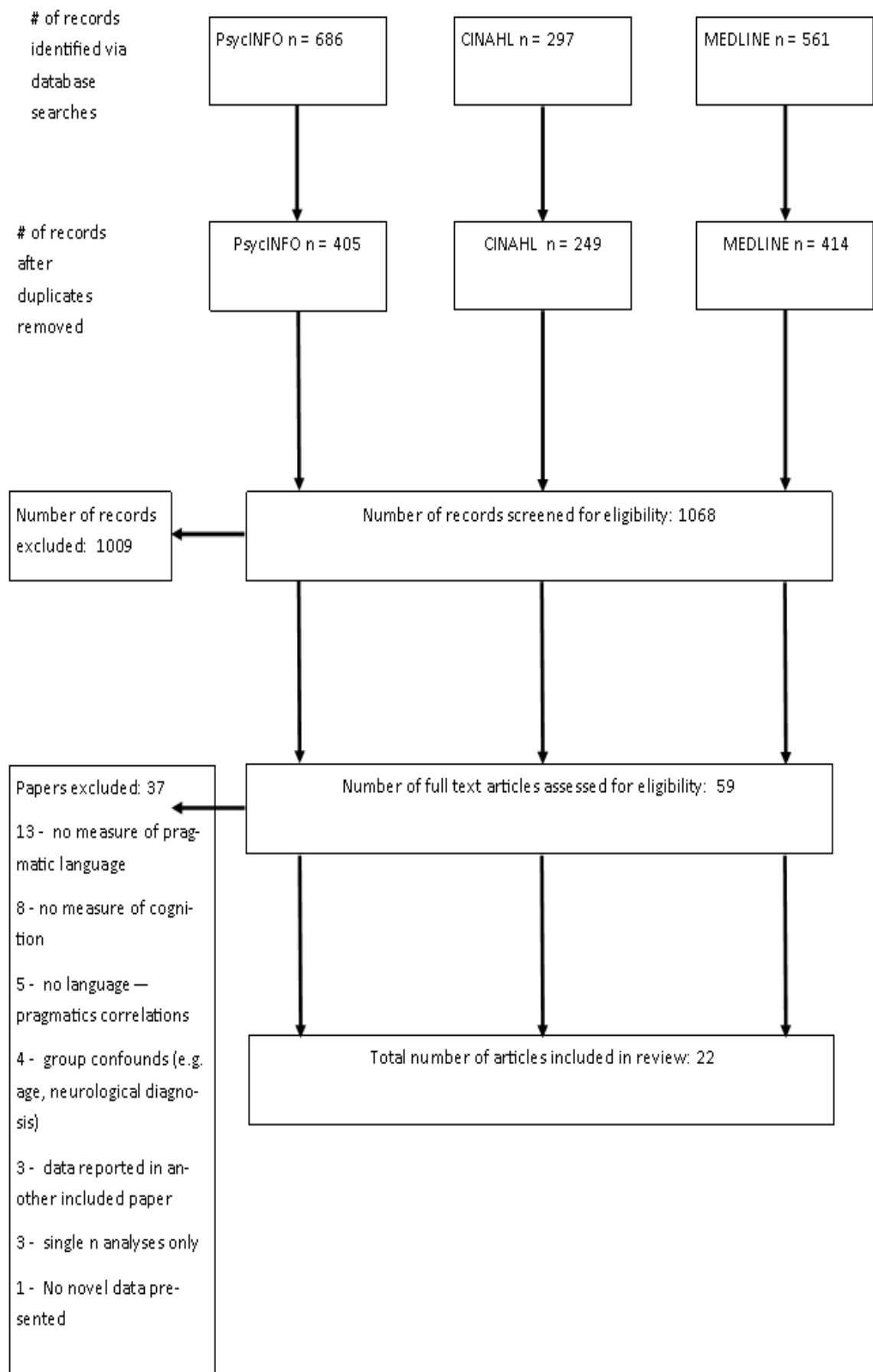
Correlative data were extracted from the selected papers using a data extraction form (see appendix C) in order to populate meta-analyses. In preparation for these analyses, each pertinent correlation reported was extracted individually. Correlation coefficients were standardised by inverting where necessary, in order to ensure that a positive r value indicated a relationship in which improvement in cognitive variable indicated an improvement of the corresponding language variable. Where multiple correlations were reported on the same construct (e.g. executive functions), these coefficients were averaged to create a single r value for input into the appropriate meta-analysis.

Where a paper included relevant measures but did not report all of the correlations between these in the paper, attempts were made to contact the author. If successful, all data was included in the study. If unsuccessful, available data was included and the incomplete dataset was noted as a limitation in the quality assessment checklist.

Variable Categorization

Neuropsychological measures employed in each study (see table 1) categorised in the first instance by the first author with reference to an authoritative compendium of neuropsychological tests (Strauss, Sherman & Spreen, 2006). These categorisations were then reviewed by an experienced clinical neuropsychologist (author MR). There was

Figure 1. Flow diagram of systematic review process



substantial inter-rater agreement; only three measures were highlighted; digits forwards, Trail Making Test B & the Stroop test. As a result of discussion, digits forwards was re-categorised from a measure of declarative memory to a measure of working memory, in accordance with the literature on the phonological loop in working memory (Baddeley, 2003). It was agreed in discussion and further consultation to Strauss, Sherman and Spreen (2006) that although TMT B and Stroop do tap aspects of executive functioning (specifically cognitive flexibility and preponderant response inhibition), the primary cognitive constructs recruited are speeded processing and selective attention respectively. Thus, in keeping with previous studies (see Table 1), these tests were categorised as attention / processing speed measures. Appendix D displays how all measures have been categorised into these broader concepts.

Data Analysis

Data extracted from the included papers was clustered according to the categorisation of variables and used to populate meta-analyses, which were computed using the “R” statistical package (R Core Team, 2012). A total of 10 meta-analyses were performed, in which comprehension and production were compared individually with each cognitive construct. Correlation coefficients, 95% confidence intervals and number of subjects were reported in accordance with best practice when reporting correlations and their magnitudes (Field, 2013). As such, significance was taken to be $p < .05$ for each correlation.

Results

Study Characteristics

Table 1 displays the characteristics of the studies included in the review. In total, the papers comprising the review included 1045 participants. The average number of participants in each study was 49.8 and the majority of studies (85.7%) reported data on participants who had sustained closed head injury (CHI). Two studies reported data on penetrating head injury (PHI). Participants were aged on average 38.9 (SD = 9.9) years of age at the time of testing, and were on average 9.1 years post injury (SD = 7.8).

Language Variables

Pragmatic language comprehension.

Table 1 outlines the instruments which were taken as measures of both pragmatic comprehension and discourse production in the meta-analysis. Of the ten studies measuring pragmatic language comprehension, six used validated measures and four used novel tasks. The measures were homogeneous in that they all assessed participant ability to make inferences about the implied meanings in ambiguous speech – whether this be related to sarcasm, humour or otherwise figurative language. Nine of the papers used direct behavioural measures of pragmatic comprehension – requiring participants to make inferences in response to a stimulus set of ambiguous linguistic material. One study (LeBlanc et al., 2014), employed a questionnaire measure in which clinicians rated the ability of their patients to generate accurate pragmatic inferences.

Discourse production.

Of twelve relevant studies, nine employed a direct macrolinguistic discourse analysis of speech, where a sample of discourse was derived using discourse elicitation tasks. Analyses were carried out in accordance with widely accepted protocols for discourse analysis (Liles, Coelho, Duffy & Zalagens, 1989), and all assessed one or more of the key facets of macrolinguistic discourse production (outlined in Table 2) which were then pooled for purposes of meta-analysis in order to investigate the overall relationship between cognition and discourse production. Table 1 outlines the way in which individual studies quantified these facets of discourse production.

Methodological Quality

Quality ratings indicated that the papers reviewed were of a moderate to high quality (mean = 83.9%; SD = 8.5%; range = 66.6 % - 94.1%). Bootstrapped Pearson correlations revealed no significant relationship between year of publication and the methodological quality of the study [$r = .276, p = .225, \text{BCa } 95\% \text{ CI } (-.283, .674)$], nor between number of participants and methodological quality [$r = -.128, p = .581, 95\% \text{ BCa CI } (-.667, .350)$].

The methodological quality assessment indicated some consistent strengths and weaknesses throughout the literature. The studies included routinely reported estimates of random variability, used recruitment strategies with minimal opportunity for bias, and used validated measures of cognition. However, language measures were not always validated, and no attempt was made to blind experimenters to participants' neurological status in the reviewed papers. In

Table 1: Characteristics of studies included in the meta-analyses

Study	N (TBI)	Severity	Type (CHI / PHI)	Age (mean)	Years post-injury	Language measures	Cognition Measures
<i>Barbey Colom & Grafman, 2013</i>	145	<i>Not reported</i>	<i>PHI</i>	58	<i>Not reported</i>	<i>DCT</i>	<i>(1) WAIS; (a) working memory index; (b) processing speed index; (2) Emotional IQ test</i>
<i>Channon, Pellijeff & Rule, 2005</i>	19	<i>Severe</i>	<i>CHI</i>	46	10	<i>Sarcasm comprehension (Exp.)</i>	<i>Mentalising ToM task (Exp.)</i>
Coelho, 2002	55	Mild - Severe	CHI	29	< 1	Macrolinguistic analysis of discourse elicited from story retelling and generation. (1) Number of total episodes (Story Grammar); (2) Proportion of T-units within episode structure (Story Grammar); (3) Complete ties / total ties (Cohesion)	WCST
Douglas, 2010	43	Severe	CHI	39	6	LCQ	(1) Verbal fluency; (2) RAVLT; (3) SCOLP silly sentences

Galetto, Andretta, Zettin & Marini, 2013	10	Mild	CHI	35	3	Macrolinguistic analysis of discourse elicited from story generation. (1) Total lexical information units (Informativeness); (2) Number of tangential or conceptually incongruent remarks / fillers, or repetitions (Global Coherence)	(1) Rey 15 word delayed recall; (2) WCST
Hartley & Jenson, 1991	11	Severe	CHI	27	< 1	Macrolinguistic analysis of elicited narrative and procedural discourse. (1) Total Words (Productivity); (2) Total time of discourse (Productivity); (3) Target content units, inaccurate content units & problems of reference (Informativeness); (4) Reference, conjunction and lexical errors (Cohesion index)	WMS (a) logical memory index; (b) digit span forwards; (c) digit span backwards
Hinchliffe, Murdoch & Chenery, 1998	25	Severe	CHI	26	< 1	<i>comprehension of humour, inference & figurative language (RHLB)</i>	(1) WAIS; (a) digit-symbol (2) D-KEFS; (a) trails A & B; (b) color-word inference 1 & 3; (3) WMS verbal paired associates; (4) RAVLT; (5) verbal fluency

Lê, Coelho, Mozeiko, Krueger & Grafman, 2014; Mozeiko, Lê, Coelho, Krueger & Grafman, 2011	167	Not reported	PHI	58	35	Macrolinguistic analysis of elicited narrative discourse. (1) Number of T-Units (Productivity); (2) Story completeness (Informativeness); (3) Complete ties / Total Ties (Cohesion); (4) Proportion of t-units in episode structure (Story Grammar); (5) Total number of episodes (Story Grammar); (6) Proportion of contiguous t-units which are related (Local Coherence)	(1) WMS; (a) working memory index; (b) immediate memory index ; (2) D-KEFS (a) tower test; (b) sort test
<i>LeBlanc et al., 2014*</i>	179	<i>Mild - Severe</i>	<i>CHI</i>	55	<1	<i>D-MEC production and comprehension indices</i>	<i>(1) WMS; (a) digits forwards; (b) digits backwards; (2) D-KEFS; (a) trails A & B; (b) verbal fluency</i>
Marini et al., 2011	14	Severe	CHI	35	5	Macrolinguistic analysis of elicited narrative discourse. (1) Linguistic information units / total units (Informativeness); (2) Proportion of: local coherence errors / total utterances (Local Coherence); (3) Proportion of: tangential and extraneous utterances / total number of utterances (Global coherence)	(1) WCST; (2) Rey 15 item (a) immediate recall; (b) delayed recall (3) D-KEFS (a) semantic fluency; (b) trails A & B

Marini, Zettin & Galetto, 2014	10	Moderate	CHI	37	2	Macrolinguistic analysis of elicited narrative discourse. (1) Linguistic information units / total words (Informativeness); (2) Proportion of: local coherence errors / total utterances (Local Coherence); (3) Proportion of: tangential and extraneous utterances / total number of utterances (Global coherence)	WCST
<i>Martin & McDonald, 2005</i>	16	Severe	CHI	39	9	<i>Pragmatic interpretation (Exp.)</i>	<i>(1) second order belief reasoning (Exp.), (2) complex non-mental state inference (Exp.) (3) CANTAB (a) circles task; (b) IED task; (4) Verbal Fluency</i>
Matsuoka, Kotani & Yamasato, 2012	26	Severe	CHI	36	12	Macrolinguistic analysis of elicited narrative discourse. (1) Total number of units (Productivity); (2) Total correct information units (Informativeness); (3) Words / total time (Informativeness); (4) Correct information units / total time (Informativeness); (5) Correct information units / total units (Informativeness)	(1) WMS; (a) Logical memory 1 and 2; (b) digits forwards and backwards; (2) BADS; (a) rule shift (b) key search; (c) temporal judgement
<i>McDonald, Fisher, Flanagan & Honan, 2015</i>	31	Severe	CHI	47	>1	<i>Intepretation of sincerity (Exp.)</i>	<i>(1) TASIT; (2) Balanced emotional empathy scale; (3) WAIS; (a) Digit Span; (b) Digit symbol; (4) Trails</i>

<i>McDonald & Flanagan, 2004</i>	34	<i>Severe</i>	<i>CHI</i>	41	9	<i>Intepretation of sincerity / sarcasm (TASIT)</i>	<i>(1) TASIT; (a) emotion recognition; (b) belief inference; (c) intention inference; (d) emotion inference</i>
<i>McDonald et al., 2014*</i>	25	<i>Moderate - Severe</i>	<i>CHI</i>	48	14	<i>Detail provided in elicited discourse, interpretation of sincerity / sarcasm (TASIT)</i>	<i>(1) Hayling test; (2) WMS; (a) logical memory index; (2) WAIS; (a) digit span; (3) D-KEFS; (a) Trails A&B (b) letter fluency; (4) TASIT; (a) emotion recognition; (5) RME; (6) IRI Perspective taking index</i>
<i>Muller et al., 2010</i>	15	<i>Severe</i>	<i>CHI</i>	37	8	<i>Indirect speech comprehension (D-MEC)</i>	<i>(1) Faux Pas Test, (2) first and second order false belief tasks (Exp.); (3) character intention task (Exp.); (4) RME</i>
<i>Schmitter-Edgecombe & Bales, 2005</i>	20	<i>Severe</i>	<i>CHI</i>	31	5	<i>Pragmatic inference comprehension (Exp.)</i>	<i>(1) WMS letter-number sequencing; (2) symbol-digit modalities test; (3) CVLT; (4) WCST; (5) D-KEFS colour-word inference</i>
<i>Snow, Douglas & Ponsford, 1998</i>	24	<i>Severe</i>	<i>CHI</i>	26	3	<i>CDA</i>	<i>(1) D-KEFS; (a) semantic fluency; (b) trails B; (3) RAVLT; (4) SCOLP comprehension speed</i>

Struchen et al., 2008	121	Mild - Severe	CHI	37	6	LCQ	(1) D-KEFS; (a) colour-word inference; (b) sort test; (2) Script analysis test; (3) Trails B; (4) verbal fluency; (5) Facial affect recognition; (6) prosody recognition
Youse & Coelho, 2005	55	Moderate - Severe	CHI	29	<1	Macrolinguistic analysis of discourse elicited from story retelling and generation. (1) Total number of episodes (Story Grammar); (2) Complete ties / Total Ties (Cohesion); (3) Proportion of t-units in episode structure (Story Grammar)	(1) WMS; (a) digit span; (b) logical memory index; (c) associate learning

Studies in italics are related to pragmatic comprehension; * denotes that the study reports data on both pragmatic comprehension and discourse production. Exp., experimental measure. Language measure abbreviations; DCT, Discourse Comprehension Test (Brookshire & Nicholas, 1984); LCQ, La Trobe Communication Questionnaire (Douglas, O'Flaherty & Snow, 2000); RHLB, Right Hemisphere Language Battery (Bryan, 1995); D-MEC, Protocole Montreal d'evaluation de la communication (Joanette, Ska & Côté, 2004); TASIT, The Awareness of Social Inference Test (McDonald et al., 2006); CDA, Clinical Discourse Analysis (Damico, 1985); WAIS, Wechsler Adult Intelligence Scale (The Psychological Corporation, 2008); WCST, Wisconsin Card Sort Task (Heaton et al., 1993); RAVLT, Rey-Osterrieth Auditory-Verbal Learning Test; SCOLP, Speed and Capacity of Language Processing (Baddeley, Emslie & Nimmo-Smith, 1992); WMS, Wechsler Memory Scale (Wechsler, 1997); D-KEFS, Delis-Kaplan Executive Functioning System (Delis, Kaplan & Kramer, 2001); CANTAB, Cambridge Neuropsychological Test Automated Battery (IED, Intra/extradimensional shift); BADS, Behavioural Assessment of the Dysexecutive Syndrome (Wilson et al., 1998); RME, Reading the Mind in the Eyes (Baron-Cohen et al., 2001); IRI, Interpersonal Reactivity Index (Davis, 1980); CVLT, California Verbal Learning Test (Delis et al., 2000)

Table 2. Overview of aspects of discourse production measured in the reviewed studies

Facet of discourse production	Description*
Productivity	The extent to which the speaker engages in discourse production - e.g. the duration of discourse and number of words produced
Informativeness	The extent to which the discourse conveys information appropriate to the context - e.g. by verbalising crucial aspects of a story
Cohesion	The extent to which a speaker makes conceptual links between, and references to, distal utterances within a discourse
Local Coherence	The extent to which utterances are conceptually related to those preceding. Erratic topic switching or production of utterances without clear referent are examples of local coherence error
Global Coherence	The extent to which the speaker relates individual utterances to the overall theme of the discourse. Errors include inclusion of tangential or irrelevant information, repetitions or fillers
Story Grammar	The extent to which temporal and causal relationships between agents and events are made clear. A typical episode includes (1) an initiating event, (2) character action and (3) consequence. Errors involve omission of one or more of these aspects of an episode

* Galetto et al., 2013; Lê et al., 2014

Table 3. Results of meta-analyses of (a) pragmatic comprehension - cognition and (b) discourse production - cognition relationships in samples of patients with TBI

	Studies (n)	Participants (n)	R	95% CI	Z	P
Comprehension						
Declarative memory	3	68	0.605	0.43 to 0.74	0.701	0.00000
Working memory	5	400	0.320	0.23 to 0.41	0.331	0.00000
Attention / Processing Speed	6	355	0.291	0.19 to 0.38	0.299	0.00000
Executive functions	5	239	0.473	0.37 to 0.57	0.514	0.00000
Social cognition	7	289	0.421	0.32 to 0.51	0.449	0.00000
Production						
Declarative memory	9	374	0.266	0.17 to 0.36	0.273	0.00000
Working memory	6	462	0.111	0.02 to 0.20	0.111	0.03651
Attention / Processing Speed	7	351	0.226	0.13 to 0.32	0.230	0.00087
Executive functions	11	650	0.295	0.22 to 0.36	0.305	0.00003
Social cognition	2	146	0.089	-0.07 to 0.25	0.089	0.37196

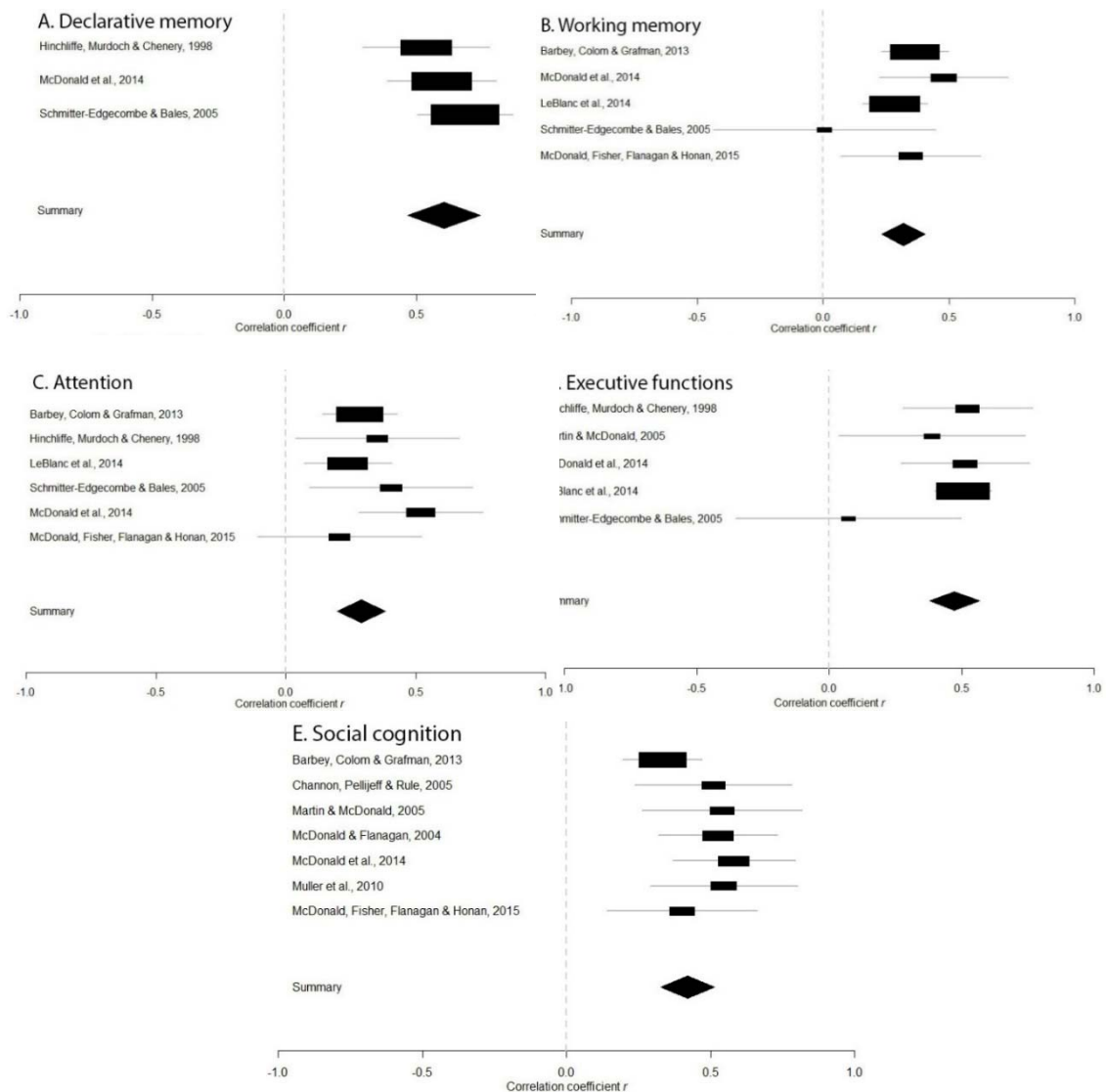


Figure 2. Forest Plots of studies included in the meta-analyses of Pragmatic Comprehension and cognitive variables. (A) Pragmatic Comprehension – Declarative Memory. (B) Pragmatic Comprehension – Working Memory. (C) Pragmatic Comprehension – Attention. (D) Pragmatic Comprehension – Executive functions. (E) Pragmatic Comprehension – Social Cognition.

In addition, the literature was variable in its reporting of actual probability values, and some studies did not report all of the correlations that were computed.

Meta-Analytic Results

Pragmatic comprehension.

Table 3 displays all of the meta-analytic results and Figures 2 and 3 display forest plots for all analyses. All cognitive variables showed significant correlations with pragmatic comprehension. Declarative memory was the strongest correlate ($r = .605, p < .001$), followed

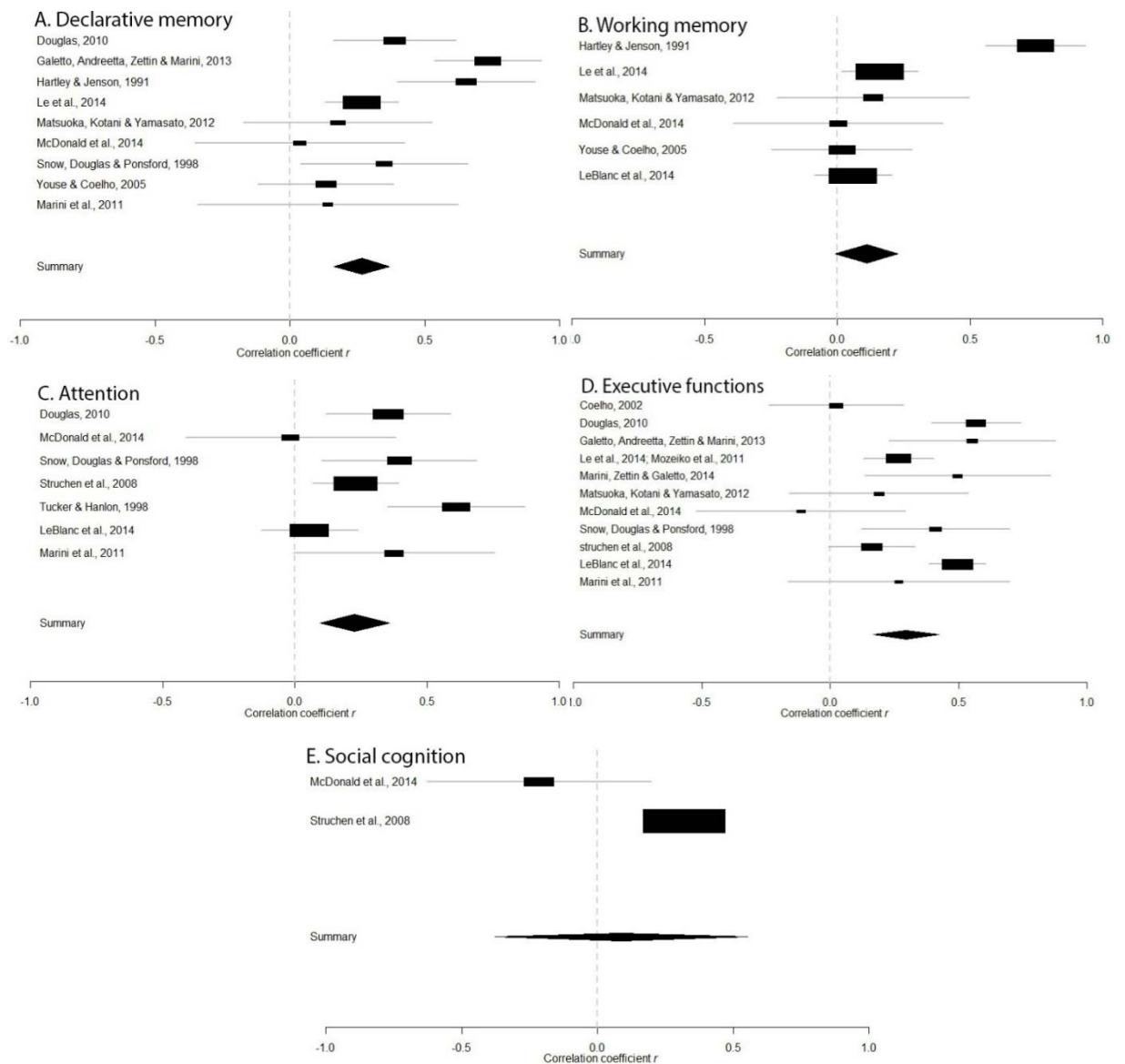


Figure 3. Forest plots of studies included in the meta-analyses of Discourse Production and cognitive variables. (A) Discourse Production – Declarative Memory. (B) Discourse Production – Working Memory. (C) Discourse Production – Attention. (D) Discourse Production – Executive functions. (E) Discourse Production – Social Cognition.

by executive functions ($r = .473, p < .001$) and social cognition ($r = .421, p < .001$). Working memory ($r = .320, p < .001$) and attention ($r = .291, p < .001$) correlated less strongly with pragmatic comprehension.

Discourse production.

Executive functions ($r = .295, p < .001$) and declarative memory ($r = .266, p < .001$) showed moderate significant correlations with discourse production. Attention also showed a weak-to

moderate significant correlation ($r = .226, p < .001$), and working memory showed a weak significant correlation with discourse production ($r = .111, p = .037$). The weak meta-analytic correlation between discourse production and social cognition relied on just two studies and was not significant ($r = .089, p = .372$).

Discussion

Humans are able to employ the language system in aid of organising complex ideas into coherent discourse, and are also capable of decoding the implied meanings within linguistically ambiguous speech. However these abilities are impaired following TBI (Douglas, 2010; Martin & McDonald, 2003), and there was a need to systematically examine the literature with a view to identifying the extent to which these communicative impairments are related to cognitive dysfunction, and which cognitive processes are most closely involved. Thus, the present paper systematically collated data from the published literature which pertained to the correlations between a host of cognitive functions and these two macrolinguistic abilities that are crucial to communicative ability following TBI, and used the data extracted to populate meta-analyses.

Pragmatic comprehension

In the present meta-analysis, pragmatic comprehension correlated strongly with declarative memory, and moderate-to-strongly with executive functions. In addition, pragmatic comprehension showed moderate correlations with working memory, attention and social cognition, indicating that a broad range of domain general cognitive processes are associated with this ability following TBI. The finding that declarative memory correlates strongly with pragmatic comprehension following TBI is in accordance with theoretical accounts that describe contextual and semantic knowledge as crucial in pragmatic interpretation (Wilson, 2005), and suggests that declarative memory processes may play a substantial role in pragmatic interpretation. Given that only three studies were identified that spoke to this relationship, our review suggests that the impact of declarative memory impairment on

pragmatic comprehension after TBI may have been underestimated in the literature and that this area warrants further study.

A debate has arisen over recent years regarding the relative contributions of executive functions and social cognition to pragmatic comprehension (McDonald et al., 2014), which has taken place in the context of a more entrenched dispute regarding the extent of independence of these cognitive constructs (Apperly, Samson & Humphreys, 2005). Our review indicates that these functions have a relationship with pragmatic comprehension which is relatively similar in strength, indicating that both may play a role in pragmatic interpretation. However the data do not offer unqualified support to accounts which ascribe primacy to the role of ToM in pragmatic comprehension (Wilson, 2005), as social cognition did not show a particularly strong correlation with pragmatic comprehension in our analyses. Additionally, given the difficulties in developing experimental tasks which precisely isolate executive components from social cognitive components in tests of the latter, many of the tasks which measured social cognition in this review contained an executive component. This issue is longstanding in the literature (Apperly, Samson, Chiavarino & Humphreys, 2004; Saxe, Schulz & Jiang, 2006) and as such, competing theoretical positions which posit central roles for mental state attribution (ToM; Wilson, 2005), executive inhibition (Faust & Gernsbacher, 1996; Gernsbacher et al., 2001) and general inferential reasoning (Martin & McDonald, 2005) cannot be convincingly discriminated between on the basis of the current results.

That working memory and attention correlated less strongly than the other cognitive constructs indicates that these may have a more peripheral role in pragmatic interpretation following TBI. Indeed, theoretical accounts have not ascribed a central role for attentional processes, but attention is nonetheless likely to have a general influence on communicative ability to the extent that lapses in attention may make pragmatic misunderstandings more likely.

Additionally, the finding that working memory correlates moderately with pragmatic interpretation provides support for the view that the two concepts are related. As suggested

by Wilson (2005), this role might be to manipulate contextual information in order to derive relevant inferences during the interpretations of ambiguous speech. One difficulty in attempting to test this possibility using correlative designs is that working memory tasks are heavily reliant on executive resources. As such, the observed correlation between working memory and pragmatic interpretation may reflect the general importance of executive processes, rather than a specific computational role for working memory. Experimental paradigms which manipulate working memory load whilst gauging pragmatic comprehension performance would be beneficial in evaluating this putative relationship in future research.

Discourse Production

The present meta-analytic findings indicated that executive functioning showed a borderline moderate correlation with discourse production; declarative memory, working memory and attention a weak correlation with discourse production, whilst social cognition showed no significant relationship with discourse production. Structure building theory (Gernsbacher, 1990) posits a central role for declarative and working memory, and executive functions, in supporting discourse production. The present findings provide support for the importance of declarative memory and executive functions, but only limited support for a key role of working memory functioning in supporting the discourse production process.

Additionally, it appeared *a priori* that attention and social cognition might play a supportive role in the process of structure building in discourse production. Our meta-analysis of social cognition and discourse production comprised just two studies which reported dissimilar findings. On this limited data then, there is no current evidence that social cognitive ability is associated with discourse production performance following TBI. However absence of evidence does not constitute evidence of absence, especially given the dearth of studies which have addressed this question. Given that social cognition is a domain specific process, it is possible that it is selectively recruited for discourse production in cases where there are important reasons to mentalise about the attitudes, prior knowledge or beliefs

of listeners. As the studies reviewed here did not explicitly address this possibility in their research designs, it is possible that a selective role for social cognition under limited circumstances has been overlooked, and further study is warranted to investigate this possibility.

The weak association between attention and discourse production suggests that this process may indeed partly underlie functional discourse production difficulties following TBI. As previously suggested by Peach (2013), attentional impairments are likely to disrupt the ability to plan sentences following TBI and therefore disrupt the clarity of discourse. However it remains unclear to what extent different aspects of attention (sustained, selective and divided) might be differentially associated with discourse production impairments in TBI.

Although, on the evidence presented here, cognition does not appear to exert a substantial or generalised influence on discourse production, such a role in specific aspects of discourse production may have been masked by the design of the review. Inclusion of all facets of discourse production under one umbrella for analysis allowed some broad and preliminary observations to be made regarding the relationship between cognitive variables and discourse production as a whole. However unfortunately it may have also served to obfuscate any strong relationships between specific aspects of discourse production and cognition. As such, these preliminary findings should not deter future research from undertaking more fine grained analyses of the cognition – discourse production interface.

Methodological Quality

As highlighted by the methodological assessment checklist, language measures were not all psychometrically validated; an observation which was particularly evident in the pragmatic comprehension literature, where novel experimental tasks were occasionally used. Although these had good face validity, their precise psychometric properties were unknown. The employment of these experimental measures perhaps reflects the dearth of well validated measures in this area and the desire of experimenters to investigate particular

niches under the pragmatic umbrella. Nonetheless the measures used were all closely related conceptually and methodologically; each asked participants to make judgements about the implied or otherwise ambiguous meanings within a speech stimulus. As such, these tasks are considered to be valid measures of the constructs they attempted to measure, especially as they required direct behavioural responses from participants, rather than relying on self-report.

Some studies of discourse production used validated measures, but others used clinical discourse analysis (Damico, 1985), which is not validated psychometrically but is nonetheless a well-established and formalised clinical procedure. This technique is crucial in understanding the precise behavioural nature of discourse production impairments after TBI, and the employment of this technique should not be seen as a weakness.

The tendency of some papers within the literature to not report all correlations may have biased the meta-analysis to overestimating the magnitude of the meta-correlations. However only four of 21 studies failed to report all correlations, and these provided data to just three of the 10 meta-analyses, which were limited to discourse production – cognition comparisons (declarative memory, working memory, and executive functioning). As such, any possible bias arising from this methodological limitation is limited to these three analyses.

Clinical and research implications

The primary clinical finding of this review is that cognitive impairment following TBI is more strongly associated with difficulties in the pragmatic interpretation of language than it is the production of meaningful discourse. Clinicians may want to pay particular attention to the extent to which patients demonstrate comprehension impairments during assessment when cognitive impairment is present, as it is tentatively possible to conclude that for patients with cognitive impairment following TBI, there is a risk of associated pragmatic interpretation difficulties. On this basis, pragmatic language disorder appears to have neuropsychological relevance in addition to speech and language aspects for patients with TBI, and should be considered during neuropsychological assessment. Future research in this

area might attempt to develop a model of the precise mechanisms by which these cognitive domains contribute to this uniquely human trait.

In contrast, although impairment in some specific cognitive domains appear related to discourse production difficulties, these were not ubiquitous and in any case were generally weak associations. In light of this evidence, clinicians should not be deterred from investigating cognitive functioning where patients present as eloquent orators, due to their apparently limited relationship. Given this observation, research might turn to other factors which may be of importance. It may be that the core language faculty plays a more central role in these processes than has traditionally been acknowledged. Despite observations that TBI patients often display impaired discourse production in the absence of an observed linguistic deficit (Yang et al., 2010), it may be that discourse production tasks place more stringent demands on the language faculty than traditional language tests, and are therefore more sensitive to subtle impairment that would not render a person frankly aphasic.

However there is also developing evidence that environmental factors may significantly influence the communicative performance of brain injured patients. In one study (Togher, McDonald, Code & Grant, 2004), TBI participants' discourse performance was variable; changing based on the competence of their communication partner. In another study (Kilov, Togher & Grant, 2009) which analysed the discourse production of TBI participants in the context of a naturalistic conversation with their friends, there were no significant differences between the conversational performances of TBI participants and their friends. This study concluded that in the context of meaningful interactions with friends, competent discourse performance is possible for TBI individuals. As such, discourse production performance following TBI might be subject to variability depending on experimental design, where designs utilizing formal interactions with researchers might give rise to poorer discourse production (Togher & Hand, 1999). With regards to the results of the present review, this extraneous variable may account for the limited relationship between cognitive impairment and discourse performance. This suggestion is bolstered by the apparent variability in the

studies which contributed to each meta-analysis regarding discourse production. Substantial between study variability in the strengths of the correlation values reported within each meta-analysis indicate that these data might be reporting on relationships where confounding variables were present, as experimental control variables relevant to this research area first require further documentation.

As such, future research might address the potential effects of variables that have escaped control in the research done to date; especially relating to the interlocutor with whom TBI participants are invited to interact during evaluation of discourse production. The present review indicates that it may be premature to attempt to coalesce the findings of research in this area to develop a substantial model of the cognitive basis of discourse production.

To conclude, the literature investigating the functional use of language and its interface with cognition is beginning to provide some insights into the extent of their relationships. This review indicates that the pragmatic interpretation of language relies substantially on a distributed, domain general cognitive architecture, in addition to utilising more domain specific social cognitive processes.

Conversely, discourse production, despite theoretical positions which posit a close relationship with aspects of cognition, does not appear strongly related to any particular cognitive domain, perhaps because of failures in the literature to identify and control for relevant extraneous factors when assessing discourse production abilities post-TBI.

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Part Two: Empirical Paper

Written for submission to *Social, Cognitive and Affective Neuroscience*

See Appendix E for submission guidelines

Word Count (excluding tables, figures and references): 4,767

Counterintuitive Moral judgement following Traumatic Brain Injury

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Abstract

Populations exhibiting frontal pathology, including Traumatic Brain Injury (TBI), appear to produce an abnormally 'utilitarian' pattern of judgements to moral dilemmas; judgements that disregard deontological moral rules in favour of maximising aggregate welfare (Martins et al., 2012). However, this patient research has always used extreme dilemmas with highly valued deontological moral rules (e.g. do not kill). Data from healthy participants suggests that when a wider range of dilemmas are employed, moral judgement is sensitive to psychologically based moral intuitions, rather than the tension between utilitarian and deontological moral doctrines (Kahane et al., 2011). We sought the moral judgements of 30 TBI participants and 30 controls on moral dilemmas where content (utilitarian/deontological) and intuition (intuitive/counterintuitive) were measured concurrently. Overall TBI participants made utilitarian judgements in equal proportions to controls; disproportionately favouring utilitarian judgements only when they were counterintuitive, and deontological judgements only when they were counterintuitive. These results speak against the view that TBI causes a specific utilitarian bias, suggesting instead that moral intuition is broadly disrupted following TBI.

Keywords: moral judgement; social cognition; emotion; traumatic brain injury; decision making

Research on the cognitive and neural bases of moral judgments has blossomed in the last 15 years and a clear finding appears to have emerged: utilitarian judgements (i.e., those that maximise aggregate welfare) are associated with increased activation in those frontal brain areas implicated in deliberate controlled processing; deontological judgements (i.e., those judgements that conform to moral laws) are associated with those brain areas associated with automatic processing (Greene et al., 2001, 2004, 2008). Moral judgement has also been investigated in clinical populations exhibiting frontal lobe dysfunction, who characteristically show emotional blunting, impaired empathy, egocentrism (Mitchell et al., 2006; Müller et al., 2003) and demonstrate socially inappropriate behaviour (Beer et al., 2006; Cicerone & Tanenbaum, 1996; Pitman et al., 2014). This profile is observed routinely in Traumatic Brain Injury (TBI), where neuropathology is caused by an impact to, or rapid acceleration/deceleration of, the brain (Lezak et al., 2012). Neural damage is characteristically diffuse in TBI, but the frontal cortex is especially vulnerable to lesion (Lezak et al., 2012), and subcortical damage caused by traumatic axonal injury impairs the ability of the frontal lobes to exert executive control over distal neural regions (Hayes et al., 2016; Lipton et al., 2009). Consequentially, frontal pathology is usually present in TBI (Stuss 2011). In this study we investigate the moral judgements made by TBI patients to further our understanding of the cognitive and neural bases of moral judgement.

In a two-system cognitive account of moral judgement, Greene et al. (2004) characterize ‘system one’ as the rapid and automatic processes delivering moral judgement, while higher order processes of deliberative reasoning are engaged by ‘system 2’. The automatic system biases toward ‘deontological’ moral judgement – judgements that conform to moral laws such as *do not lie; do not harm others* (Kant, 1785/1959), whereas controlled processing allows our deontological intuitions to be surmounted in favour of a *reasoned* ‘utilitarian’ judgement – which maximises aggregate welfare (Greene et al., 2008). Indeed, in dilemmas where utilitarian judgement required the maiming or killing of another person, participants took longer to endorse utilitarian actions than deontological ones, and neural activity in dorsolateral prefrontal and anterior cingulate cortices, (areas associated with controlled processing) correlated with utilitarian moral judgement. This was taken as evidence for the involvement of effortful

cognition in utilitarian judgement, both in these extreme scenarios and more broadly (Greene et al., 2001, 2004, 2008).

However data from patient studies would appear to pose a problem for Greene's model. Populations with TBI (Martins et al., 2012), circumscribed ventromedial prefrontal cortex (VMPFC) lesions (Ciaramelli et al., 2007; Koenigs et al., 2007), fronto-temporal dementia (Mendez et al., 2005) and psychopathy (Koenigs et al., 2012) all show utilitarian bias compared to healthy controls in moral dilemmas, which appears incongruent with the view that these judgements require careful and controlled moral processing. One explanation for this apparent discrepancy is that impaired empathy and socio-emotional processing in these patients underlies utilitarian judgements, by attenuating an instinctual aversion to harming others. Indeed, although in healthy controls a strong skin conductance response (SCR) precedes utilitarian judgements, no such SCR is present when patients with VMPFC lesions make identical judgements (Moretto et al., 2010). Further, in healthy participants, reduced aversion to harming others (Cushman et al., 2012), lower trait empathy (Choe & Min, 2011), and higher psychoticism (characterised by reduced empathy and emotional blunting; Weich et al., 2013) all correlated with increased levels of utilitarian judgement.

Taken together then, on the evidence presented thus far, some authors have suggested a link between impaired socio-emotional processes and utilitarian judgements in both clinical and non-clinical populations, and that this link may arise because a diminished aversion to harming others makes utilitarian solutions to moral dilemmas more appealing (Ciaramelli et al., 2007; Koenigs et al., 2007). However this is not an undisputed claim.

Another difficulty for the two systems theory is that only extreme moral dilemmas have been employed to test it, where utilitarian judgements required the violation of highly regarded deontological rules, such as *do not kill*. These extreme dilemmas represent only one instance in which utilitarian and deontological principles compete, and other more realistic dilemmas might involve deontological rules that are not considered so absolute (e.g. *do not lie*). As such, the observed association between controlled processing and utilitarian judgement could be due to deontological judgements being more intuitive in the set of dilemmas employed (Kahane et al.,

2011). This possibility has *prima facie* appeal; judgements which endorse murder in the service of aggregate welfare might be highly counterintuitive, whereas judgements which only require a lie or a broken promise may be more immediately compelling.

For this reason then, Kahane and colleagues (2011) devised new dilemmas which captured the tension between maximising utility and adherence to a wide range of deontological rules, whilst concurrently measuring intuitiveness. They collected normative data for these dilemmas; recording the non-reflective judgements of a group of independent judges and assigning dilemmas to one of two categories. A dilemma was categorised as *Intuitively Utilitarian (UI)* when most judges intuitively violated the moral rule in order to maximise aggregate welfare. For example:

“You know a man called Fred. Fred is a prejudiced and grumpy person who often takes a disliking to people for no good reason. You also have a friend who admires Fred and gives great weight to his opinions. However, Fred despises your friend. One day, your friend asks you what Fred thinks of him. Your friend would be devastated to discover that Fred despises him, but will only find out if you tell him. Should you tell your friend that Fred despises him?” [Adapted from original]

In this case, normative data indicates that people are intuitively drawn to disregard the deontological rule “do not lie” in favour of the course of action which maximises utility (preserving your friend’s self-esteem) and so it was categorised as a UI dilemma. Thus, a utilitarian judgement in these dilemmas is also an “intuitive” judgement, whilst a deontological judgement is a “counterintuitive” judgement.

Conversely, dilemmas were categorised as *Intuitively Deontological (DI)* when most judges upheld the deontological rule. This category involved deontological rules which were considered more absolute, such as the impermissibility of killing. For example:

“You are a Doctor. You have five very poorly patients who are all about to die of various failing organs. You have another patient who is healthy. The only way you can save the lives of the first five patients is to remove this man’s organs, and transplant them into the five poorly patients. The healthy man does not want you to take away his organs. If you do this, the health man will die, and the five will live. Should you perform these transplants?” [Adapted from original]

The normative sample overwhelmingly rejected utilitarianism here, choosing to uphold the deontological rule despite the net harm (five deaths rather than one). As such, this was categorised as a DI dilemma. In this category then, a utilitarian judgement is a “counterintuitive” judgement, and a deontological judgement is an “intuitive” judgement (the exact inverse of the UI dilemmas, thus allowing preferences for utilitarian and deontological judgements to be measured independently of their intuitiveness).

In an fMRI study using these new stimuli (Kahane et al., 2011), the previously reported neural and behavioural association between controlled processing and utilitarian judgements disappeared. Healthy participants rated counterintuitive judgements as more difficult than intuitive judgements, but did not rate utilitarian judgements as more difficult than deontological ones. Furthermore, the intuitiveness of the judgement was predictive of robust patterns of neural activation. During intuitive judgements, activation was recorded in the visual, premotor, and orbitofrontal cortices, and the temporal lobe; areas which have been associated with visual imagery (Lambert et al., 2004; O’Craven & Kinwisher, 2000), empathy (Nummenmaa et al., 2008) and emotional perspective taking (Lamm et al., 2007). During counterintuitive judgements, activation was recorded in the rostral and dorsal cingulate cortex, primary and secondary somatosensory cortex, insula, ventro-lateral prefrontal cortex, and lateral orbitofrontal cortex, irrespective of the (deontological/utilitarian) content of the judgement. In light of these findings, the authors suggested a possible role for socio-emotional processes in directing attention towards salient aspects of moral dilemmas during intuitive judgement. The

authors concluded that previous findings associating utilitarian judgement with controlled processing were an artefact of the limited dilemmas employed, and that controlled processes are in fact simply employed by neurologically normal people in order to facilitate the selection of any counterintuitive moral judgement, regardless of its content (though see Paxton et al., 2013).

The evidence suggests then that the intuitiveness of a judgement, rather than its content, is the key factor in controlled versus automatic processing, and thus there is reason to doubt reports of utilitarian bias in frontal injury (Ciaramelli et al., 2007; Koenigs et al., 2007; Martins et al., 2012), as these studies employed a limited range of extreme dilemmas which did not control for intuitiveness. To date, no study has investigated the effect of brain pathology on both content and intuitiveness in moral judgement, and therefore their relative importance in explaining atypical moral judgement patterns is unknown. In order to address this issue, the present study employed a cross-sectional case-control design in which participants with TBI and healthy controls gave their moral judgements on dilemmas devised by Kahane and colleagues (2011), and completed a range of cognitive and social cognitive assessments.

If brain injury involving frontal dysfunction causes a *specific* bias towards utilitarianism, then TBI participants should make more utilitarian judgements compared to controls, regardless of intuitiveness. Such a finding would suggest that the content (utilitarian/deontological) of moral judgement is relevant to the processes of automatic and controlled moral judgement, and would support, and extend previous findings to less extreme dilemmas involving lying and breaking promises.

However, if intuitiveness is the crucial factor, TBI participants should make more utilitarian judgements than controls only in DI dilemmas, *where utilitarianism is counterintuitive*. This would indicate that the neural structures impacted by TBI are not sensitive to the content of a judgement *per se*, but instead its intuitiveness.

In dilemmas where the utilitarian option is *intuitive*, it remains unclear whether TBI participants would show a preference for counterintuitive judgements. One possibility is that TBI causes a preference for counterintuitive judgements only in extreme (DI) dilemmas where

serious physical harm is at stake. Alternatively, TBI may result in a general tendency to make counterintuitive judgements, irrespective of dilemma type.

Finally, if reduced aversion to harm underlies counterintuitive judgement following frontal injury, then the TBI group should be able to make these judgements with relative ease. As such, we expect TBI participants to show a reduced difficulty cost for counterintuitive responses compared to controls, within both UI and DI dilemmas. In addition, if socio-emotional processes underlie moral judgement disturbance following TBI, then affective aspects of Theory of Mind (ToM) should be associated with counterintuitive moral judgement.

Method

Participants

Thirty adults (5 female; mean age = 41.3 (SD = 13.67)) with non-penetrating TBI were recruited via NHS community neuropsychology services, Brain Injury Rehabilitation Trust inpatient and community services and the Headway charity across England. Inclusion criteria were: (1) history of TBI, (2) at least 12 months post-injury, (3) fluent in English. Exclusion criteria were: (1) significant visual, perceptual or language impairment, (2) TBI incurred before 18 years, (3) other neurological disorder, (4) current major depressive disorder, PTSD or psychosis, (5) developmental disorder.

TBI severity was categorised according to available information on post-traumatic amnesia (PTA) duration, length of unconsciousness (LOC) and lowest Glasgow Coma Scale (GCS; Jones, 1979) score, in that order of preference. Table 1 displays cut-offs for injury severity categorisation and the number of TBI participants in each category.

Thirty healthy controls (11 female; mean age = 39.8 (SD = 14.56)) were recruited to match the demographic of TBI participants. Exclusion criteria were: (1) neurological disorder, (2) current major depressive disorder, PTSD or psychosis, (3) developmental disorder. All participants gave informed consent and the study was approved by an NHS research ethics committee, in accordance with the Declaration of Helsinki (1991).

Table 1. Classification of severity by Post-Traumatic Amnesia Duration (PTA), Length of loss of consciousness (LOC) and Glasgow Coma Scale (GCS), and number of participants (n) in each group

Severity classification	PTA	LOC	GCS	n
Mild	< 1 hour	<15 minutes	13 - 15	1
Moderate	1 hour - 24 hours	15 minutes - 6 hours	9 - 12	3
Severe	24 hours - 7 days	6 hours - 48 hours	3 - 8	8
Very severe	> 7 days	> 48 hours		18

Table 2. Demographic, clinical and cognitive characteristics of TBI and control groups

	TBI Group (N = 30) M (SD)	Control Group (N = 30) M (SD)	<i>t</i>	<i>p</i>
Age	41.3 (13.67)	39.8 (14.56)	0.402	.689
Years post-injury	9.3 (9.83)	N/A		
HADS Depression	4.3 (3.67)	3.5 (4.35)	0.770	.445
HADS Anxiety	6.0 (3.84)	6.2 (5.05)	-0.144	.886
HADS Total	10.2 (7.01)	9.7 (8.97)	0.273	.786
VIQ	100.8 (19.17)	113.2 (12.47)	-2.954	.005**
PIQ	101.5 (17.21)	113.8 (21.11)	-2.487	.016*
FSIQ	101.3 (18.07)	117.5 (11.13)	-4.190	.000***

* $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$

The TBI and control groups were comparable in terms of gender [$\chi^2(2, 60) = 3.068, p = .080$] and level of education [$U = 404.5, z = -0.706, p = .480$]. The groups did not differ significantly in age or the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) scores, but differed significantly in verbal (VIQ), performance (PIQ) and full scale (FSIQ) intellectual ability as measured by the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) (see Table 2).

Materials and procedure

Ten of the eighteen dilemmas from Kahane et al (2011) were adapted for the study. These were selected to encompass the range of deontological rules involved in the originals, comprising five UI and five DI dilemmas. The dilemmas were rearranged into storyboards and cartoon drawings were created to aid comprehension (see Appendix O). In a piloting exercise, two groups (total $n = 18$) of independent judges gave their *non-reflective* responses to the original or the adapted dilemmas. On average, judges placed each dilemma in its originally

assigned category 77% of the time (range = 67% - 100%) (see Appendix N), and as such all ten of the adapted dilemmas retained their original categorisation based on previously employed cut-off of 67% agreement (Kahane et al., 2011).

Dilemmas were presented to participants first, in a fixed randomized order on laminated paper. The experimenter read the dilemmas aloud once, before inviting participants to make a judgement on what they *should* do. Participants were then asked to rate the difficulty of each judgement on a 1 (*not difficult at all*) to 10 (*very difficult*) scale. Answers to each dilemma were recorded and subsequently categorised (intuitive/counterintuitive; utilitarian/deontological).

A perspective taking task (Tversky & Hard, 2009) was administered second. Participants were shown a photograph and asked to give the spatial location of an object, where the answer differed depending on whether participants took their own or another's visual perspective. This was taken as a measure of spontaneous perspective taking (an automatic process relevant to ToM computation).

The WASI (Wechsler, 1999) was then administered, after which participants were offered a short break.

The Faux Pas test was administered next (FP; Stone, Baron-Cohen & Knight, 1998), which measures the ability to identify a social *faux pas*, and represent both the beliefs, intentions (cognitive ToM) and feelings (affective ToM) of characters involved.

The Reading the Mind in the Eyes test (RME; Baron-Cohen et al., 2001) followed, which measured affective ToM by asking participants to ascribe an emotional experience to actors in 36 images of eyes, choosing one of four adjectives.

Finally, participants completed the HADS (Zigmond & Snaith, 1983).

Data Analysis

Within Group Analyses.

Moral judgement data was transformed into proportions for each participant. Proportions of intuitive and counterintuitive moral judgement were analysed separately for UI and DI dilemmas using one-sample t-tests, reporting 95% CI's. Preference for utilitarian versus

deontological judgements were analysed similarly, pooled across all dilemmas. Mean proportions were tested against a value of 0.5; the value expected if participants showed no preference for either option during moral judgement. Paired-samples t-tests were used to compare difficulty ratings between intuitive and counterintuitive judgements in both UI and DI dilemmas, and between utilitarian and deontological judgements in all dilemmas.

Between Group Analyses.

One way mixed ANOVA analysed differences between groups and dilemma type (UI/DI) in proportion of counterintuitive judgements. Dilemmas were then pooled across dilemma type and group differences in counterintuitive judgement were investigated using independent samples t-tests with 95% CI's. Group differences in utilitarian judgement were analysed similarly. As this data was proportional, the sum of intuitive and counterintuitive judgements (and utilitarian and deontological judgements) for each participant was 1.0.

The difficulty cost of selecting the counterintuitive response over the intuitive response, and the utilitarian response over the deontological response, was calculated by subtracting the latter from the former for each case. These were computed because both utilitarian judgements and counterintuitive judgements should theoretically be more difficult than their opposites, according to the positions of Greene and colleagues (2008) and Kahane and colleagues (2011). A one way mixed ANOVA was used to analyse the differences between groups and dilemma type in the difficulty cost of counterintuitive judgements. Again, all dilemmas were then pooled and group differences investigated using independent samples t-tests.

Social Cognition Analyses.

Independent samples t-tests were employed to test for group differences on ToM and IQ variables and Pearson's correlation coefficients were calculated for the whole sample between moral judgement and cognitive variables. BCa 95% CI's are reported.

For the TBI group, ToM variables were entered into a hierarchical multiple regression model, with proportion of counterintuitive responses as the dependent variable. Bootstrapped-p-

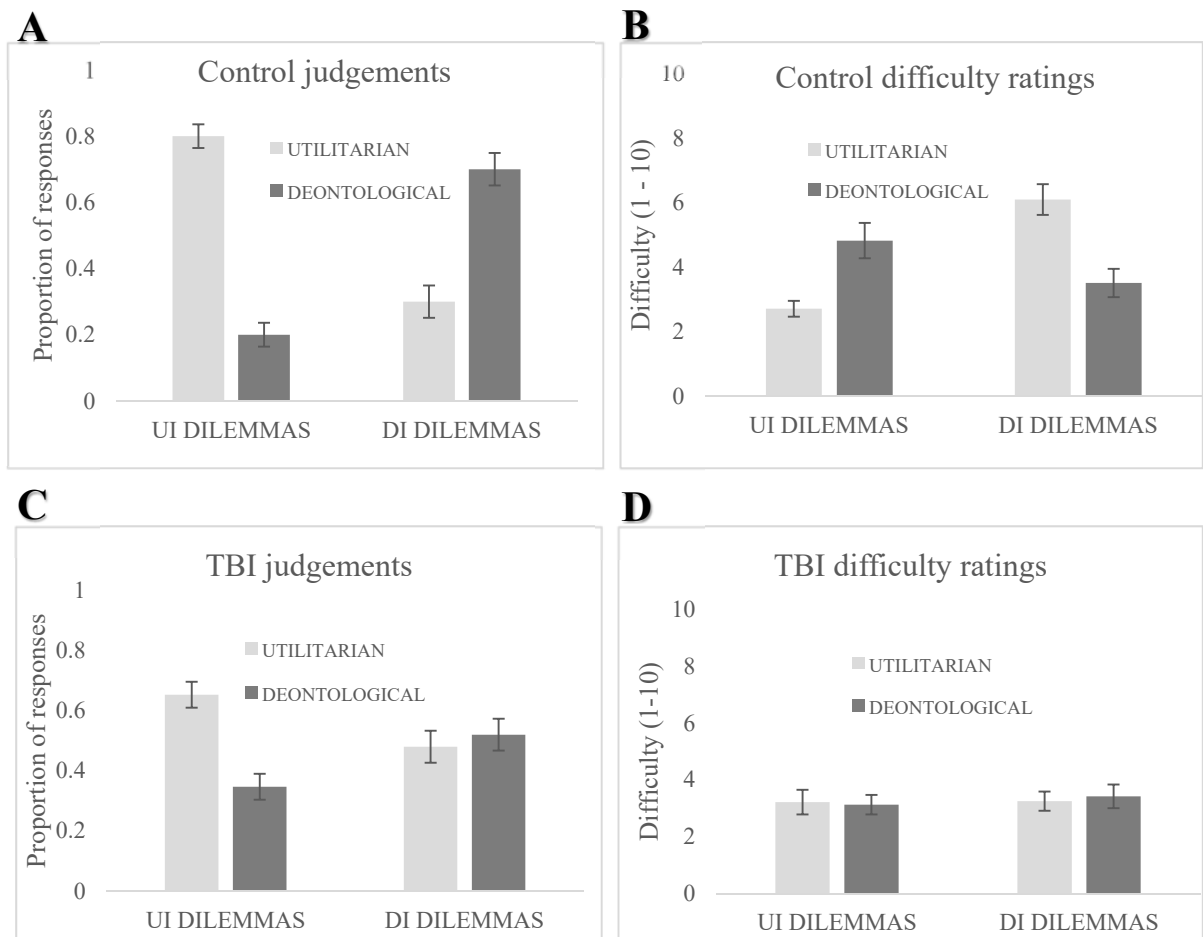


Figure 1. Judgement and difficulty rating data for TBI and controls individually. (A) Average proportion of utilitarian and deontological responses in the control group, in dilemmas where the utilitarian option is intuitive (UI) and where the deontological option is intuitive (DI). (B) Average difficulty ratings of utilitarian and deontological responses in the control group, in UI and DI dilemmas. (C) Average proportion of utilitarian and deontological responses in the TBI group, in UI and DI dilemmas. (D) Average difficulty ratings of utilitarian and deontological responses in the TBI group, in UI and DI dilemmas. Error bars are standard error of the mean.

values were computed. Affective ToM variables (Faux Pas empathy and RME) were entered at step one, and the cognitive ToM variable (Faux Pas cognitive index) at step two.

Results

Within Group Analyses

Control group moral judgements.

The proportion of intuitive judgements was significantly higher than the 0.5 baseline in both UI [$t(29) = 8.361, p < .001, 95\% \text{ CI } (.227, .373)$] and DI [$t(29) = 4.110, p < .001, 95\% \text{ CI } (.101, .300)$] dilemmas (see Figure 1A). The control group showed no significant preference for utilitarian (or deontological) judgements when all dilemmas were pooled together and

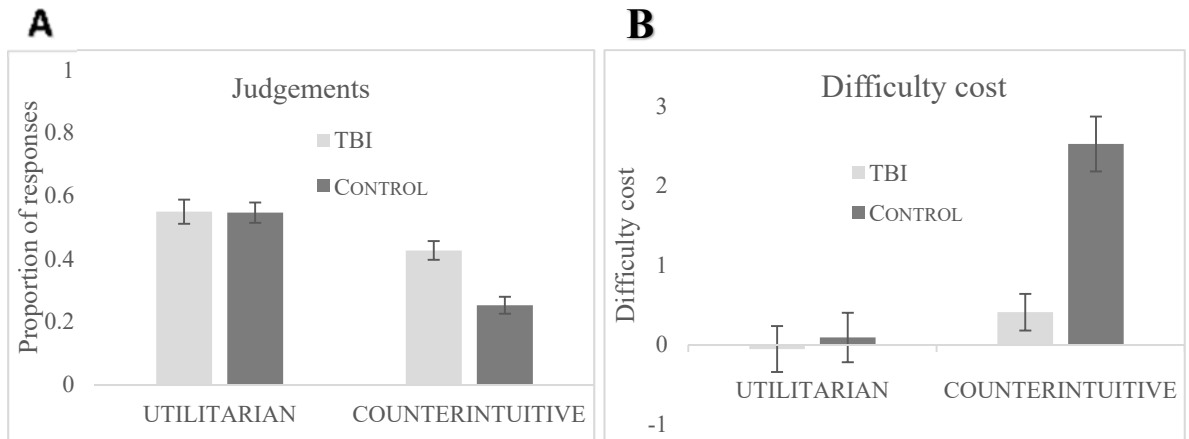


Figure 2. Judgement and difficulty rating data in control and TBI groups. (A) Average proportions of utilitarian and counterintuitive judgements in TBI and controls, across all dilemmas. (B) Average difficulty cost of counterintuitive judgements (over intuitive judgements) and utilitarian judgements (over deontological judgements) separately for TBI and control groups. Error bars are standard error of the mean.

compared against the 0.5 baseline [$t(29) = 1.455, p = .156, 95\% \text{ CI } (-.019, .112)$].

Control group difficulty ratings.

Controls rated counterintuitive judgements as significantly more difficult than intuitive judgements in both UI [$t(19) = -3.931, p = .001, 95\% \text{ CI } (-3.24, -.988)$] and DI [$t(20) = -3.839, p = .001, 95\% \text{ CI } (-3.987, -1.179)$] dilemmas (see Figure 1 B). However difficulty ratings did not differ significantly between utilitarian and deontological judgements overall [$t(29) = 0.300, p = .766, 95\% \text{ CI } (.543, .730)$].

TBI group moral judgements.

The proportion of intuitive judgements was significantly higher than the 0.5 baseline in UI [$t(29) = 3.137, p = .004, 95\% \text{ CI } (.044, .209)$], but not DI [$t(29) = 0.377, p = .709, 95\% \text{ CI } (-.089, .129)$] dilemmas (see Figure 1C). The TBI group showed no significant preference for utilitarian (or deontological) judgements when all dilemmas were pooled and compared against the 0.5 baseline [$t(29) = 1.306, p = .202, 95\% \text{ CI } (-.028, .128)$].

TBI group difficulty ratings.

In the TBI group there was no significant difference in the difficulty ratings of intuitive versus counterintuitive judgements in UI [$t(26) = 0.232, p = .818, 95\% \text{ CI } (-.703, .882)$] or DI [$t(26) = 0.419, p = .679, 95\% \text{ CI } (-.669, 1.010)$] dilemmas (see Figure 1D). Additionally,

difficulty ratings did not differ significantly between utilitarian and deontological judgements overall [$t(29) = -0.180, p = .858, 95\% \text{ CI } (-.644, .539)$].

Between Group Analyses

Moral judgements.

There was a main effect of group on the proportions of counterintuitive judgements [$F(1, 58) = 19.484, p < .001$], with more counterintuitive judgements in the TBI group, and a main effect of dilemma type [$F(1, 58) = 4.362, p = .041$], with more counterintuitive judgements in DI dilemmas. There was no significant group x dilemma type interaction [$F(1, 58) = 0.005, p = .947$].

Group comparisons pooled across both dilemma types (see Figure 2A) indicated that overall the TBI group made a significantly higher proportion of counterintuitive judgements than controls [$t(58) = 4.331, p < .001, 95\% \text{ CI } (.093, .253)$], but the two groups did not differ significantly in their preference for utilitarian judgements [$t(58) = 0.067, p = .947, 95\% \text{ CI } (-.097, .103)$].

Difficulty cost data.

There was a main effect of group on the difficulty cost of counterintuitive judgements, with the control group exhibiting higher difficulty costs [$F(1, 33) = 27.065, p < .001$]. There was no significant effect of dilemma type [$F(1, 33) = 0.364, p = .550$] and no significant group x dilemma type interaction [$F(1, 33) = 0.154, p = .697$].

Group comparisons pooled across dilemma type revealed that the control and TBI groups differed significantly in the difficulty cost exhibited when they selected the counterintuitive response [$t(55) = -5.132, p < .001, 95\% \text{ CI } (-2.938, -1.288)$], with the control group exhibiting a higher mean difficulty cost than the TBI group (see Figure 2B). TBI and control groups did not differ significantly in the difficulty cost associated with utilitarian judgements [$t(58) = -0.342, p = .733, 95\% \text{ CI } (-.996, .705)$].

Table 3. *Pearson product moment correlations between moral judgement variables and cognitive and social cognitive variables in the whole sample*

		Proportion of utilitarian responses	Cost of Utilitarian response	Proportion of Counterintuitive responses	Cost of Counterintuitive response
WASI Verbal IQ	r	.104	.069	-.329*	.269*
	p	.441	.609	.013	.043
	BCa 95% CI	-.134,.367	-.123,.281	-.533,-.042	.056,.451
WASI Performance IQ	r	-.097	.099	-.359**	.154
	p	.474	.463	.006	.251
	BCa 95% CI	-.279,.119	-.109,.358	-.654,-.125	-.128,.483
WASI Full Scale IQ	r	.057	.143	-.482***	.320*
	p	.674	.29	.000	.015
	BCa 95% CI	-.175,.300	-.048,.345	-.636,-.293	.101,.505
Faux Pas Intentions Score	r	.086	.208	-.357**	.198
	p	.526	.121	.006	.139
	BCa 95% CI	-.122,.259	-.077,.444	-.536,-.151	.013,.407
Faux Pas Belief Score	r	.026	.214	-.379**	.26
	p	.845	.11	.004	.051
	BCa 95% CI	-.250,.313	-.117,.486	-.579,-.135	.015,.474
RME	r	-.056	.321*	-.266*	.303*
	p	.676	.015	.046	.022
	BCa 95% CI	-.319,.230	.096,.527	-.465,-.049	.119,.468

* $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$. BCa bootstrap 95% CI's reported

Social cognition.

The TBI group attained significantly lower scores than controls on cognitive [$t(33.61) = -3.465, p = .004, \text{BCa } 95\% \text{ CI } (-.112, -.031)$] and affective [$t(30.31) = -3.360, p = .012, \text{BCa } 95\% \text{ CI } (-.193, -.051)$] Faux Pas indices, and the RME [$t(58) = -2.097, p = .035, \text{BCa } 95\% \text{ CI } (-.136, -.011)$]. There were no significant group differences in the tendency toward spontaneous perspective taking [$X^2(2, 60) = 0.084, p = .959$]. As such no further analyses of this measure were conducted.

Moral judgement and Social Cognition

Whole sample.

Neither the proportion of utilitarian judgements nor the difficulty cost associated with utilitarian decisions significantly correlated with any ToM or IQ variables. However all IQ and ToM variables showed significant, generally moderate, correlations with the proportion of counterintuitive judgements (see Table 3).

TBI group.

The first model in the regression equation, containing affective ToM variables, significantly predicted 20.6% of the variance [$F(2, 27) = 3.492, p = .045$]. In this model, only the RME contributed uniquely to prediction of counterintuitive judgements ($\beta = -.520, p = .022$). The second model, containing both cognitive and affective ToM variables, accounted for only 3.6% of additional variance in counterintuitive judgements (R^2 change = .036) and did not attain statistical significance [$F(3, 26) = 2.755, p = .063$].

Discussion

Previous research has demonstrated atypical moral judgement following frontal pathology of multiple aetiologies (Ciaramelli et al., 2007; Koenigs et al., 2007; Martins et al., 2012; Mendez et al., 2005), although how best to interpret the data was unclear. The present study adapted a range of dilemmas from previous research (Kahane et al., 2011), which allowed the intuitiveness of moral judgement to be controlled for, and applied these new dilemmas to participants with TBI involving the frontal lobes, for the first time.

Characterising Moral Judgement in TBI

Overall, our TBI participants made similar proportions of utilitarian judgements to controls - but they made substantially more counterintuitive judgements. On closer analysis, our TBI group did in fact show an atypical preference for utilitarian judgements under limited circumstances; disproportionately selecting utilitarian judgements in extreme moral dilemmas where the utilitarian option was counterintuitive (i.e. DI dilemmas similar to those used in previous research). However in more everyday dilemmas where utilitarianism was intuitive (i.e.

UI dilemmas), our TBI participants were *less* likely than controls to endorse the utilitarian option, again favouring the counterintuitive (and incidentally, deontological) response. On this evidence then, TBI causes a generalised bias toward the counterintuitive option, not a specific bias towards utilitarianism.

These findings support the hypothesis that the distributed neural systems impacted by TBI are not sensitive to the content of a judgement, but instead its psychological intuitiveness. They speak directly against the assertion that TBI causes atypically utilitarian judgement (Martins et al., 2012), and cast doubt more broadly on the generalisability of similar conclusions in other frontal neurological populations (Ciaramelli et al., 2007; Koenigs et al., 2007; Mendez et al., 2005). Such studies may have been biased by the limited range of dilemmas they employed; our TBI participants made more counterintuitive judgements regardless of utilitarian or deontological content. Previous research has focussed exclusively on extreme dilemmas where a utilitarian response was counterintuitive – as a consequence counterintuitive judgements were able to masquerade as a tendency towards utilitarian judgements.

The generalised pattern of counterintuitive judgements reported here deviates somewhat from recent evidence that higher levels of psychoticism correlates selectively with increased levels of counterintuitive utilitarian judgements, but not counterintuitive deontological judgements (Weich et al., 2013). However, in the present study, 87% of the TBI group had suffered a severe or very severe TBI. Injuries of this type are known to cause extensive cortical and subcortical pathophysiology resulting in chronic and severe disturbances in social cognition, judgement and decision making, and a host of supportive cognitive functions (Cicerone & Tanenbaum, 1997; Lezak et al., 2012; Newcombe et al., 2011; Mathias & Wheaton, 2007). Given this level of impairment, it is perhaps unsurprising that judgement disturbances were apparent across extreme and more everyday moral dilemmas.

Moral Judgement and Social Cognition in TBI

As illustrated in Figure 2B, neither group demonstrated a significant difficulty cost when selecting the utilitarian response over the deontological response, supporting previous findings that utilitarian judgements are not more difficult than deontological judgements (Kahane et al.,

2011). Our controls exhibited a substantial difficulty cost when making counterintuitive judgements over intuitive judgements, but the TBI group showed a complete absence of this effect, indicating that they arrived at these counterintuitive judgements with ease relative to controls. This data supports the hypothesis that a strongly attenuated aversion to harm underlies counterintuitive judgements following TBI.

This is consistent with neuroimaging and behavioural evidence which implicates socio-emotional processes in moral judgement (Greene et al., 2001; Avramova & Inbar, 2013). It is striking that our TBI group were able to make counterintuitive judgements in complete absence of a difficulty cost, and this concurs with evidence that VMPFC patients showed a total absence of SCR when making counterintuitive utilitarian judgements involving highly aversive emotional content (Moretto et al., 2010). This pattern persisted across both DI and UI dilemmas, indicating that aversion to harm is relevant across the spectrum of moral dilemmas. Indeed, although harms were more extreme in DI dilemmas, UI dilemmas still involved significant harms, where negative outcomes included serious social consequences such as the breakdown of a friend's marriage. Nonetheless, the use of objective physiological measures of affect would be beneficial in evaluating this theory in future research.

In our whole sample, affective and cognitive ToM correlated moderately with proportion of counterintuitive judgements. General intelligence was however the strongest correlate, indicating that some aspects of this construct may be relevant to moral judgement. Finally, affective ToM, as measured by the RME, captured significant variance in counterintuitive judgements after TBI, but the Faux Pas test failed to add significant predictive value to the regression model. These findings also provide general support for the involvement of emotional processes and harm aversion in counterintuitive moral judgement following TBI.

Finally, the combined observations that TBI results in a bias toward counterintuitive moral judgement, and that these judgements tend to be arrived at with relatively little effort, may go some way to explaining the clinical and familial observations that TBI survivors are often impulsive in their decision making and make judgements that are hard for others to understand (Bechara & Van Der Linden, 2005). Indeed, when TBI participants responded in a

counterintuitive way, our data indicates that they did so *as though the judgement had come to them intuitively*. This is likely to be disconcerting to others and could certainly contribute to post-injury social and communication difficulties.

Conclusion

Our study presents behavioural evidence that intuitive and counterintuitive moral judgements are perturbed in TBI, but utilitarian judgements are not. This evidence is in accordance with recent neuroimaging data (Kahane et al., 2011) and indicates that the neural systems involved in moral judgement are sensitive to the properties of psychologically generated intuitions, but not to the tensions between competing normative philosophical doctrines. Our difficulty rating and social cognition data further suggests that atypical moral judgement in TBI is attributable, at least in part, to an impaired ability to mentalize about the emotional experiences of others, and ultimately an absence of emotional aversion to harming others.

These disturbances in moral judgement held across a wide range of dilemmas, including extreme ‘killing’ scenarios which are unlikely to ever occur to a person, as well as more ‘everyday’ dilemmas regarding marital infidelity, stealing and conflict resolution. It is likely that investigation of these everyday dilemmas will show the most promise in enhancing the clinical impact of this research, which has been identified as an objective for the area (Rosas & Koenigs, 2014).

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Part Three: Appendices

Appendix A – Submission Guidelines for *Brain and Language*

Introduction

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Item	Barbey et al., 2013	Channon et al., 2005	Coelho, 2002	Douglas, 2010	Galetto et al., 2013	Hartley & Jenson, 1991	Hinchliffe et al., 1998	Lê et al., 2014; Mozeiko et al., 2011	Leblanc et al., 2014	Marini et al., 2011	Marini et al., 2014	Martin & McDonaki, 2005	Matsuoka et al., 2012	McDonaki et al., 2015	McDonaki & Flanagan, 2004	McDonaki et al., 2014	Muller et al., 2010	Schmitter-Edgecombe & Bales, 2005	Snow et al., 1998	Struchen et al., 2008	Youse & Coelho, 2005		
are relevant concepts appropriately defined?	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1
Is the hypothesis / aim / objective of the study clearly described?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Are the main outcomes to be measured clearly described in the introduction or method section?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1
Are the characteristics of the participants included in the study clearly described?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Is the procedure clear?	0	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Are the main findings of the study clearly described?	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1
Are estimates of the random variability in the data provided for the main outcomes?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Have actual probability values been reported for the main outcomes except where the probability value is less than 0.001?	1	1	1	0	0	1	0	0	0	0	1	1	0	1	0	1	1	0	1	1	0	0	0
Does the study report all the values of all correlations computed?	1	1	1	0	1	1	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
Were the subjects asked to participate in the study representative of the entire population from which they were recruited?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Were those subjects who were prepared to participate representative of the entire population from which they were recruited?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Was an attempt made to blind those measuring the main outcomes?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Are adequate descriptive statistics provided?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
If any of the results of the study were based on "data dredging", was this made clear?	-	1	-	-	-	0	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Were the statistical tests used to assess the research questions appropriate?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Were the cognitive measures used validated?	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Were the language measures used validated?	1	1	0	0	1	0	0	0	1	0	0	1	0	1	1	1	1	0	1	1	1	0	0
Did the measures used accurately reflect the cognitive concepts they were taken as a measure of?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Quality Rating	88.2%	94.4%	82.4%	76.5%	88.2%	88.2%	66.6%	55.6%	88.2%	66.6%	88.2%	94.1%	88.2%	82.4%	94.1%	82.4%	94.1%	70.6%	76.5%	94.1%	82.4%	94.1%	94.1%
Inter-rater agreement	93.4%							85.0%			93.7%								100.0%		92.8%		

YES (1); NO (0); N/A (-)

Appendix C: Data Extraction Form

1. Author(s) / Year

2. Study Objectives (including predictors and dependent variables)

3. Participants:

i) Groups (inc. CHI / PHI)

ii) Sample Sizes:

iii) Demographic information

	Age	Gender	Injury Severity	Time post (years)
TBI				
Control				

4. Method

i) Cognitive and Language Measures employed

ii) Statistical tests

5. Results & Interpretation

i) See below for correlative data extraction

ii) Conclusions of study authors

6. Reviewer comments

Study:

Correlation Type:

Notes:

	language measure 1			language measure 2			language measure 3		
	r.	n.	p.	r.	n.	p.	r.	n.	p.
cognition measure 1	xx	xx	xx	xx	xx	xx	xx	xx	xx
cognition measure 2	xx	xx	xx	xx	xx	xx	xx	xx	xx
cognition measure 3	xx	xx	xx	xx	xx	xx	xx	xx	xx

Appendix D – Neuropsychological Measure Categorization

Declarative memory	Working memory	Attention / Processing speed	Executive functions	Social cognition
RAVLT Rey 15 wordimmediate / delayed recall	WAIS working memory index	WAIS processing speed index	WCST	Emotional IQ Test
WMS logical memory	WAIS Digit spans	SCOLP silly sentences	Verbal Fluency	Mentalising ToM task (Exp.)
WMS verbal paired associates	WMS working memory index	WAIS Digit symbol	D-KEFS complex non-mental state inferences	Second order belief reasoning
WMS immediate memory index	WMS digit spans	symbol-digit modalities test	CANTAB	TASIT (selected indices)
CVLT	WMS letter-number sequencing	SCOLP comprehension speed	BADS	Balanced emotional empathy scale
WMS associate learning			Hayling Test Script analysis test	RME IRI perspective taking index
				Faux Pas Test first and second order false belief tasks Character intention task facial affect recognition prosody recognition

Appendix E - Submission Guidelines for Social Cognitive and Affective Neuroscience

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Costa, D. C., Morgan, G. F., & Lassen, N. A., editors. (1993) *New trends in neurology and psychiatry*. London: John Libbey.

Handwerker, H. O., & Kopal, G. (1993) Psychophysiology of experimentally induced pain. *Physiology Review*, 73, 639-71.

In the text, the author's name and year of publication are given in parentheses. If there are three or more authors, the name of the first is followed by et al. References to papers 'in press' must give the name of the journal or book. Reference citations should not include 'personal communications' or other inaccessible information; information derived from personal communications or from unpublished work by the authors should be referred to in the text.

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- The sentence should begin: 'This work was supported by ...'
- The full official funding agency name should be given, i.e. 'National Institutes of Health', not 'NIH' (full RIN-approved list of UK funding agencies) Grant numbers should be given in brackets as follows: '[grant number xxxx]'
- Multiple grant numbers should be separated by a comma as follows: '[grant numbers xxxx, yyyy]'
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Appendix F – NHS Research Ethics Committee (REC) Approval; Research and Development (R&D) Approval

i. REC Approval Letter

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ii. Brain Injury Rehabilitation Trust Ethical Approval Letter

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iii. R&D Approval Letter: Hull and East Yorkshire Hospitals NHS Trust

[Removed for hard binding]

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Appendix G – Participant Information Sheet



PARTICIPANT INFORMATION SHEET

Research title: Does Theory of Mind Influence Moral Judgement following a Traumatic Brain Injury?

Name of Researcher: Dane Aaron Rowley

We would like to invite you to participate in this research on the effects of Traumatic Brain Injury.

We are looking for two groups of people for this study:

- 1. People who have had a traumatic brain injury**
- 2. People who have NOT had any type of brain injury**

What Is a *Traumatic Brain Injury*?

A traumatic brain injury is an injury caused to the brain by an outside force, or something hitting you on the head. Being in a road traffic accident, being attacked in the street, or falling from a ladder are all common ways that people might get a traumatic brain injury.

What is the purpose of the study?

After a traumatic brain injury, people sometimes find it hard to understand other people as well as they did before. They might find it difficult to think about what others might be feeling or thinking, and this can make it hard for them to get back into the swing of things with their friends and family.

Also, people who have had a traumatic brain injury can find it more difficult to distinguish between “right” and “wrong”, and sometimes get into trouble for doing things that they shouldn’t do, without realising.

These problems are related to certain areas of the brain being injured.

Researchers want to know if these two problems are linked. This research is intended to help us to find out. This will help to develop better ways of predicting who is at risk of

having these problems, and may also help doctors to develop new ways of helping people after a traumatic brain injury.

What will I be asked to do?

We will do the study in one meeting, which will take an hour and a half or less. We can arrange to meet somewhere convenient for you – perhaps at your home or somewhere close by to you.

Firstly we will talk about your medical history to make sure you can take part. If you take part, there are then 6 things you will then be asked to do:

1. Answer some questions relating to a social situation (this will be audio recorded)
2. Look at some pictures of faces and pick an emotion
3. Look at a photo and decide the location of an object
4. Look at a storyboard and make some decisions on what the person should do in different situations
5. Answer some questions about your mood at the moment
6. Do two puzzles and some general knowledge questions

There are no right and wrong answers to the situations in task 4. This is NOT a test of whether you are a good person. Different people give different answers in these situations, and this is okay.

Your rights

- You do not have to take part
- You can drop out of the study at any point without giving a reason
- You can remove your data from the study until the results are analysed
- All of your data will be kept safe and cannot be linked back to you
- You have a right to ask questions about the research before and after participating
- Participating or not participating will have no effect on your medical care

Benefits and Risks

It is hoped that this study will help us understand traumatic brain injury better, especially the issues discussed in the introduction. Participants often feel happy that they have helped with this.

There are no serious risks when participating in this study. However in the unlikely event you become upset we will stop and the researcher will offer support.

The research involves a measure of your mood, and if there are any concerns here the researcher will ensure that any professionals involved in your care will be informed.

What will happen to the results of the study?

The study will be written up and we will try to get it published in an academic journal. The study will also be presented to the services that helped in the study, and promoted as widely as possible. None of your identifiable data will be included in any of this.

If you want to hear about the results of the study then do contact the researcher, Dane Rowley, who will be happy to provide you with a written summary of the research.

Confidentiality

Your information will be kept strictly confidential – this means it will be stored privately and will only be available to the people directly involved in the research.

- We will use a code to make sure that you cannot be linked to your data
- We will not publish anything that could be linked to you
- After the research is completed all audio recordings will be destroyed

If you told the researcher something that suggests you or another person could be seriously harmed, the researcher would have to tell someone about this.

Who is funding this research?

This research is being conducted as part of a doctorate training course in Clinical Psychology at the University of Hull.

The University of Hull and Humber NHS Foundation Trust are funding this research. Data collected during the study may be audited by the supervisors of this research or the funder in order to ensure that the research was completed in an ethical manner.

Who has reviewed this research?

The Leeds West NHS research ethics committee, which is an independent organisation that protects the wellbeing of people who participate in research, has approved this research. The study has also been approved by the ethics committee of the Brain Injury Rehabilitation Trust.

Researcher contact details

Please get in touch if you would like to participate, or have any questions or concerns

Yours sincerely,

Dane Aaron Rowley
Chief investigator
Hertford Building
Department of Clinical
Psychology
University of Hull
HU6 7RX
D.A.Rowley@2013.hull.ac.uk
07846031093

Dr Tim Alexander
Research co-ordinator /
Academic Supervisor
Hertford Building
Department of Clinical
Psychology
University of Hull
HU6 7RX
T.Alexander@hull.ac.uk

Permission to be contacted

If you are interested in participating, please complete the form below and the researcher will get in touch to discuss the study with you.

Name: _____

Address:

.....
.....

.....
.....

.....
.....

.....
.....

Telephone (daytime):

.....
.....

Telephone (evening):

.....
.....

When would you like to be contacted?

.....
.....

Any further comments or preferences?

.....
.....

.....
.....

Signature: _____

Date: _____

Thanks very much for your interest!

Appendix H – Participant consent form 1

Dane Aaron Rowley
Trainee Clinical Psychologist
Department of Psychological Health & Wellbeing
Hertford Building
University of Hull
Cottingham Road
Hull
HU6 7RX

Centre Number:

Study Number:

Participant Identification Number:

CONSENT FORM 1

Title of Project: Does Theory of Mind Influence Moral Judgement following a Traumatic Brain Injury?

Name of Researcher: Dane Aaron Rowley

Please initial all boxes

1. I confirm that I have read and understand the information sheet dated **10/04/15 (version 1.2)** for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my medical care or legal rights being affected.
3. I understand that relevant sections of my medical notes and data collected during the study may be looked at by individuals from regulatory authorities or from the NHS Trust, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records.
4. I agree to part of the study being audio recorded
5. I agree to take part in the above study.

Name of Participant

Date

Signature

Name of Person taking consent

Date

Signature

Appendix I – Participant consent form 2



Dane Aaron Rowley
Trainee Clinical Psychologist
Department of Psychological Health & Wellbeing
Hertford Building
University of Hull
Cottingham Road
Hull
HU6 7RX

Centre Number:

Study Number:

Participant Identification Number:

CONSENT FORM 2

Title of Project: Does Theory of Mind Influence Moral Judgement following a Traumatic Brain Injury?

Name of Researcher: Dane Aaron Rowley

As part of the study, the researcher might need a little bit more information about you and your background. If you have had a brain injury we may need to know a little bit more about this before you can take part in the study.

There are three ways we might get this information.

- a) Talking to you
- b) Talking to people involved in your care
- c) Looking at your medical records

This form ask your permission for each. You do not have to consent to any of these.

Please initial all boxes

- 6. I give the researcher permission to talk to me
- 7. I give the researcher permission to talk to people involved in my care
- 8. I give the researcher permission to look at my medical records

Name of Participant

Date

Signature

Name of Person taking consent

Date

Signature

Appendix J – Participant demographic questionnaire

Demographic information Questionnaire

1. Date of birth: _____

2. Gender: _____

3. Educational level (tick highest attained):

- None
- GCSE / GCS / O-Level
- A-Level
- Batchelor degree
- Postgraduate degree

4. Employment (tick one):

- Employed
- Voluntary work
- Homemaker
- Unemployed

5. Is the participant taking any prescription medications? [*remind participant that answering is optional*]

6. Is the participant currently experiencing any mental health difficulties? (e.g. PTSD, Major depression or Psychosis) [*remind participant that answering is optional*]

7. Does the participant have a diagnosis of dementia, or history or presence of neurological disorder or acquired brain injury (excluding TBI)? (e.g. stroke)

8. Does the participant show signs of aphasia significant enough to interfere with ability to consent or participate?

9. Does the participant have a diagnosis of social communication disorder? (e.g. Autism-spectrum condition)

Appendix K – Participant TBI questionnaire

Traumatic brain injury information questionnaire

1. Sources of information (Tick all that apply):
 - Participant
 - Professional involved in care of participant
 - Medical records accessed via researcher

2. Has the participant sustained a traumatic brain injury? **Yes** / **No** (circle one)

(Defined as any one or more of the following):

- Any loss of consciousness
 - Any loss of memory for events immediately before or after injury
 - Any alteration in mental state (e.g. confusion, disorientation)
 - Any focal neurological signs
-

3. Age at traumatic brain injury: Months: _____
Years: _____
OR Date of traumatic brain injury: _____
4. Cause of the traumatic brain injury (e.g. road traffic accident):

5. Severity indicators:
 - a) Was the participant in a coma following the injury? **Yes** / **No** (circle one)
 - b) How long for? _____
 - c) **Glasgow Coma Scale rating:** _____
 - c) Duration of **Post-Traumatic Amnesia:** _____
 - d) Length of **Loss of Consciousness:** _____
6. What brain areas were affected by the injury? (e.g. left prefrontal / right parietal etc.)
7. What difficulties does the participant have as a result of the injury? (e.g. memory, concentration)

Appendix L – Debrief Sheet



DEBRIEFING

The experiment is over, thank you for taking part!

What happens next?

The answers you gave will now be given a data number, and no reference to your personal details will be kept with the data.

Your data will be added together with the data collected from others, and analyzed by the researchers. This will then be reported in a written document in an attempt to answer the research questions. These research questions asked:

- whether people make different types of judgments in moral dilemmas
- whether this might be partly because people find it difficult to think about what others are thinking after a brain injury

A version of this written report will be submitted for publication in an academic journal. Nothing that could identify you will be included in the study.

Will I find out about the results?

If you want to, yes. If you want us to tell you about the results of the study, please let the researcher know. We will then send you some information on what we found when the research is finished.

What if I have questions later on?

You can contact the researcher on the details below directly, or ask a member of your care team to do so (if you were not recruited through a clinical service then the latter will not apply to you).

What if I no longer want my answers to be in the study?

If you want to take your answer out of the study, please contact the researcher (details below). We can remove your answers from the study up until they are analyzed, which is likely to be early 2016.

What if I am upset after taking part in this study?

If you are upset, please let the researcher know. The researcher will be able to talk about it with you, and offer you some sources of support.

Researcher details

Dane Aaron Rowley
Clinical psychology department
Hertford building
University of Hull
d.a.rowley@2013.hull.ac.uk

SOURCES OF SUPPORT

Why have I been given this leaflet?

Everyone who participated in the research has been given this leaflet.

I feel worried or upset, where can I get help?

This leaflet contains some places where you can access support if you would like to. You can:

Speak to your GP:

If you are concerned about depression or anxiety, you can speak to your GP about it and they can talk to you about your options.

Speak to your case manager

You may not know who your GP is. If you are currently using a clinical service, you could speak to someone involved in your care such as a key worker or case manager.

What other sources of support are there?

Headway

Headway is a leading brain injury association in England. It provides advice and support for people who have suffered a brain injury, and their friends, family, and supporters.

National helpline: 0808 800 2244

Website: www.headway.org.uk

Email helpline: helpline@headway.org.uk

The Samaritans

Samaritans offers confidential support at any time of day for people who want someone to talk to, feel upset, or who might feel like hurting themselves.

Telephone: 08457 90 90 90

Email: Jo@samaritans.org

Website: www.samaritans.org

MIND

Mind is England's leading mental health charity. It offers advice and support on all mental health problems.

Website: www.mind.org.uk

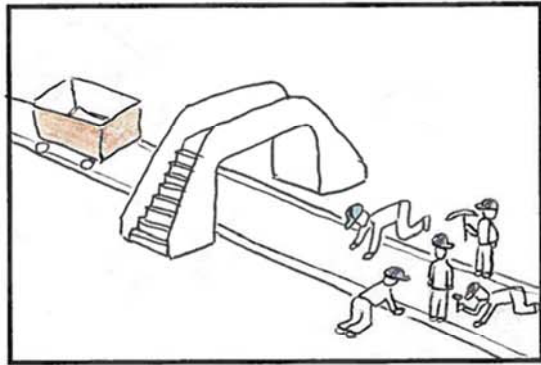
Please speak to the researcher if you have any concerns

Appendix N – Piloting response data

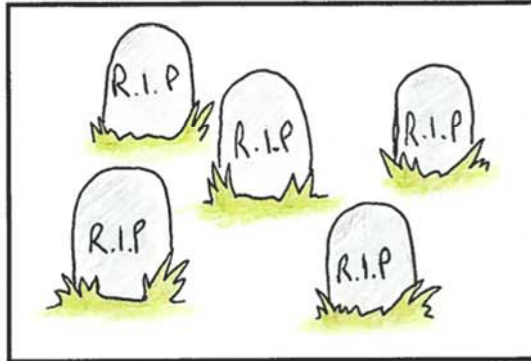
<u>Original dilemmas</u>										<u>Total intuitive responses</u>
	1	2	3	4	5	6	7	8	9	
A troublesome property	N	y	N	N	N	Y	N	N	Y	6/9
Footbridge	N	N	N	N	N	N	N	N	N	9/9
Lie 1	N	y	Y	Y	N	Y	N	N	N	5/9
mod. Preventing the disease	Y	Y	Y	Y	N	Y	N	Y	N	6/9
lie 3	N	Y	N	Y	N	N	N	Y	N	6/9
autonomy 2	Y	N	N	N	Y	N	N	Y	N	6/9
lie 5	N	Y	N	N	N	N	N	N	N	8/9
vitamins	N	Y	N	N	N	N	N	N	N	8/9
enzymes	N	Y	N	N	N	N	N	N	Y	7/9
transplant	N	N	N	N	N	N	N	N	N	9/9
<u>Illustration dilemmas</u>										
	1	2	3	4	5	6	7	8	9	
A troublesome property	N	Y	N	N	Y	N	N	N	N	7/9
Footbridge	Y	Y	N	N	N	N	N	N	N	7/9
Lie 1	N	N	N	N	Y	N	N	Y	Y	6/9
mod. Preventing the disease	Y	Y	N	N	Y	Y	Y	N	Y	6/9
lie 3	Y	Y	N	Y	N	N	N	N	N	6/9
autonomy 2	Y	N	Y	N	N	N	Y	N	N	6/9
lie 5	N	N	N	N	N	Y	N	Y	N	7/9
vitamins	N	Y	N	N	N	N	N	N	N	8/9
enzymes	N	Y	N	N	N	N	N	N	N	8/9
transplant	N	N	N	N	N	N	N	N	N	9/9

Appendix O – Adapted moral dilemmas

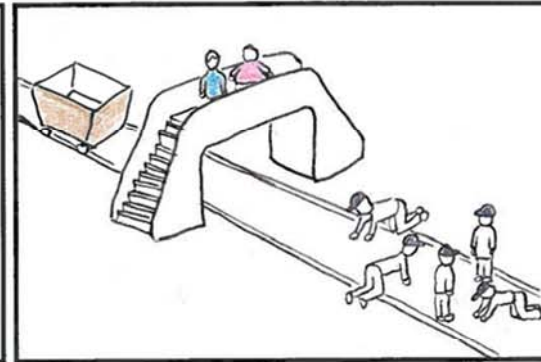
Footbridge *Version 1.1* 11/01/15



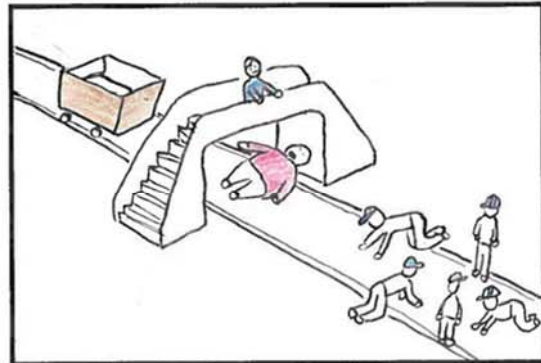
A runaway trolley is heading down the tracks toward five men who are working on the track



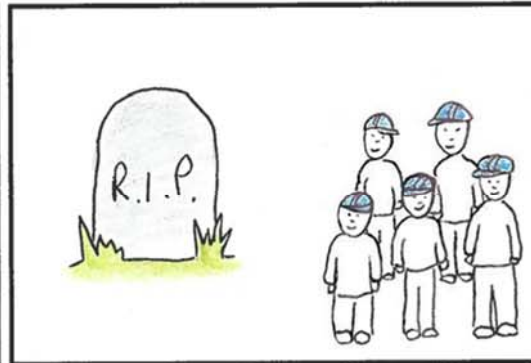
These five men will be killed if the trolley reaches them



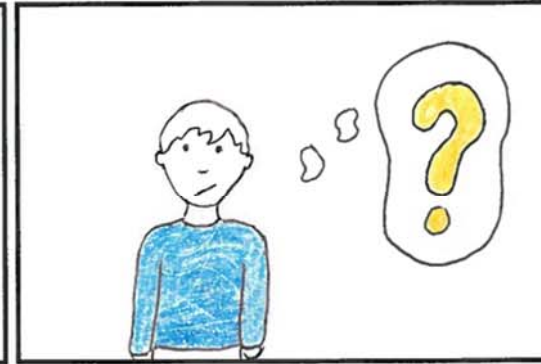
You are on a bridge over the tracks, in between the approaching trolley and the workmen, and next to you is a stranger who is very large



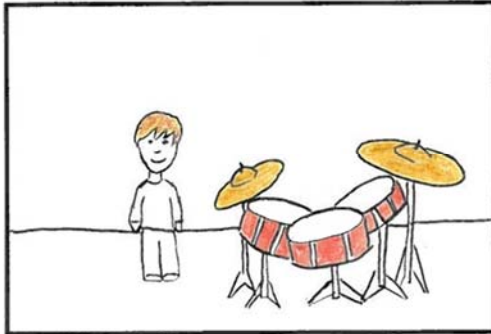
The only way to save the five workmen is to push this stranger off the bridge, so that he stops the trolley with his large body.



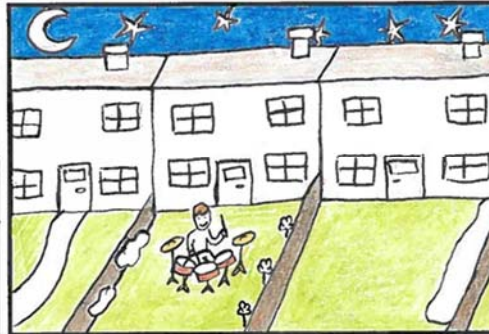
If you do this, the large man will die, but the five workmen will be saved



Should you push the man onto the tracks in order to save the five workmen?



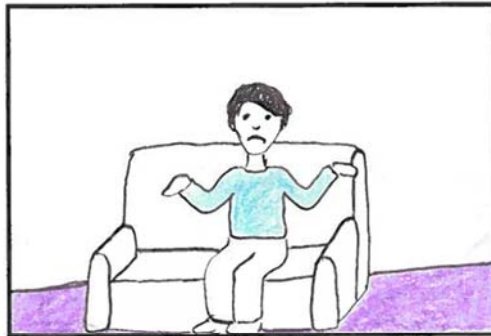
Your next door neighbour's son, Joey, enjoys playing the drums, and owns a cheap drum-kit



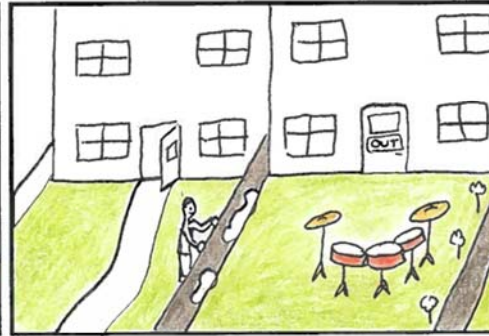
The problem is Joey plays his drum-kit loudly in his garden, even at night



This keeps you, your family, and others in the neighbourhood awake at night



You have tried reasoning with the boy and his family, but this hasn't helped. The police will not help, and life has become a real nightmare

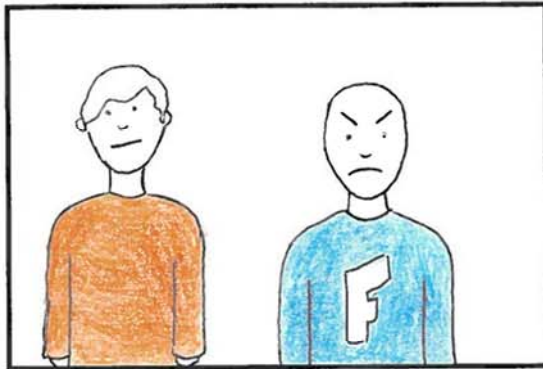


One day, you notice that your neighbours are out of the house. You could go into the garden and take the drum-kit and get rid of it somewhere.



Should you take Joey's drum-kit?

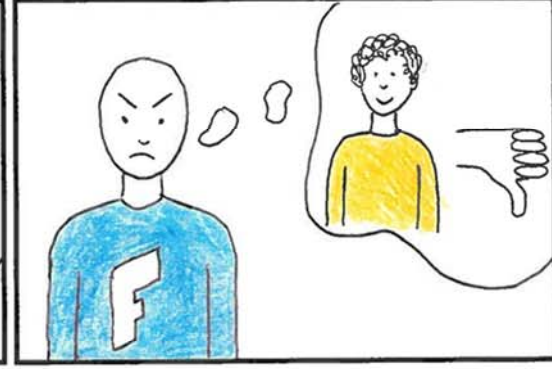
lie 1 version 1.1 11/01/15



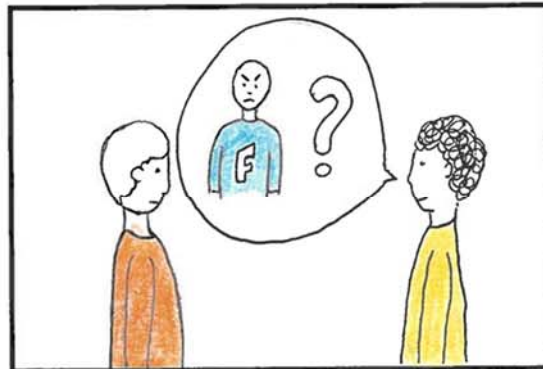
You know a man called Fred. Fred is a prejudiced, grumpy person who often takes a disliking to people for no good reason.



You also have a friend who admires Fred and gives great weight to his opinions



However, Fred despises your friend.



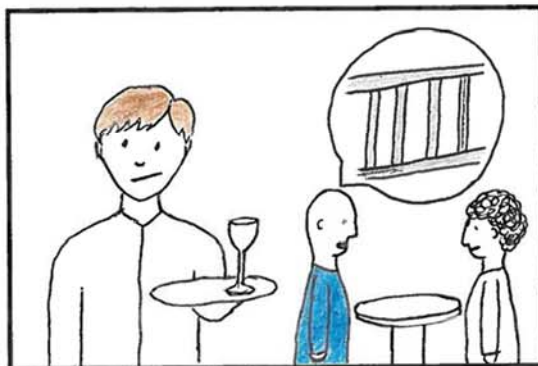
One day, your friend asks you what Fred thinks of him.



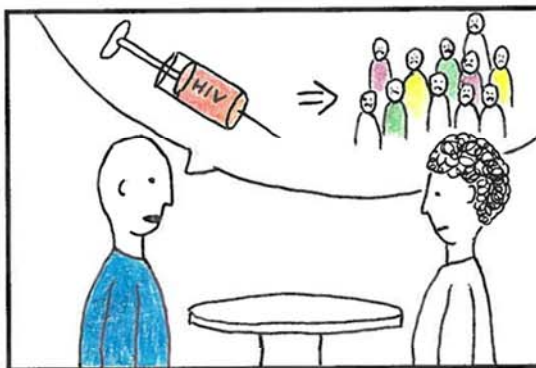
Your friend would be devastated to discover that Fred despises him, but will only find out if you tell him.



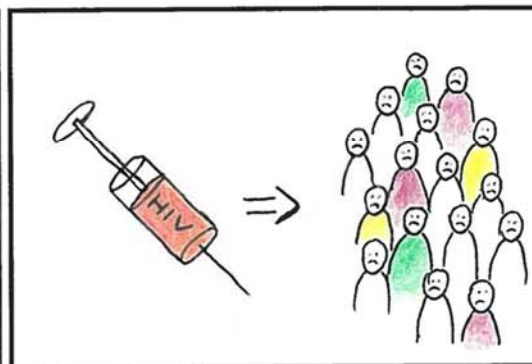
Should you tell your friend that Fred despises him?



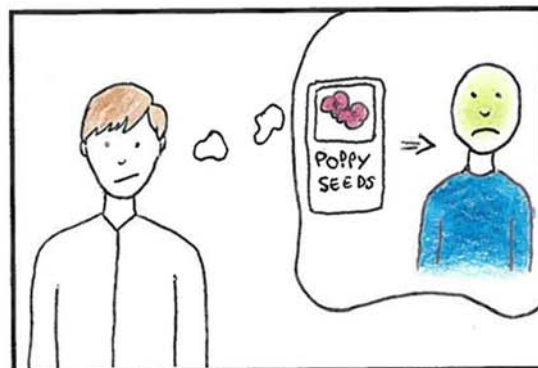
You are a waiter. You overhear one of your customers say that he is about to go to prison...



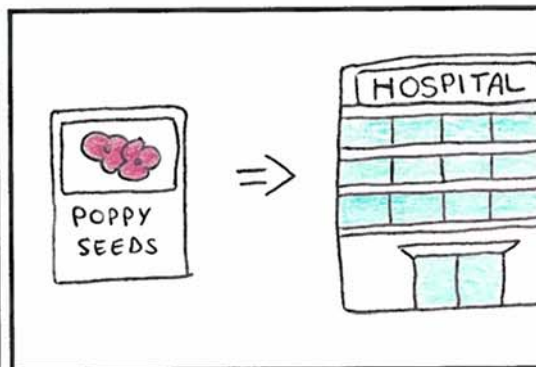
...and that in his last 48 hours of freedom he plans to intend to infect as many people as he can with HIV



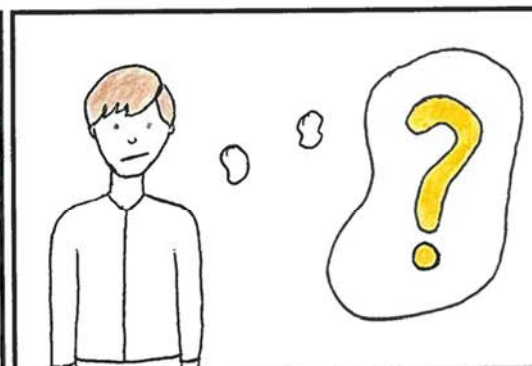
You know this man well enough to know he is telling the truth and has access to many potential victims



You also know that this man has a strong allergy to poppy seeds



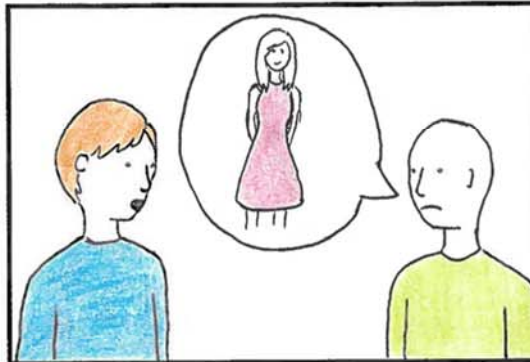
If he eats just one he will go into convulsions and have to be hospitalised for at least 48 hours



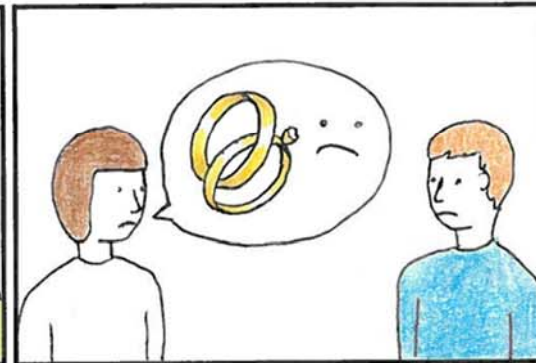
Should you cause this man to have a serious allergy attack in order to prevent him from spreading HIV?



You have a close friend called Jane.



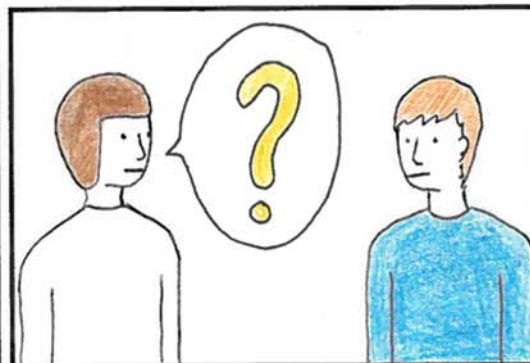
Jane's husband has told you that four years ago he had an affair with another woman, but he would never do it again as his marriage means so much to him



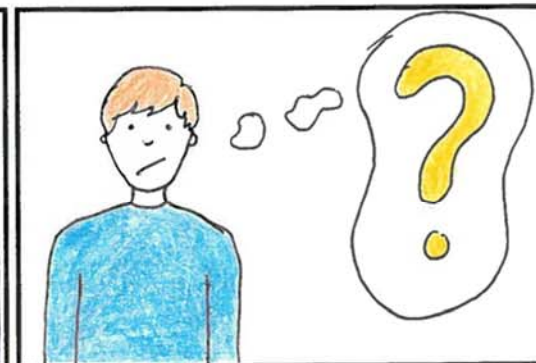
One night, Jane tells you that she has in the past been worried about her marriage



She tells you that her marriage is immensely important to her, and that if her husband was ever unfaithful it would destroy the marriage



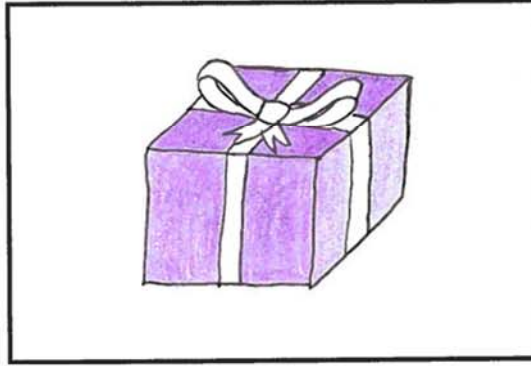
Jane asks you if you have any reason to believe that her husband has not been faithful.



Should you tell Jane that her husband had an affair?



Your friend, Jack, recently had Hepatitis, and has been told by his doctor that he must not drink alcohol again.



You have promised to buy him whatever he wants for his birthday.



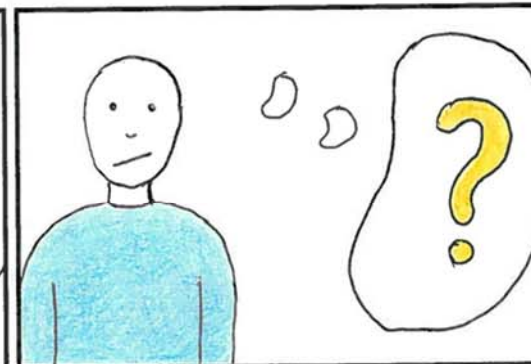
Jack insists you buy him a bottle of single-malt whiskey that you bought him years ago for being the best man at your wedding.



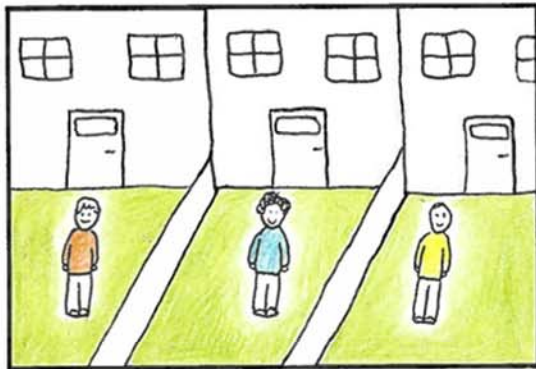
Jack will feel betrayed if you don't respect his wishes



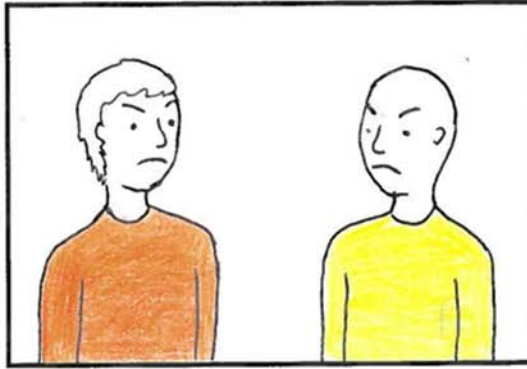
But you know that giving him almost any other present would be better for him.



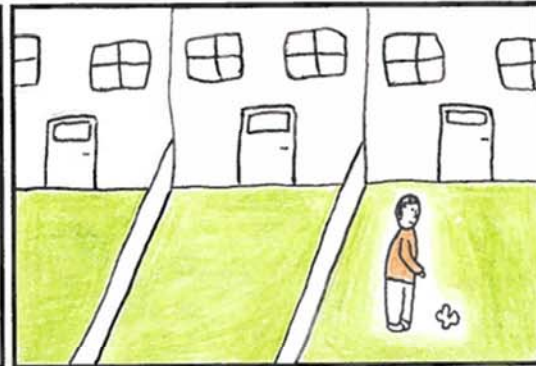
Should you buy Jack the bottle of whiskey?



You are on friendly terms with both of your neighbours, Jeff and Bob.



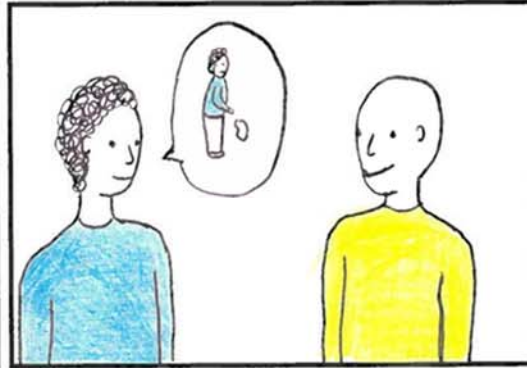
However they are both hot-headed and hate each other. Things have been becoming very tense between them recently.



Yesterday, you saw Bob carelessly drop some litter near Jeff's garden.



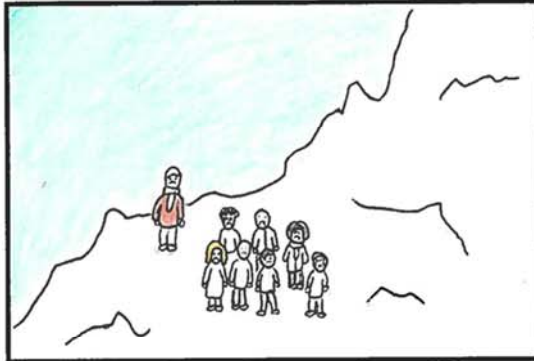
An angry Jeff has come to your house and asked if it was Bob who dropped the litter. If you tell him the truth, he will go over to Bob's house and there will be a violent fight.



However if you lie and tell Jeff that you accidentally dropped the litter, he will soon forget about the whole thing.



Should you tell him that Bob dropped the litter?



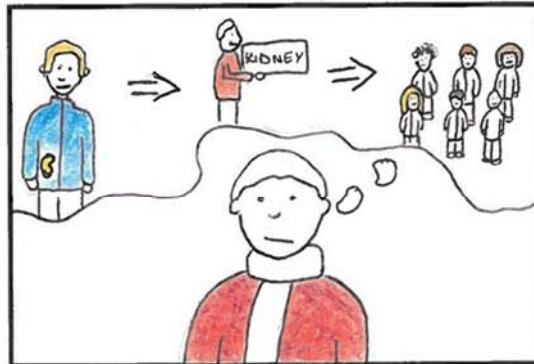
You are the leader of a mountaineering expedition that is stranded in the wilderness, waiting to be rescued



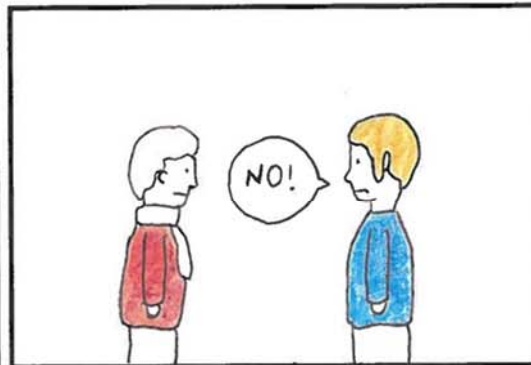
In the party is a family of six with a dangerous vitamin deficiency who will die before you are rescued if they do not get the vitamins they need



One man's kidney contains a lot of this vitamin



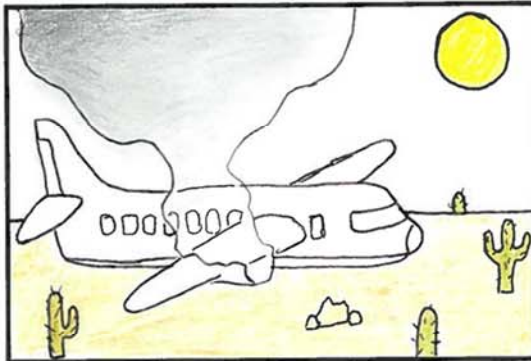
The only way to save the lives of the six people is to remove one of this man's kidneys and extract its vitamins



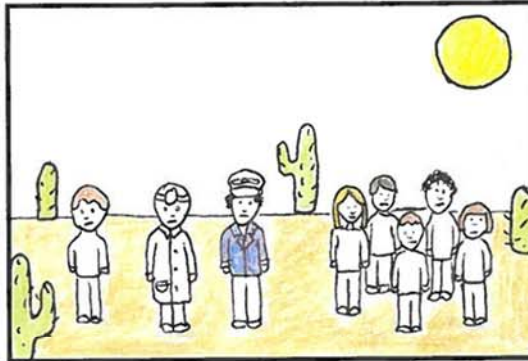
The man does not want you to take his kidney, as although it will not kill him, it will make him poorly



Should you force the man to have his kidney removed in order to save the lives of the six people?



A small plane has had to put down in the desert



You, a surgeon, and five people with a dangerous vitamin deficiency are stuck in the desert with the Pilot, but you will be rescued in two days



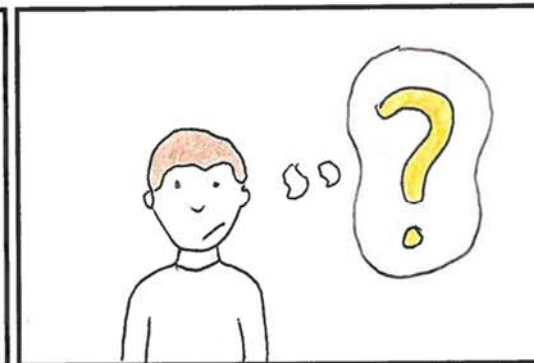
The five people with a vitamin deficiency will die before you are rescued if they do not get the vitamins they need



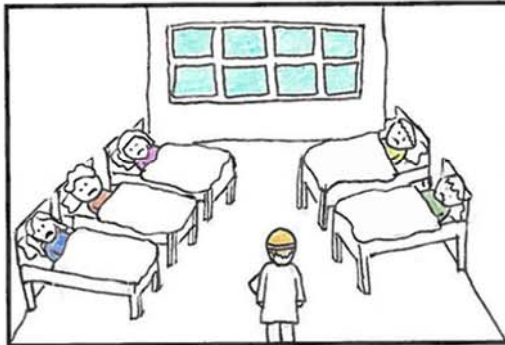
Kidneys contain lots of this vitamin. The only way to save the five people is to have the surgeon remove one of the Pilot's kidneys and extract its vitamins



The pilot does not want you to take his kidney, as although it will not kill him, it will make him poorly



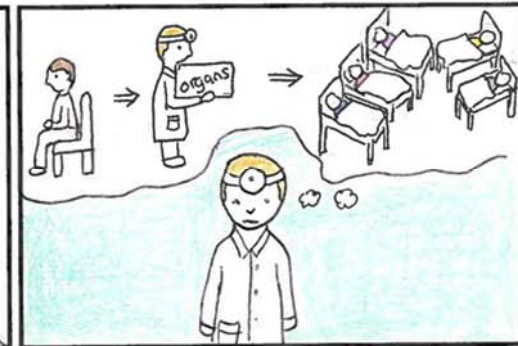
Should you force the pilot to have a kidney removed in order to save the lives of the five people?



You are a doctor. You have five very poorly patients who are about to die because of various failing organs.



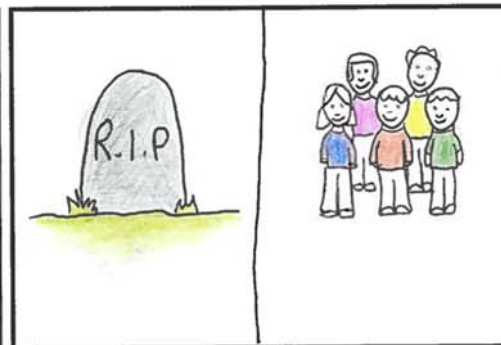
You have another patient who is healthy.



The only way you can save the lives of the first five patients is to remove this man's organs and transplant them into the five poorly patients.



The healthy man does not want you to take away his organs



If you do this, the healthy man will die, and the five will live.



Should you perform these transplants?

Appendix P - Reading the Mind in the Eyes (author introduction, instructions and example item)

For all users of the revised version of the Adult .Reading the Mind in the Eyes Test.

Enclosed you will find the adult version of the above test the word definition handout, the correct answers. A copy of the paper describing the test in full. As you know, publication details of the original version appeared in the Journal of Child Psychology and Psychiatry, 38, 813-822 (1997). The revised version which we have sent you was published in the Journal of Child Psychiatry and Psychiatry, 42, 241-252 (2001).

A child version of this test has also been developed and is available upon request. It was published in the Journal of Developmental and Learning Disorders, 5, 47-78 (2001).

We would, of course, appreciate hearing of any results you obtain with this test. Thank you.

Best wishes

Simon Baron-Cohen

Adult Eyes Instructions

For each set of eyes, choose and circle which word best describes what the person in the picture is thinking or feeling. You may feel that more than one word is applicable but please choose just one word, the word which you consider to be most suitable. Before making your choice, make sure that you have read all 4 words. You should try to do the task as quickly as possible but you will not be timed. If you really don't know what a word means you can look it up in the definition handout.

Appendix Q – Faux Pas Test (summary record form and example faux pas item)

jealous

panicked



arrogant

hateful

**Faux Pas Test
Record form**

Participant Details:

Age:

Gender:

Initials:

Recruitment site:

PIC:

Index scores:

Correct Control Questions Score (FP)

Correct Control Questions Score (C)

Faux Pas Detection Score (ratio)

Understanding Inappropriateness Score (ratio)

Intentions Score (ratio)

Belief Score (ratio)

Empathy Score (ratio)

Total Faux Pas recognition test score (ratio)

“I’m going to be reading you some brief stories and asking you some questions about them. You have a copy of the story in front of you so you can read along and go back to it.”

Story 2

Helen's husband was throwing a surprise party for her birthday. He invited Sarah, a friend of Helen's, and said, "Don't tell anyone, especially Helen." The day before the party, Helen was over at Sarah's and Sarah spilled some coffee on a new dress that was hanging over her chair.

"Oh!" said Sarah, "I was going to wear this to your party!"

"What party?" said Helen.

"Come on," said Sarah, "Let's go see if we can get the stain out."

1. Did anyone say something they shouldn't have said or something awkward?

Circle: **YES** / **NO**

If yes, ask:

2. Who said something they shouldn't have said or something awkward?

3. Why shouldn't he/she have said it or why was it awkward?

4. Why do you think he/she said it?

Always ask:

5. Did Sarah remember that the party was a surprise party?

6. How do you think Helen felt?

7. In the story, who was the surprise party for?

8. What got spilled on the dress?

Appendix R – Perspective taking task



In relation to the bottle, where has she
placed the book?

[left = her perspective; right = self-perspective]

Appendix S – Hospital Anxiety and Depression Scale

[Removed for hard binding]

Appendix T – Sample Size Calculations

t tests – Means: Difference between two independent means (two groups)

Analysis: Sensitivity: Compute required effect size

Input: Tail(s) = Two

α err prob = 0.05

Power (1–β err prob) = 0.8

Sample size group 1 = 30

Sample size group 2 = 30

Output: Noncentrality parameter δ = 2.8490482

Critical t = 2.0017175

Df = 58

Effect size d = 0.7356211

t tests – Means: Difference between two independent means (two groups)

Analysis: A priori: Compute required sample size

Input: Tail(s) = Two

Effect size d = 0.75

α err prob = 0.05

Power (1–β err prob) = 0.8

Allocation ratio N2/N1 = 1

Output: Noncentrality parameter δ = 2.8559149

Critical t = 2.0032407

Df = 56

Sample size group 1 = 29

Sample size group 2 = 29

Total sample size = 58

Actual power = 0.8014083

Exact – Correlation: Bivariate normal model

Options: exact distribution

Analysis: A priori: Compute required sample size

Input: Tail(s) = Two

Correlation ρ H1 = 0.4

α err prob = 0.0125

Power (1–β err prob) = 0.8

Correlation ρ H0 = 0

Output: Lower critical r = -0.3082007

Upper critical r = 0.3082007

Total sample size = 65

Actual power = 0.8039353

Exact – Correlation: Bivariate normal model

Options: exact distribution

Analysis: Sensitivity: Compute required effect size

Input: Tail(s) = Two

Effect direction = $r \geq \rho$

α err prob = 0.0125

Power (1–β err prob) = 0.8

Total sample size	=	60	
Correlation ρ H0	=	0	
Output:			
	Lower critical r	=	-0.3206343
	Upper critical r	=	0.3206343
	Correlation ρ H1	=	0.4134723

F tests – Linear multiple regression: Fixed model, R^2 increase

Analysis:	Sensitivity: Compute required effect size		
Input:	α err prob	=	0.05
	Power ($1-\beta$ err prob)	=	0.8
	Total sample size	=	30
	Number of tested predictors	=	2
	Total number of predictors	=	4
Output:	Noncentrality parameter λ	=	10.8886688
	Critical F	=	3.3851900
	Numerator df	=	2
	Denominator df	=	25
	Effect size f^2	=	0.3629556

t tests – Means: Difference between two independent means (two groups)

Analysis:	Sensitivity: Compute required effect size		
Input:	Tail(s)	=	Two
	α err prob	=	0.0125
	Power ($1-\beta$ err prob)	=	0.8
	Sample size group 1	=	30
	Sample size group 2	=	30
Output:	Noncentrality parameter δ	=	3.4321352
	Critical t	=	2.5779884
	Df	=	58
	Effect size d	=	0.8861735

Appendix U – Key inferential statistics

One-sample t-test of moral judgement proportions data; controls

	Test Value = 0.5					
	t	df	Sig.	Mean Diff	95% CI of the Difference	
					Lower	Upper
proportion of intuitive responses within UI dilemmas	8.361	29	.000	.30000	.2266	.3734
proportion of intuitive responses within DI dilemmas	4.110	29	.000	.20000	.1005	.2995
Proportion of utilitarian responses	1.455	29	.156	.0467	-.019	.112

Paired samples t-tests of difficulty rating data; controls

	Paired Differences					t	df	Sig.
	Mean	SD	SEM	95% CI of the Difference				
				Lower	Upper			
Pair 1 Difficulty ratings of intuitive answers on UI dilemmas - Difficulty ratings of counterintuitive answers on UI dilemmas	-2.11245	2.40296	.53732	3.23707	-.98783	3.931	19	.001
Pair 2 Difficulty ratings of Intuitive answers on DI dilemmas - Difficulty ratings of counterintuitive answers on DI dilemmas	-2.58329	3.08397	.67298	3.98709	-1.17948	3.839	20	.001

Difficulty of Utilitarian responses -								
3	.093333	1.704250	.311152	-.543044	.729711	.300	29	.766
Difficulty of Deontological Responses								

One-sample t-tests of moral judgement proportions data; TBI

	Test Value = 0.5					
	t	df	Sig.	Mean Difference	95% CI of the Difference	
					Lower	Upper
Proportion of utilitarian responses	1.306	29	.202	.0500	-.028	.128
proportion of intuitive responses within UI dilemmas	3.137	29	.004	.12667	.0441	.2093
proportion of intuitive responses within DI dilemmas	.377	29	.709	.02000	-.0885	.1285

Independent samples t-tests of difficulty rating data; TBI

Paired Samples Test								
	Paired Differences					t	df	Sig.
	Mean	SD	SEM	95% CI of the Difference				
				Lower	Upper			
Difficulty ratings of intuitive answers on UI dilemmas - Difficulty ratings of counterintuitive answers on UI dilemmas	.08944	2.00226	.38534	-.70262	.88151	.232	26	.818
Difficulty ratings of Intuitive answers on DI dilemmas - Difficulty ratings of counterintuitive answers on DI dilemmas	.17008	1.98661	.40551	-.66879	1.00895	.419	23	.679

Difficulty of Utilitarian Paired responses - Difficulty of r 3 Deontological Responses	-.052100	1.5842 73	.28924 7	-.643677	.53947 7	-.180	29	.858
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One way mixed ANOVA of moral judgement proportions data

Tests of Within-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	
Dilemma_type	Sphericity Assumed	.320	1	.320	4.362	.041
	Greenhouse-Geisser	.320	1.000	.320	4.362	.041
	Huynh-Feldt	.320	1.000	.320	4.362	.041
	Lower-bound	.320	1.000	.320	4.362	.041
Dilemma_type * Group	Sphericity Assumed	.000	1	.000	.005	.947
	Greenhouse-Geisser	.000	1.000	.000	.005	.947
	Huynh-Feldt	.000	1.000	.000	.005	.947
	Lower-bound	.000	1.000	.000	.005	.947
Error(Dilemma_type)	Sphericity Assumed	4.259	58	.073		
	Greenhouse-Geisser	4.259	58.000	.073		
	Huynh-Feldt	4.259	58.000	.073		
	Lower-bound	4.259	58.000	.073		

Tests of Within-Subjects Contrasts

Source	Dilemma_type	Type III	df	Mean Sq	F	Sig.
	e	SoS's				
Dilemma_type	Linear	.320	1	.320	4.362	.041
Dilemma_type *	Linear	.000	1	.000	.005	.947
Group						
Error(Dilemma_type)	Linear	4.259	58	.073		

One way mixed ANOVA of difficulty cost data

Tests of Within-Subjects Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Dilemma_type	Sphericity Assumed	2.771	1	2.771	.364	.550
	Greenhouse-Geisser	2.771	1.000	2.771	.364	.550
	Huynh-Feldt	2.771	1.000	2.771	.364	.550
	Lower-bound	2.771	1.000	2.771	.364	.550
Dilemma_type * Group	Sphericity Assumed	1.172	1	1.172	.154	.697
	Greenhouse-Geisser	1.172	1.000	1.172	.154	.697
	Huynh-Feldt	1.172	1.000	1.172	.154	.697
	Lower-bound	1.172	1.000	1.172	.154	.697
Error(Dilemma_type)	Sphericity Assumed	250.978	33	7.605		
	Greenhouse-Geisser	250.978	33.000	7.605		
	Huynh-Feldt	250.978	33.000	7.605		
	Lower-bound	250.978	33.000	7.605		

Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	90.495	1	90.495	19.644	.000
Group	124.682	1	124.682	27.065	.000
Error	152.024	33	4.607		

Independent samples t-tests across all dilemmas; moral judgement proportions data and difficulty cost data

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	95% Confidence Interval of the Difference	
							Lower	Upper
Proportion of utilitarian responses	Equal variances assumed	1.096	.300	.067	58	.947	-.0966	.1033
	Equal variances not assumed			.067	56.271	.947	-.0967	.1034
Proportion of Counterintuitive responses	Equal variances assumed	.005	.942	4.331	58	.000	.0932	.2534
	Equal variances not assumed			4.331	57.544	.000	.0932	.2535
Cost of Counterintuitive response	Equal variances assumed	3.557	.065	-5.132	55	.000	-2.937958	-1.287749
	Equal variances not assumed			-5.098	47.316	.000	-2.946468	-1.279239
Cost of Utilitarian response	Equal variances assumed	.488	.488	-.342	58	.733	-.995821	.704954
	Equal variances not assumed			-.342	57.694	.733	-.995917	.705050

Independent samples t-tests of group differences in social cognition measures

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	95% Confidence Interval of the Difference	
							Lower	Upper
Faux Pas combined beliefs & Intentions	Equal variances assumed	27.755	.000	-3.465	58	.001	-.10908	-.02919
	Equal variances not assumed			-3.465	33.610	.001	-.10970	-.02856
Faux Pas Empathy Score	Equal variances assumed	29.024	.000	-3.360	58	.001	-.182820	-.046313
	Equal variances not assumed			-3.360	30.305	.002	-.184173	-.044960
Reading the mind in the eyes proportion correct	Equal variances assumed	.584	.448	-2.097	58	.040	-.143024	-.003309
	Equal variances not assumed			-2.097	57.522	.040	-.143036	-.003297

Hierarchical multiple regression model for proportion of counterintuitive judgement and social cognition measures; TBI group

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.453 ^a	.206	.147	.1494	.206	3.492	2	27	.045
2	.491 ^b	.241	.154	.1488	.036	1.223	1	26	.279

a. Predictors: (Constant), Reading the mind in the eyes proportion correct, Faux Pas Empathy Score

b. Predictors: (Constant), Reading the mind in the eyes proportion correct, Faux Pas Empathy Score, Faux Pas combined beliefs & Intentions

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.156	2	.078	3.492	.045 ^b
	Residual	.603	27	.022		
	Total	.759	29			
2	Regression	.183	3	.061	2.755	.063 ^c
	Residual	.576	26	.022		
	Total	.759	29			

a. Dependent Variable: Proportion of Counterintuitive responses

b. Predictors: (Constant), Reading the mind in the eyes proportion correct, Faux Pas Empathy Score

c. Predictors: (Constant), Reading the mind in the eyes proportion correct, Faux Pas Empathy Score, Faux Pas combined beliefs & Intentions

Appendix V - Epistemological statement

Theories in clinical psychology are often grand, overarching and able to encompass entire sets of extremely complex phenomena. We offer, as a profession, answers to fundamental questions regarding the nature of the human condition, and arguably we sell ourselves as the healers of the modern day. But are our explanations empirically satisfying?

In centuries gone by, the scholars of the day had comprehensive answers to a whole range of physical observations. Objects fell to the ground and steam rose to the sky because of the opposing forces of *sympathy* and *antipathy* (Lehoux, 2012). Given hundreds of years of development in the physical sciences, we now have more satisfying answers, involving *base* causal mechanisms. But what would have happened if the investigators of the time had given up, thrown their hands in the air and proclaimed that *there is no right answer*? I believe that it would be profoundly unfortunate if, faced with challenges of almost unintelligible complexity, clinical psychology were to give up on empiricism so early on.

The study of moral judgement in particular provides a rich focal point for epistemic controversy. There has been debate for centuries over the nature of morality, with positions ranging from morality as an innate and universal biological endowment (Hauser, 2004), a socially constructed and infinitely malleable societal product (Wong, 1991), or a set of rules designed by the ruling class for purposes of controlling the proletariat (Wood, 1991).

In this context then, it is important to state the epistemological stance of this empirical project explicitly. The research within these pages takes a positivist view; that some statements are more true than others, and that we can come closer to knowing the truth (defined as the real state of things) by the diligent application of the scientific method. Having had substantial exposure to postmodernist thought during the course of this degree, I have come across no convincing reason that this modest statement cannot apply to observations involving moral judgement, language, or cognitive processes. I agree with Shackel (2005) that postmodern thought as applied to the sciences often conflates the truth with *our beliefs* about the truth, and has little of importance to say about the former.

The empirical project reported here thus aims to contribute to the development of a *descriptive* account of moral judgements. I am fascinated by the human ability to pick out morally relevant information from an infinitely large array of data, process this information, and arrive at moral judgements, often intuitively and without any conscious deliberation. This is doubtlessly an empirical issue rather than a normative one; as Hume taught, you cannot derive an “*ought*” from an “*is*” (Hume, 1739; 1978).

Chomsky (1957) famously revolutionised the field of linguistics with the idea that human language is a biological endowment that functions according to a limited set of principles. Chomsky’s insight was that despite apparently infinite cross-cultural variation, the deep syntactical structure of language remains invariant across all languages. Once this was accepted, the task for linguists became to understand this underlying structure, and thus understand the nature and limitations of the human language system. One influential theory in the psychology of morality employs an analogy with language. If we accept the assertion that humans are endowed with a *universal moral grammar* (Hauser, 2004) in the same way that we are equipped to develop language, then the task becomes to explicate the nature of this grammar; its laws, limitations, and neural correlates.

It is this foundational epistemological assertion on which my empirical paper rests. Our moral judgements may be “socially constructed” in the sense that they are developed, maintained, adjusted and communicated within a social structure, but if they are a product of a biological system, they must logically conform to certain limits set by that system.

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Appendix W - Reflective statement

Choice of project

It was my undergraduate dissertation at Hull University that gave me my first experience of developing a novel research project in psychology, during which I elected to undertake a quantitative investigation of visual perspective taking. My overwhelming impression was that the departmental culture in which I conducted this project highly valued technical investigation and controlled experimental procedures. Fascinating research was being conducted on the cognitive and neural bases of our ability to understand other minds, and the development of this uniquely human trait. These research areas appeared to bite at the heels of intractable philosophical difficulties (e.g. Gallese & Sinigaglia, 2011); as an enthusiastic novice, I was fascinated.

In an epistemic sense, the geographically short relocation across campus to the clinical psychology department was then a substantial one. My dawning sense was that the culture was different here; gone were the technical debates and controversies relating to *the truth of the matter*, replaced by an incorrigible commitment to individual experience. Armed with optimism and encouraged by wise introductory words from our former Course Director (*“treat everything during these three years as a learning experience”*), I put aside my bemusement and climbed aboard for a short time.

My choice of thesis topic was made suddenly and amid encouragement to undertake a qualitative project. Nonetheless, on hearing about the possibility of investigating morality in traumatic brain injury from Dr Miles Rogish, my mind was instantaneously made up. To this day I am not entirely certain as to why this project provoked such certainty in me (I am generally not well known for decisiveness). Perhaps I was already missing the technical aspects of research, but more so I think it was the philosophical nature of the topic area which really excited me. I have a keen interest in philosophy, particularly with regards to language and mind, and the topic offered me an opportunity to investigate some of these issues in a clinical context.

Project design

The design of my experimental paper was a protracted and at times agonizing process. I consistently wrote research proposals that substantially exceeded the recommended word counts and took hours of research to put together coherently. Looking back now, I don't know where I found the energy for this. Gathering and synthesising this dense literature from scratch was necessary for me to arrive at some relevant research questions for my first two proposals, and was undoubtedly spurred on by a mixture of enthusiasm for the possibilities of the eventual project, but also a dull sense of anxiety and desire to "prove" myself as able to conceptualise of it. Following countless hours of agonising work, and my second research proposal, I happened by chance upon a paper (Kahane, 2011) which fundamentally challenged the conceptual basis on which my thinking had so far been built. One of the authors of this paper encouraged me to employ their own measure, which was undoubtedly a sound suggestion but essentially meant rewriting the entire research design and including another variable (moral intuition) into an already conceptually difficult area. I got to work and produced a 10,000 word fourth research proposal, to the veritable dismay of my supervisors. Although this was a dense, rambling document, twice the length of the eventual manuscript, every word felt vital, which perhaps reflects my state of mind at the time.

Throughout the early stages of this work I had a persistent sense that the project would not be seen as clinically relevant enough, and that research into *moral* judgement might be seen as an attempted condemnation of the moral fibre of people with traumatic brain injury (TBI). I was at times full of doubt in the project, and convinced myself that it was "too academic", and would not get past the early proposal stages. Almost my entire cohort were undertaking qualitative research, adding to this deep sense that I was erring from the acceptable. Supervision was crucial here and I raised this issue several times. The response from my supervisors was reassuring; Miles Rogish spoke eloquently about the nature of the social (including moral) judgement disturbances he sees clinically after TBI, and the extent of the social isolation that these can cause. This reassured me partially at the time, but it wasn't until I had the opportunity to experience these clinical issues first hand some time later that I came to truly appreciate Miles' remarks, and the clinical importance of this area.

The service user input that I sought in relation to the project also helped to ease my concerns to some extent regarding this issue. I approached the local Headway group for input regarding the project and the suitability of all of the materials I intended to administer with participants. Aside from getting great feedback on issues with these materials which I had not considered (making them more accessible and easily comprehensible), the Headway response to my project was overwhelmingly positive. When I explained that the project was on changes in moral judgement and emotional processes I received a multitude of comments that they had experienced changes in exactly those areas, or witnessed them in their loved ones.

Nonetheless, it is crucial to emphasise the point touched upon in the epistemological statement of this thesis. The empirical paper within these pages aims only to contribute to an account of how humans make moral judgements. At no point are any claims made about the rightness or wrongness of particular moral judgements or viewpoints; to do this would be to engage in philosophy, not psychology. Counterintuitive moral judgements are not wrong, they are only counterintuitive.

As it stands now, I am exceptionally proud of the empirical paper within these pages and very pleased that I stuck with it despite my doubts. I do not believe that we need to carry out applied research in order to satisfy the “clinical relevance” requirement; basic research has contributed enormously towards medical and societal advances (Executive Board of the International Council for Science, 2004) and this paper has clear relevance to the development of empirical theory regarding judgement disturbances in TBI.

A key question during the design of the study related to which measures of social cognition to employ, and relatedly, which aspects of social cognition we expected would be related to moral judgement. Supervision helped enormously here, as the literature did not speak to this issue, especially as we were in uncharted territory, investigating a new aspect of moral judgement. We decided to use a social cognition battery that covered all bases – automatic, controlled, affective and cognitive.

Another issue related to the precise details of the inclusion criteria. Again due to my inexperience I had very little workable idea of the numbers of participants I might be able to expect from each recruitment site. My power calculations demanded 30 TBI participants, but in those early stages this number meant little to me. This issue has been a consistent source of anxiety; I heard whispers that TBI populations are “notoriously” difficult to recruit and I knew that two previous trainees had fallen victim to this fact.

Nevertheless, amid my boundless optimism during the early stages I pushed for a strict inclusion protocol; recruiting only from clinical services (thus excluding headway participants) and requiring neuroimaging material to support diagnosis (which I also wanted to use for analysis to address lesion-symptom research questions). Miles kindly rained on my bonfire in this instance; a characteristic act of realism for which I am eternally grateful. Should I have had my way with those inclusion criteria the project reported within these pages would likely have been a case study.

Reflecting on this now I realise how critically important it is to have access to experienced supervisors when undertaking research, and to keep in mind at all times the issue of feasibility. I have a tendency to be keen to take on large projects out of enthusiasm for the possibilities of the end product, only to struggle with the realities of the undertaking. Happily with use of supervision, although there were no doubt struggles, this project turned out to be a feasible undertaking and I was able to bring it in on time.

Data collection

It was during the data collection phase where I experienced some of the worst and best parts of the research. It involved an inordinate amount of travelling, often to distant locations to Headway meetings and clinical services in order to recruit participants into the study. Throughout the process I was almost constantly anxious about the prospect of not reaching “my number”, which drove me to fill almost every free space in my diary from August to December 2015. Evenings and weekends existed for the sole purpose of work during those three months, and in the depths of despair I tacked a note to the wall above my desk imploring me to “keep

digging!'. Looking back now, I could have spared myself this special kind of hell and carried the process out over a period of six months rather than three. I am well aware that my inability to tolerate uncertainty drove me to this extreme solution, but I am glad that I took this approach nonetheless as it bought me plenty of time for write-up and ridded me of the anxiety which had been building up as the project progressed.

Despite my woes, I experienced some of the most profound moments of my doctorate during the data collection period. Meeting with people in the context of a research study carries a qualitatively different atmosphere to clinical appointments. Entering a person's world (or a family unit) as a researcher is emancipating; it allows conversations to develop which are not based on the implication that I will be able to take what is said and use it for purposes of intervention. The fact that I was able to simply listen to these stories, tragic and heroic, made them all the more powerful. As a result of these experiences, I have come to believe that our emphasis on technical skill and neutrality in clinical practice can serve as barriers to truly empathising with others.

Analysis and write-up

The analysis and write-up of my empirical paper was the stage which I had eagerly anticipated throughout the conception and execution of the project. I have raised countless sets of eyebrows with my expressed enthusiasm for SPSS and the process of writing. I love the challenge, the precise nature of the work, and the unparalleled sense of achievement when a polished manuscript is finally ready.

Data analysis revealed a beautiful dataset, which allowed some substantive conclusions to be drawn in relation to the research questions, and further indicated that some high profile publications might have drawn erroneous conclusions. This undoubtedly increased the sense of pressure to do the study justice and give it the best possible chance of publication.

My rambling research proposals were useful to the extent that they provided a comprehensive resource for almost every reference I needed, but given the strict word limit of my chosen journal, I needed to substantially rethink the way I had presented my ideas. In the

end almost no content was suitable to be transferred directly from the proposal to the final manuscript.

On the whole the write-up was, as predicted, a pleasant experience. However it was doubtlessly an arduous process at times; redrafting would make the content clearer and easier to follow, but invariable led to further flouting of the word limit, so further redrafting was required, and so on. The requirement to adhere to the 5000 word limit challenged me to concision in a way that I have never experienced before, and the redrafting process has doubtlessly benefitted my writing style enormously. Under Kevin Riggs' exacting supervision, this process has taught me that even when you think it is good, it can be better.

Systematic Literature Review (SLR)

Received wisdom is that the SLR is a piece of work equal in size to the empirical paper. Although this may be true in relation to word count, scientific value and rigour, it was certainly not true in terms of the work hours required.

I arrived at the choice of topic for this piece of work following clinical observations of one particular patient during my work in a brain injury rehabilitation hospital. Although this person showed no evidence of frank aphasia, his communication was significantly impaired, apparently as a result of his memory and/or executive impairments. However the literature here appeared very disjointed and there was little solid evidence on which to draw for formulation purposes, regarding the likely contributions of his cognitive difficulties to communicative impairment.

Although I was enthusiastic about the topic of my SLR, it more than once languished near to bottom of my things to do list and on top of my empirical project I must admit to occasionally viewing its mere existence with outright contempt. I began to work on it when hold ups inevitably occurred in my empirical paper, and as such it was put together over a much more protracted period, with long gaps occurring during which I would lose track of what needed doing next. This way of working was not particularly comfortable for me and does not compliment my tendency to work solely on one project until it is complete. I never really felt immersed in the process of the SLR as I did with the empirical paper, and I wonder what would

be different about the finished manuscript had I been able to devote more time exclusively to it. Nonetheless I think that the finished piece of work was “good enough”, and I realise now, perhaps for the first time, that I am able to complete projects to this standard without having to obsess absolutely over them.

Final thoughts

This project represents a rare constant through my clinical training. My clinical interests, epistemic world view and ambitions have changed drastically since I embarked on this course three years ago, but this research has not. During the darkest of hours, it was this project that provided me with a reason to continue the training when none could be found elsewhere. Although I am uncertain as to what the future holds, I await my next opportunity to conduct research of this sort with great anticipation.

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