Implicit Relational Assessment Procedure (IRAP): An Examination of the Impact of Response Options Theoretically Deemed as Contextual Relations versus Relational Coherence Indicators

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Declaration

I, the undersigned, hereby certify that this material, which I now submit in fulfilment of a M.Sc. degree, has not been previously submitted as an exercise for a degree at this or any other University, and is, unless otherwise stated, entirely my own work.

Signed:_____

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Abstract

The aims of the current research programme were to investigate the use of different response options (e.g., contextually cued relational responding (C_{rels}) or relational coherence indicators (RCIs)) in the implicit relational assessment procedure (IRAP). In each of the four studies, participants (total N=124) completed two Pleasant-Unpleasant IRAPs in varying order and Consistent relations ('Pleasant-Positive') were contrasted with Inconsistent relations ('Unpleasant-Positive'). Study 1 (N=40) employed the response options "Same"/"Opposite" (C_{rels}) versus "Accurate"/ "Inaccurate" (RCIs). The results of both IRAPs in this study indicated an 'IRAP effect' (bias) favouring 'Consistent' verbal relations, as expected. There was a statistically significant difference when data from both IRAPs were compared, indicating an effect for type of response option used. That is, the overall D-IRAP score for the C_{rel}-IRAP was significantly greater than that of the RCI-IRAP. A significant interaction effect between the type of response option employed, order of congruent/incongruent blocks, and order of completion was also revealed.

Study 2 (N=40) was similar to Study 1 except that the RCI response options employed on this occasion were "Right"/"Wrong". Results revealed that responding across both IRAPs was mediated by a congruent bias and that there was a significant difference between participant data for the two IRAPs, with the C_{rel}-IRAP producing a greater overall D-IRAP score. The sole difference between Study 3 (N=24) and the preceding studies, was the use of "True"/"False" as RCI response options. Again, the results indicated that responding was mediated by a congruent bias in both IRAPs. The findings also revealed that the overall D-IRAP score of the C_{rel}-IRAP was significantly greater than that of the RCI-IRAP. Given the findings in studies 1, 2, and 3, in which there was a significant between the two IRAPs, Study 4 (N=20) attempted to clarify if completing two immediately successive IRAPs would in

itself impact participant data. To this end, the response options were held constant across both IRAPs on this study (i.e. both used C_{rel} response options; "Same"/ "Opposite"). Participant data in both IRAPs showed an IRAP effect which was 'consistent' with natural verbal relations. There was no significant difference between participant data from both IRAPs and analyses did not indicate that completing two successive IRAPs in one sitting impacted participant data.

Taken overall, these exploratory research studies provide support for the effect of type of response options used on IRAP outcomes, and tentatively corroborate the proposal that RCIs may have a distinct function from C_{rels} under certain circumstances.

Chapter 1

General Introduction

General Introduction

Relational Frame Theory (RFT; Hayes, Barnes-Holmes, & Roche, 2001) is a modern

behavioural approach to human learning, language and cognition. The theory primarily rests

on the assumption that relational responding and derived stimulus relations are the

fundamental elements of the human ability to communicate and of higher-cognitive

functioning. A cornerstone in the development of RFT was Sidman's (1971) research in

relational responding, derived stimulus relations and stimulus equivalence. He found that

with continued reinforcement of interrelated conditional discriminations (e.g., B is the same

as A and C is the same A), human participants commonly derive unanticipated yet

predictable stimulus relations, such as B is the same as C and C is same as B, without any

explicit feedback or instructions to that effect. That is, participants derived the B-C relations

based on learned B-A and C-A relations. When taught an A-B relation, humans derive a B-A

relation untaught. Sidman (1971) referred to this form of relation as one of symmetry.

Similarly, taught relations such as B-A and A-C result in derived B-C/C-B relations. Sidman

described this as transitive relations. These concepts were then extended in RFT to

accommodate increased levels of complexity among relational responses. With this in mind,

RFT proposes that all derived stimulus relations share the properties of mutual entailment,

combinatorial entailment and the transformation of stimulus functions (Hayes, Barnes, &

Roche, 2001).

Like the concept of symmetry, mutual entailment refers to the deduction that is made

when participants are taught that A is the same as B and then reason that B must also be the

same as A. However, unlike symmetry, relations need not be symmetrical to be mutually

entailed. For instance, if a person is taught that A is better than B, they can surmise that B is

worse than A. Therefore, symmetry, as devised by Sidman, can be viewed as a subtype of

mutual entailment based on similarity. Whereas, mutual entailment also allows for relations which are non-equivalent in nature (Blackledge, 2003).

Combinatorial entailment, which can be thought to encompass Sidman's concept of transitivity, also applies to the deduction of a relation beyond that which has been taught (Hayes et al., 2001). However, it is important to note that combinatorial entailment extends beyond this concept (Blackledge, 2003). Specifically, this type of entailment refers to the fact that two or more relations can combine to entail novel relations. For example, if a person is taught that A is related to B and B is related to C, the relations of C to A and A to C will emerge without explicit training. Thus, while there are other possible forms of combinatorial relations that are not equivalent, Sidman's 'transitivity' can be viewed as a subtype of combinatorial entailment in which the derived and taught relations are similar (Hughes & Barnes-Holmes, 2016a).

The final shared property of derived stimulus relation, the transformation of functions between stimuli, is of particular importance to RFT. It is through this process that stimuli lose, change or come to acquire their psychological properties. That is, when the function of one stimulus in a relation is modified in some way the corresponding functions of the other stimuli in that relation also change. For example, assume that the relation formed between a novel liquid and the word 'poisonous' is one of sameness or co-ordination. If a second relation of sameness is then developed between the novel liquid and a gas, it is likely that the equivalence relation between these three stimuli will result in the transfer of function. Such that the gas will also be considered poisonous (Hughes & Barnes-Holmes, 2016a).

The importance of this type of derived relational responding was further elaborated in RFT, which proposes many other types of derived relational responding in addition to derived equivalence relations (e.g. "relational frames"; for a full account see Hayes et al., 2001).

According to RFT, it is the nature of these derived stimulus relations to be arbitrarily applicable. The ability to respond to arbitrary relations among stimuli is considered to be uniquely human (Hayes et al.); to illustrate, animals and humans can respond to relations based on formal properties of stimuli such as greater-lesser relations with concrete physical stimuli (e.g., a large or a small pile of edibles), but humans can also respond to greater-lesser relations that are arbitrary, in that they are not constrained by physical properties of the stimuli, but are instead assigned by convention or contextual in nature. Children or adults who have been thought the value of money can relate to the value of monetary coins in terms of 'greater-lesser' relations that may entail the 'greater' monetary value assigned to the smaller of two coins; they can understand that the 'value' of the coin is not necessarily related to the physical size of the coin. Indeed, similarly, the entire concept of 'money' may be said to be based on what is termed 'arbitrarily applicable relational responding' (Hayes et al.), as modern monetary currency bears no physical relationship whatsoever to the purchasing value it represents. This responding is often illustrated in RFT literature through a discussion of the choice of three coins equal in size but each with a different monetary value, it is the contextual cue of worth, value or comparative responding, determined by social convention, that influences participant responding. If coin C is worth significantly less than coin B and coin A holds greater value than coin B, coin A is the logical choice for monetary gain. In such cases, this decision is made independent of any physical or formal relationship that exists between the three coins.

Over recent years RFT research has built a substantial body of work with language-able participants showing derived relational responding in domains such as co-ordination/ same-different relations (e.g., "*Poodle is same as dog*;" Cahill et al., 2007), comparative relations (e.g., "*Milk is better than water;*" Vitale, Barnes-Holmes, Barnes-Holmes, & Campbell, 2008), oppositional relations (e.g., "*Big is the opposite of Small*;" Dymond, Roche,

Forsyth, Whelan, & Rhoden, 2008), hierarchal relations (e.g., "*Bananas are fruit;*" Gil, Luciano, Ruiz, & Valdivia-Salas, 2012), deictic relations (e.g., *"I am not you;*" McHugh & Stewart, 2012) and temporal relations (e.g., "*April comes before August;"* O'Hora et al., 2008). Thus, the ability to relate stimuli governed by contextual cues as described in RFT encompasses the generation of diverse patterns of relational responding including, for example, generativity (e.g., see Wulfert & Hayes, 1988). Such patterns indicate the importance of relational responding in human language and indeed also in human cognitive activity. This in turn directs attention toward a precise understanding of how human language and cognition are influenced by, and influence, the complexity of our relational responding repertoires (Hughes & Barnes-Holmes, 2016a).

Contextual Cues and Relational Responding

The contextual cues which enable the formation of these stimulus relations are broadly categorised into two forms: functional cues and relational cues. Functional cues (or C_{funcs}; Hayes et al., 2001) define the psychological properties that can be transformed across stimuli participating in a relational frame. For example, the recollection of what an apple taste like, that is evoked in an individual in the presence of the verbal stimulus "Apple", is controlled by C_{funcs} and is based upon the equivalence relation between the word "Apple" and the object "Apple", which evokes similar sensory stimulation. Relational cues (or C_{rels}) denote the type of relational responding that is likely to be reinforced by the verbal community; words such as "Same", "Opposite", "Bigger", and "Smaller" are examples of C_{rels} in that they directly imply a relation between two stimuli or events. For example, the word "mountain" may form a comparative (greater-lesser) relation with "molehill", or the word "hot" may form an oppositional relation with "cold". To return to the exemplar of arbitrary relational responding with coins, the C_{rels} "greater-lesser" aid in the conclusion that Coin A is the most valuable, based on the learned relations among the stimuli, even though

the greater value of Coin A was not explicitly taught, and regardless that it was not "greater" in physical size compared to other coin stimuli.

Empirical Evidence of Relational Frames

The implications of phenomena such as derived relational responding and transformation of functions in the area of higher cognition are so far-reaching that a number of methodologies have been developed with the purpose of extending this examination of derived relational responding. One of the more dominant methodologies for studying stimulus relations are Matching-to-Stimulus (MTS) procedures. In short, during a MTS procedures participants are often trained to relate stimuli with conditional discriminations. That is, participants would be taught to form certain relational pairs from the stimuli available (e.g., when sample is A1, select comparison B1; A1-B1). Using this format as a basis, stimulus equivalence relations are established (e.g., A1-B1 and B1-C1). Participants can then be tested to determine if further, predictable but untrained, relations have been derived (e.g., A1-C1 and C1-A1) (Sidman & Trailby, 1982).

Relational frames of greater complexity than this simple example have also been effectively trained and tested using the MTS procedure as a basis (e.g., Leslie et al., 1993; Barnes, Lalor, Smeets, & Roche, 1996). It is the assumption of this practice that natural verbal relations (pre-experimental) would overcome any laboratory-induced pairings (Walt, Keenan, Barnes, & Cairns, 1991). The rationale of this method is that natural verbal relations have been formed through a greater number of exposures than those which are laboratory trained and, thus, would be more well-established in the individual's repertoire. Among the first to employ this strategy, using lab-based MTS procedures as a basis for equivalence testing, were Watt et al. (1991) as they assessed religious stereotypes related to Northern Ireland. The procedure used two groups of participants, one group with residents of Northern

Ireland where the community was expected to be sensitive to symbols of religious identity, and one with residents of Britain who were expected to be less attuned to the recognition of religious identity. Participants of this study were initially trained to match symbols regularly categorised by the verbal community in Northern Ireland as Protestant symbols to nonsense syllables. The same participants were then trained to match nonsense syllables with family names frequently considered by the verbal community of Northern Ireland to be Catholic names. Participants residing in Britain were then able to derive the equivalence relation between the relevant Protestant and corresponding Catholic names. For some participants from Northern Ireland, this pairing was not derived. It was reasoned that the pre-experimental natural learning history of verbal relations of those living in Northern Ireland had inhibited the production of laboratory-induced relations. Specifically, prior learning experiences had prevented some resident participants from deriving a relation of co-ordination between Protestant and Catholic names (Walt et al., 1991). This research set the ground for newer methodologies to study cognition.

Despite its success, MTS based methods of studying derived relations are not without critique. The procedure itself can take time to employ (Barnes-Holmes, Hayes, Dymond, & O'Hora, 2001) but of greater importance is the suggestion that the study of equivalence relations has relied on the procedure to the extent that for a time it was the almost the sole method used for assessing stimulus relations (Barnes-Holmes, Barnes-Holmes, Smeets, Cullinan, & Leader, 2004). With that acknowledged, new methodologies were developed to provide alternative means for the training and testing of derived relations.

The Relational Elaboration Procedure (REP)

The Relational Evaluation Procedure (REP; Hayes & Barnes, 1997) is one example of the alternative methods which were developed. In a typical REP, a participant must report on

a stimulus relation presented to them, generally without a time constraint. Two stimuli (the Sd or discriminative stimulus and the CS or conditional stimulus) are presented on screen alongside a contextual cue and two relational responses in each trial of the procedure. For example, a participant would be presented with two identical shapes with the contextual cue of SAME and would then be required to select the response of "Yes" from the options before them. If the contextual cue had been DIFFERENT, the participant would be required to respond "No". The participant is first trained with contingency feedback and then tested to assess relational networks (e.g., O'Hora, Barnes-Holmes, Roche, & Smeets, 2004). The REP's development is considered to be a landmark in the empirical study of verbal relations that would ultimately lead toward the development of an efficient behavioural protocol for the empirical study of implicit cognition, or implicit bias demonstrated in participant responding (Barnes-Holmes et al., 2006).

Other Studies in Implicit Cognition: Associations in Memory

As these developments were occurring in behavioural psychology, the concept of associations – which predates work on stimulus equivalence – was rejuvenated by social psychologists seeking to assess implicit cognition (e.g., Fazio, Sanbonmatsu, Powell, & Kardes, 1986). A number of new methodologies were generated to this end. The assumption of many of these methodologies is that participants should be able to categorise terms which are closely related in memory with greater ease than terms which have a weaker association (Greenwald, McGhee, & Schwartz, 1998). The strength of these associations are thought to be determined by the natural learning history of the participant and, similar to the concept of stimulus relations, the strength or existence of a particular association may be unknown until tested. With this logic, it would appear that implicit cognitions do not require 'conscious' effort to form but rather are a manifestations of contextual cues (Shiffrin & Dumais, 1981). Participants would, therefore, be unaware of how the relevant association

may be influencing their actions or judgement. As such, the association can be described as automatic, unconscious or an 'implicit' attitude or bias (Greenwald et al., 1998). Prior to the development of measures for testing implicit cognition, psychologists relied almost entirely on self-report or explicit questionnaire rating measures to obtain information from clients or participants about their attitudes towards certain stimuli. Problems with self-report measures in psychology have been widely reported as participants may intentionally avoid reporting attitudes they deem to appear less socially desirable (Dovidio & Fazio, 1992). In addition, people may be unaware of their attitudes or unable to introspect and report accurately. Several robust methodologies were developed to circumvent these issues and, thus, the study of implicit cognition was expanded from explicit and questionnaire based measures to computerised tasks designed to examine implicit beliefs. Those currently in use include: the Implicit Association Test (IAT; Greenwald et al., 1998); the Extrinsic Affective Simon Task (EAST; De Houwer, 2003); Evaluative Priming (Fazio, Sanbonmatsu, Powell & Kardes, 1986); name-letter preference task (Koole, Dijksterhuis, & van Knippenberg, 2001); and the Go/No-Go Association Task (GNAT: Nosek, & Banaji, 2001). Such implicit measures of "cognition" (beliefs or attitudes) usually require participants to respond to stimuli presented under time pressure. More rapid responding to particular pair of stimuli is then thought to indicate that the presented pairing is more closely associated in memory and is, therefore, a reflection of a certain belief or attitude. Of these implicit measures, the IAT (Greenwald et al., 1998) has been the most extensively used and is a prominent measure of implicit cognitions.

The Implicit Association Test (IAT)

The IAT is computerised measure conceptualised on the assumption that cognition is associative and, therefore, that it is easier to categorise attribute-concept pairings that are strongly associate in memory than those that are unrelated (Greenwald, Poehlman, Uhlmann,

& Banaji, 2009). It is a latency based measure which compares the time taken for participants to respond to associations deemed congruent with natural learning histories and those which are incongruent. Specifically, attribute-concept pairings which are strongly associated will required less time to categorise than pairings which have a weaker association. As participants are required to respond under a time constraint they are unable to provide a considered response, thus the procedure is thought to elicit 'automatic' or implicit responses (Greenwald, Nosek, Banaji, & Klaur, 2005).

In a typical IAT procedure the responses to four categories of terms are tested. For example, in the first IAT study Greenwald et al., (1998) examined Pleasant words, Unpleasant words, Insect, and Flower. Participants began by categorising images of insects into "Insects" and images of flowers into "Flower". Participants were then required to perform the same task with synonyms for the word pleasant into "Pleasant" and for unpleasant into "Unpleasant". Step 3 of the IAT procedure combines both sorting tasks such that in each trial participants are categorising a word as "Pleasant" or "Unpleasant" and then an image as "Insect" or "Flower". One response key is assigned each concept-attribute pairing (e.g., Key 1 for Unpleasant and Insect, Key 2 for Pleasant and Flower). The key assignment is reversed after a block of trials is completed so that congruent and incongruent relations are both examined. After a subsequent block of trials, then response keys revert to their original consignment for the remaining trials (Nosek, Greenwald, Banaji, 2005).

Greenwald et al. (1998) assumed that the attribute "Pleasant" is strongly associated in memory with the concept "Flower", as are the attribute "Unpleasant" and the concept "Insect". Based on this assumption, the researchers predicted that responding on the IAT would be quicker for congruent word pairings (e.g., press Key 1 for Pleasant-Flower; press key 2 for Unpleasant-Insect) than for incongruent pairings (e.g., press key 1 for Pleasant-Insect; press key 2 for Unpleasant-Flower). As anticipated, mean response latencies were

shorter for congruent (consistent) tasks than for incongruent (inconsistent). It was then inferred that the association between Pleasant-Flower and Unpleasant-Insect was better established in the memory of participants than Pleasant-Insect and Unpleasant-Flowers. This pattern of responding is known as the IAT effect (Greenwald et al., 1998).

Since this seminal study, the basic effect of the IAT has been replicated many times, and the IAT has become a well-established and effective tool measuring implicit cognitions in a wide range of socially sensitive domains including: self-esteem (e.g., Bosson, Swann, & Pennebaker, 2000); gender stereotypes (e.g., Rudman & Glick, 2001); religious stereotypes (e.g., Rudman, Greenwald, Mellott, & Schwartz, 1999); racial bias (Nosek, Banaji, & Greenwald, 2002) and attitudes towards homosexuality (e.g., Banse, Seise, & Zerbes, 2001) to name but a small number of research studies. Of particular note, is the finding that the results of the IAT often diverge with those collected from explicit measures, especially in socially-sensitive domains. For example, implicit measures in the domain of race may show a bias toward affirming White-Safe associations compared to Black-Safe associations, whereas no such bias may be evident in self-report measures. This susceptibility of explicit measures to have a low correlation with the results of implicit measure highlights the need for robust procedures to assess attitudes and biases (Hofmann, Gawronski, Gschwendner, Le, & Schmitt, 2005).

Despite the popularity of the IAT in examining implicit attitudes, it remains a measure conceptualised on the theory that it is memory associations which are fundamental to higher cognitive functions (De Houwer, 2002). Critically, this implies that while the IAT provides a measure of relative associative strength (i.e., one pair of stimuli versus another pair of stimuli) it cannot be used as means of determining the valence of that association between concepts. In effect, as the IAT does not require participants to engage in a task that asks them to directly confirm or deny a certain belief, it cannot reveal if the effects noted by the

measure reflect are wholly positive or negative (De Houwer, 2002). For example, a strong association may be found between negative words and old-age-related concepts but it cannot be identified through that single IAT if the association indicates an underlying negative attitude towards "old people" or the extent to which that attitude exists (Cullen, Barnes-Holmes, Barnes-Holmes, & Stewart, 2009).

The Go/No-Go Association Task (GNAT)

The GNAT (Nosek & Banaji, 2001) is a popular alternative of measuring implicit cognition. Similar to the IAT, participants in the GNAT are required to categorise an attribute with a stimulus across two separate tasks. The GNAT differs from the IAT in that participants are not required to respond to all the stimuli presented on each trial. For example, in a GNAT procedure assessing an attitude towards age, participants may be asked to respond when 'old-age' is presented with a positive term in the first task but required to respond only when the 'old-age' is presented with negative words in the second task. Similar to the IAT, it is thought that the more rapid responding on one task (e.g., old-age-negative) indicates a strong association between those terms in memory. Thus, the GNAT presents the same critical limitation as the IAT and other variants developed as alternatives to the IAT. As participants are not required to directly confirm or deny the attitude under examination across tasks, the directionality of that attitude cannot be determined from the procedure. Therefore, while such methodologies may measure associations which are reasonably assumed to imply an attitude, they cannot be described as direct measures of said beliefs or attitudes (De Houwer, 2002).

The Implicit Relational Assessment Procedure (IRAP)

To return to the study of implicit cognition in terms of derived relational responding, the REP provided the basis for a behavioural measure that has been gaining ground in

researching a domain previously considered to be the province of cognitive psychologists. Inspired also by the computerised methodology of the IAT, the Implicit Relational Assessment Procedure (IRAP; Barnes-Holmes, Barnes-Holmes, Milne, Power, & Stewart, 2006) has a methodology that is capable of providing a more direct measure of relational responding rather than appealing to phenomena that are representative of memory associations. Similar to the IAT, the IRAP is an automated latency-based measure which juxtaposes trial-blocks that present verbal relations that are deemed Consistent or Inconsistent with a particular concept (e.g., thin-positive/fat-negative). It is distinguished from other popular measures of implicit cognition by the inclusion of specific directional response options on each trial. Participants are required, across alternate trial-blocks, to affirm relations presented such as *thin-positive-same/* fat-negative-opposite (Consistent) and thin-negative-same/fat-negative-opposite (Inconsistent). Thus, the incorporation of relational response options (e.g., "Same"/"Opposite", "Similar"/"Different") enables the IRAP, via a four trial-type methodology (see Barnes-Holmes *et al.,* 2006), to examine participant responding to four sets of relations as described. The mean difference in response latency for participants across four trial-types can then be analysed to reveal whether, for example, participants data indicates responding in a pattern which is pro-thin, neutral, anti-fat, or some combination. Critically, this directionality can be shown in a single IRAP procedure (Campbell, Barnes-Holmes, Barnes-Holmes, & Stewart, 2011). In this regard, the IRAP confers a distinct advantage over the IAT or GNAT in that the latter cannot provide data indicating the directionality of bias shown.

One of the first published IRAP studies compared the implicit and explicit attitudes of Irish people towards people of the same and of other nationalities (Power, Barnes-Holmes, Barnes-Holmes, & Stewart, 2009). Results of this study showed a stronger preference for Irish over Scottish, and for American over African. Thus, the results revealed that the Irish

participants held a preference for themselves over people from Scotland and a preference for people from America over those from Africa. Critically, there was a clear divergence between results from the explicit measure and those from the IRAP in this study, as has been shown frequently in IAT research in socially sensitive domains (e.g. Dasgupta & Greenwald, 2001). Results of this kind, illustrate the need for robust measures which can address subjects of a socially sensitive nature and highlight the difficulties with understanding different results from explicit versus implicit measures (Power et al., 2009).

The Relational Elaboration and Coherence (REC) model

In RFT, the divergence between implicit and explicit measures can be explained through the Relational Elaboration and Coherence (REC) model (Barnes-Holmes, Barnes-Holmes, Stewart, & Boles, 2010). As the IRAP requires participants to respond accurately and with speed to conditions which are either consistent or inconsistent with their prior verbal learning histories; it is assumed that responding to novel relations will result in longer response times than those relations which have previously been established (i.e., the IRAP effect). Thus, consistent trials (e.g., choosing "Similar" in response to a pairing of the label "Pleasant" and the target "Peace") should produce quicker responding as they coordinate with incipient relational responding. In contrast, participants are expected to respond less rapidly on inconsistent trials (e.g., choosing "Similar" in response to a pairing of the label "Pleasant" and the target "Murder") as they must respond against the predicted incipient relational responses. That is to say that specific IRAP trials produce relatively brief and immediate relational responses (BIRRs) which will most probably often be emitted first by the participant. A critical assumption of the REC model is that as relations become increasingly extended and elaborate (Extended and Elaborate Relational Responding: EERRs) they are more carefully considered and are, therefore, less likely to be a reflection of an 'automatic' or implicit response (Cullen, Barnes-Holmes, Barnes-Holmes, Stewart, 2009). As the IRAP was

designed to capture BIRRs it does not function as a reliable and valid measure of EERRs (Hughes, Barnes-Holmes, & Vahey, 2012). The REC model assumes that explicit measures likely reflect relatively elaborate and coherent relational responding. Specifically, when asked to explicitly comment on a particular issue of social sensitivity, it is assumed that participants will consider a variety of past exemplars before deciding. In essence, the REC model proposes that the time constraint of the IRAP requires participants to respond in an "automatic" and spontaneous manner to produce the IRAP effect, while explicit measures allow for elaborated and extended reasoning before responding (Barnes-Holmes, Barnes-Holmes, Stewart, & Boles, 2010); in the latter scenario it may be expected that additional pre-experimental learned relations come into play. That is, while IRAP procedure may show stereotyped participant responding (e.g., attractive-employable-true/ unattractive-employable-false), the expanded time period allowed for the completion of explicit or non-latency based measures provides opportunity for participants to consider factors beyond their implicit relational learning such as the unreliability or unfairness of beauty based judgements (Murphy, MacCarthaigh, & Barnes-Holmes, 2014). Other researchers have also referred to "automatic" responding captured under time constraints in implicit test procedures versus more "deliberative" responding demonstrated when participants are responding to questionnaires or other self-report measures (e.g., Cullen, Barnes-Holmes, Barnes-Holmes, & Stewart, 2009; Roddy, Stewart, & Barnes-Holmes, 2009).

Since its development, the IRAP has been successfully employed as a measure of implicit cognition across a wide range of socially sensitive topics. Among the psychological phenomena which have been assessed are: attitudes towards homo and hetero sexuality (Cullen & Barnes-Holmes, 2008); attitudes around ideal and actual self-esteem in individuals with dysphoria and in healthy individuals (Remue, De Houwer, Barnes-Holmes, Vanderhasselt, & De Raedt, 2013); and even attitudes related to the sexualisation of children

among sexual offenders (Dawson, Barnes-Holmes, Gresswell, Hart, & Gore, 2009). In addition to this, the IRAP has been shown to provide an informative measure of attitude-change following exemplar training (Cullen et al., 2009). While this research into implicit attitudes continues, a sizeable amount of IRAP research is presently being directed towards fortifying and refining the IRAP as a procedure. Research of this kind has suggested that the IRAP is difficult to fake (McKenna, Barnes-Holmes, Barnes-Holmes & Stewart, 2007), is comparable to the IAT as a measure of individual differences (Barnes-Holmes, Waldron, Barnes-Holmes, & Stewart, 2009), and is a valid measure of implicit cognition (Golijani-Moghaddam, Hart, & Dawson, 2013). Tentative steps have also been taken to begin an examination of the components of the IRAP and their function. For example, Campbell et al. (2011) attempted to determine the impact of stimuli presentation on implicit responding by systematically manipulating stimulus presentations in the IRAP. This research found that the IRAP effect varied in strength dependent on the fixed or randomised positioning of sample stimuli, target stimuli and response options. Despite this recent flurry of research, there remains many facets and features of the IRAP which are yet to be subjected to careful systematic empirical analysis.

Testing the Methodology: Response options in the IRAP

As noted above, the IRAP is distinct from other measures of implicit cognition as it employs relational terms as response options. Early IRAP studies (e.g., Barnes-Holmes, Hayden, & Barnes-Holmes, 2008), and a host of more recent research (e.g., Hussey et al., 2016), have favoured the use of typical C_{rel} terms as response options in accord with fundamentals in RFT. However, there has been an alternative tendency, in that some recent IRAP research has shifted towards the use of other terms as response options, such as "True" and "False"; "Right" and "Wrong"; "Yes" and "No"(e.g., McEnteggart, Barnes-Holmes, & Adekuoroye, 2016; Hussey & Barnes-Holmes, 2012; Nicholson & Barnes-Holmes, 2012).

Thus, a review of the available IRAP research would suggest that the terms used as response options have come to be regarded as interchangeable. In fact, the choice of response options is rarely addressed further than a brief description to those employed in the study. It is important to note, however, that a distinction is made between words such as "Same" and words akin to "True" in RFT literature, though this distinction is not discussed at length (Hayes, Barnes-Holmes, & Roche, 2001). In RFT, terms such as "True" and "False" have been recognised as evaluative: functioning as a verbal response to verbal relations, rather than as verbal relations themselves (Barnes-Holmes, Hayes, Dymond, & O'Hora, 2001). As such, these terms are often employed to indicate relational coherence (Hayes & Barnes, 1997). For example, a statement is considered to be true if it coheres with wider patterns of relational responding in natural language. In contrast, statements which do not cohere with expected language practices are considered to be false. It could therefore be surmised that the terms "True" and "False" (and potentially their variants) have a different verbal function to relational terms such as "Same" and "Opposite", in that the former operate as relational coherence indicators (RCIs) in some contexts (Maloney & Barnes-Holmes, 2016) and not as C_{rels} *per se*. If this is the case, it may be that the choice of response options for use in IRAP research, specifically whether these are C_{rels} or RCIs, may exert an influence on resulting IRAP effects.

In an exploratory study of this topic, participant data (*N*=52) collected from two consecutive IRAPs, one using C_{rel} response options and one using RCI response options, were analysed to examine any potential influence on the IRAP effect. The stimuli selected for presentation were non-emotive; participants were simply required to relate the terms "Pleasant" and "Unpleasant" with words that could be categorised as positive or negative without difficulty (Maloney & Barnes-Holmes, 2016).

Specifically, Maloney and Barnes-Holmes (2016) asked participants to complete two IRAPs, one with the response options using C_{rels} ("Similar" and "Different") and a second with RCI response options ("True" and "False"). Both IRAPs were otherwise similar; the IRAP with C_{rel} response options presented four relations as follows: *Pleasant/Positive/Similar*; *Unpleasant/Positive/Different*, *Pleasant/Negative/Similar*, *Unpleasant/Negative/Different*, whereas the IRAP with RCI response options presented: *Pleasant/Positive/True*, *Unpleasant/Positive/False*, *Pleasant/Negative/True*, *Unpleasant/Negative/False*.

It was expected that Pleasant-Positive and Unpleasant-Negative relations would be more rapidly affirmed by participants, compared to the converse, in both IRAPs. The comparison of resultant data was to determine if there was any significant difference found when the type of response options used was manipulated. The order in which participants completed both IRAPs was counterbalanced so that twenty-six participants (*N*=26) were randomly assigned to complete the C_{rel} IRAP first while a further twenty-six participants (*N*=26) completed the RCI IRAP first. The order of trial-blocks was also manipulated to avoid the confounding of results from other variables. There was no main effect reported for the type of response option used, however, the results indicated a significant interaction effect related to the order in which participants completed the two types of IRAP. Specifically, the IRAP effect was reduced in conditions when the second IRAP employed the RCI response options ("True" and "False"). The IRAP effect remained stable across both IRAPs when the sequence of presentation was reversed (i.e., there was no impact on IRAP effect if the RCI IRAP was completed first).

The researchers surmised that this result may have been mediated by the function of the terms "True" and "False" and their distinction from "Similar" and "Different". In short, it was tentatively suggested that by completing the C_{rel} IRAP first, ("Similar" and "Different"),

a pattern of responding was developed which may then have influenced later responding on the RCI IRAP. That is, participants on the subsequent RCI IRAP may have continued to respond, privately, to the stimulus pairing onscreen using "Similar" and "Different" and then respond overtly by pressing the corresponding key for either "True" or "False". Thus, responding on the second IRAP potentially involved two responses: the consideration of the appropriate relation followed by the confirmation or denial of said relation depending on whether a consistent or inconsistent trial was presented (i.e., "Similar" or "Different" succeeded by "True" or "False"). In effect, the observed reduction in IRAP outcomes when the second IRAP used RCIs as response options could possibly be related to the elaboration of participants' response patterns, in that completing the C_{rel} IRAP first impacted so that participants related for example, Positive-Pleasant-(Similar)-True; Unpleasant-Positive-(Different)-False, which might cause a reduction in the BIRR-like quality of performance. However, this remains a speculative proposal, and it is important to note that this first study is but a tentative beginning toward a systematic analysis of effects of using C_{rels} or RCIs as response options in the IRAP.

The Current Thesis: Further Tests of the IRAP Methodology

At the time of writing, Maloney and Barnes-Holmes (2016) is the sole published study that has explored the role of C_{rel} and RCI response options in the IRAP. This preliminary study and has given rise to a number of research questions. For example, could the findings taken from this research be due to participant fatigue, or to a practice effect of completing two consecutive IRAPs? Do other terms such as "Right" and "Wrong" potentially function as RCIs, and similarly interact with order of IRAP type presented? It is the purpose of the current project to illuminate these questions and, consequently, to extend the existent literature discussing the behavioural dynamics of the IRAP. It is important to note that all four studies of the current thesis were tentative and exploratory. Thus, no firm predictions

were made as to how (or if) the response options employed across the studies would impact the resultant data.

The first study of this research programme was conducted with adult participants (*N*=40 college students) and aimed to further determine whether the type of response options presented in an IRAP had an influence over the IRAP effect. Specifically, whether there was a difference in responding between an IRAP with RCI response options, other than "True" and "False" as per Maloney and Barnes-Holmes (2016), and one with C_{rels} as response options with all other aspects held constant. The terms "Accurate" and "Inaccurate" were employed as the RCI response options for Study 1. The aim and procedure of Study 2 (*N*= 40) was identical to that of Study 1 with the exception that "Right" and "Wrong" were utilised as potential RCI (instead of Accurate v. Inaccurate) response options in one of the two IRAPs. The third study of the current thesis aimed to continue the exploration of response options in the IRAP by replicating, in part, the study which first tentatively identified RCIs (Maloney & Barnes-Holmes, 2016). Thus, Study 3 (*N*=24) employed "True" and "False" as RCI response options in one of the two IRAPs presented. The final aim of this thesis was to determine if the consecutive completion of two identical IRAPs had an impact on the resultant data. This aim was addressed in Study 4, where participants (*N*= 20) completed two IRAPs in succession both presenting the same stimuli and C_{rel} response options ("Same" and "Opposite").

Chapter 2

Study 1: An investigation of the impact of using RCIs ("Accurate"/"Inaccurate") versus

C_{rels} ("Same"/"Opposite") as response options in the IRAP

Experiment 1

The presentation of relational response options (e.g., "Same" and "Different", "True" and "False") is a key component of the IRAP methodology. However, the potential effects of the type of response options utilised, and whether the type used accords with the theoretical framework underlying the procedure, has generated little systematic analysis. Initial IRAP research typically employed what are considered to be C_{rels} in RFT literature as relational response options (e.g., Barnes-Holmes et al., 2006). As this field of research progressed, researchers began to introduce other response options, such as "True" and "False", without empirical evidence to support the assumption that all sets of response options would function equally (e.g., Nicholson & Barnes-Holmes, 2012). As previously outlined, a distinction was made in early RFT literature between words which speak directly to a relation (i.e., C_{rels} such as "Same"/"Opposite"; "Similar"/"Different"; "More"/"Less"; "Before"/ "After") and those which indicate whether a presented relation is coherent with wider patterns of relational responding (i.e., RCIs such as "True" and "False"; Hayes et al., 2001). While this area was briefly addressed in the theoretical literature, the functionality of C_{rels} versus RCIs has only just begun to be considered in terms of empirical investigation.

Recently, a singular exploratory experiment has yielded results which suggest that when participants (*N*=52) complete an IRAP with C_{rels} as response options (i.e., "Similar" and "Different") prior to completing an IRAP with RCIs as response options (i.e., "True" and "False") a significant decline in the IRAP effect is demonstrated on the second IRAP, compared to the effects shown in the C_{rel}-IRAP. This decline in the IRAP effect was not noted when the order of presentation was reversed. That is, there was no significant difference in IRAP effects under these conditions (Maloney & Barnes-Holmes, 2016). At the time of writing, this is the sole study to note this effect and indeed, the sole study to systematically manipulate the presentation of response options. Thus, there is no evidence to

suggest that the difference in responding reported by Maloney and Barnes-Holmes (2016) would be apparent with relational terms other than those used as response options in that particular study (i.e. "Similar", "Different" and "True", "False"). Moreover, the speculations arising from that research – in particular, that the terms "True" and "False" may have a different function to C_{rels} (i.e., that they are RCIs) and, thus, produce a different pattern of responding in certain contexts - remain unsubstantiated.

With this in mind, Study 1 of the current research programme aimed to extend the existent literature discussing the role of response options in the IRAP. Specifically, Study 1 sought to further determine whether there was a difference in responding between an IRAP with C_{rels} as response options versus an IRAP with RCIs as response options by employing a novel set of RCI response options. Naturally, a simple IRAP, presenting neither controversial nor socially sensitive relations was chosen for this purpose. The terms "Accurate" and "Inaccurate" were chosen to act as the RCI response options in this study as they are words which indicate the veracity of a statement and closely resemble the RCI response options of Maloney and Barnes-Holmes (i.e. "True" and "False"). "Same" and "Opposite" were chosen as the C_{rel} response options. This choice was based on a review of the available empirical IRAP literature which indicated that the terms "Same" and "Opposite" have the greatest precedent in IRAP research and represent distinct C_{rels}. That is, "Same" and "Opposite" indicate a direct and unequivocal contextual relation between two terms. As this study is exploratory and relatively novel, no firm predictions were made as to the results.

Methods

Participants

A sample of forty participants (*N*=40) were recruited from the student population of the National University of Ireland (NUI), Maynooth for Study 1. Seventeen of this number

were male while the remaining 23 participants were female (age $M = 23$, range 18 – 45

years). Each participant completed the experiment individually in quiet lab cubicles at the

Department of Psychology of NUI, Maynooth. Eligibility to participate was dependent upon

the participant recognising English to be their primary language. No financial or other

incentives were offered for participation in the study. Fifty-two individuals began the

research programme, however the data from twelve participants were removed (leaving

N=40) prior to analysis as those participants had failed to maintain the pre-determined

performance criteria on the IRAP.

Apparatus/Materials

All participants completed both IRAPs on a laptop computer (Lenovo G50). The

IRAP software, written in Microsoft Visual Basic 6.0, controlled the presentation of all

stimuli and the recording of responses. Each trial of the IRAP presented one of two sample

stimuli; "Pleasant" or "Unpleasant". One of twelve target stimuli were also presented in each

IRAP trial. The target stimuli consisted of six synonyms of the term "Pleasant" (Good,

Positive, Nice, Likeable, Lovely, and Wonderful) and six synonyms of "Unpleasant" (Bad,

Negative, Nasty, Unlikeable, Horrible, and Awful).

Procedure

The experiment began with the experimenter describing the IRAP procedure,

illustrating the layout of the screen using printed images of each of the four different trial-

types, and verbally explaining how the task is to be completed. Participants were told that on

each trial four words would appear on screen simultaneously. At the top of the screen one of

two sample stimuli, "Pleasant" or "Unpleasant", would appear along with a target word in the

centre of the screen. Participants were also made aware which set of response options (either

"Same" and "Opposite" or "Accurate" and "Inaccurate") would appear in the bottom left and

right hand corners of the screen and that these positions would switch quasi-randomly from trial to trial (not appearing in the same position three times in succession). Participants were instructed to choose one of these response options for each trial, by pressing either the "d" or "k" key. All other keys were disabled during trials. The phrases "PRESS 'd' FOR" and "PRESS 'k' FOR" appeared directly above the presented response options on each trial and indicated which key corresponded to which response option on said trial.

The instructions presented on screen by the IRAP program during this instructional phase of the study included the appropriate 'rule' which would indicate the feedback contingency for the upcoming block of trials. The 'rule' alternated from block to block and participants were informed prior to each new block of trials that the previously correct and incorrect answers would now be reversed. The two potential 'rules' of the current research were as follows: "Pleasant is Positive. Unpleasant is Negative." or "Pleasant is Negative. Unpleasant is Positive.". The information that the upcoming trial-blocks were for practice and the guidance to "Try to avoid the red 'X' on every question" was also presented. For test blocks this guidance would change to say "Please try to get as many right as possible". In explaining the rule to participants they were informed that for some of the procedure they would be required to respond in a manner which is deemed consistent with the English language (i.e., when the rule stated that Pleasant is Positive and Unpleasant Negative) and that for the rest of the procedure they would have to forgo this logic to respond in a manner considered inconsistent with the English language (i.e., when the rule stated that Pleasant is Negative and Unpleasant Positive). It was emphasised to participants that it was important for them to respond accurately, in accordance with the 'rule', and quickly on all trials of the IRAP. The reasoning for this was not explained to participants until after the experimental process.

Participants were informed that the input of the response deemed correct in a given trial would allow them to progress to the next trial and would remove all stimuli from the screen for a 400ms interval until that new trial was presented. Incorrect responses would result in an emboldened red 'X' appearing in centre screen, directly below the target stimulus, which would remain until the desired response had been emitted by the participant. If a participant failed to respond within 2000ms, an emboldened red exclamation mark would appear in the bottom centre of the screen. The exclamation mark would remain there until one of the two available responses had been made.

The IRAP procedure comprised of a minimum of eight blocks of trials, specifically a minimum of two practice blocks followed by a fixed set of six test blocks. The same 24 trials were presented in each practice and test block. Within each block the sample stimuli of "Pleasant" and "Unpleasant" were presented randomly across trials with the constraint that each term was to appear 12 times within the 24 trial block. The 12 target stimuli (e.g., Wonderful) were also presented in a quasi-random sequence with the constraint that each be presented twice across the 24 trials (see Figure 1).

To progress from practice to test blocks participants were required to achieve a pre-determined criteria of at least 80% accurate responses with an average response latency of less than or equal to 2000ms. If a participant failed to meet this inclusion criteria for either of the first two practice blocks, the level of responding they had achieved and the standard required were presented on screen at the end of the set. Participants were permitted up to six further practice blocks (three attempts) to reach the required standard of responding. Participants who failed to meet this criteria after the additional practice were thanked for their participation, debriefed and excused from the study. Their data were discarded. Successful participants proceeded to the six test blocks. For practice blocks the experimenter sat adjacent to the participant and watched as they responded to the IRAP. The experimenter did

not remain with the participant during test blocks, returning only after the task had been

completed. Feedback was presented on screen immediately after each block of trials. This

feedback detailed the accuracy and the median latency achieved for the foregoing block.

When ready to continue to the next block of trials participants were to hit the space bar.

Upon completion of all six test blocks, participants were notified to alert the researcher via an

on screen message.
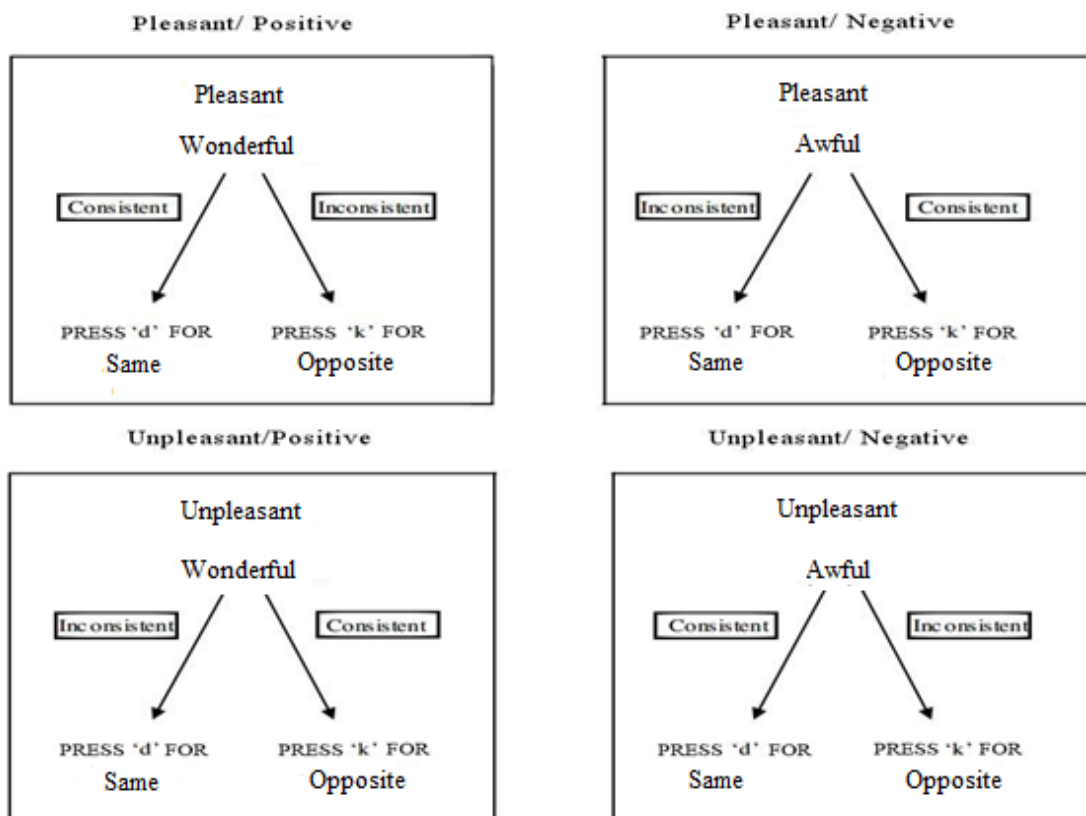
Figure 1. Examples of the four IRAP trial types. The sample stimulus ("pleasant" or

"unpleasant"), target word (wonderful, lovely, nasty etc.,), and response options (Similar and

Different) appeared simultaneously on each trial. Responses which were deemed consistent

or inconsistent are indicated by arrows with superimposed text boxes (arrows and text boxes

did not appear on screen).

Each participant in this study was required to complete two consecutive IRAPs in one sitting. The sole difference between the two IRAPs was the relational terms used as response options. One IRAP presented "Same" and "Opposite" as response options (henceforth referred to C_{rel}-IRAP) while the other presented "Accurate" and "Inaccurate" as response options (henceforth referred to as RCI-IRAP). The order in which participants completed both stimuli sets was dependent upon their random allocation of to one of four experimental groups. That is, half of the participants (N=20) first completed the C_{rel}-IRAP, while the remaining half underwent the RCI-IRAP first. Both of these groups were further divided so that in both IRAPs (N=10) some participants completed Consistent trial-blocks first (e.g., Pleasant-Positive/Unpleasant-Negative) and the remainder (N=10) completed Inconsistent trial-blocks first (e.g., Pleasant-Negative/Unpleasant-Positive. Thus, the four experimental groups were as follows: consistent relations with C_{rel}-IRAP first; inconsistent relations C_{rel}-IRAP first; consistent relations with RCI-IRAP first; inconsistent relations with RCI-IRAP first (see Table 1).

Table 1.

A tabular representation of the four experimental groups for Study 1.

Group	Response Option Order	Block Order
1	C_{rel}-IRAP first	Consistent relations first
2	C_{rel}-IRAP first	Inconsistent relations first
3	RCI-IRAP first	Consistent relations first
4	RCI-IRAP first	Inconsistent relations first

Ethical considerations

Prior to experimentation, each participant was required to read and sign a consent form (Appendix A). The eligibility requirements for participation (noted above) were

detailed on this form and participants were asked to confirm that they were a minimum of 18 years of age by signing. A more comprehensive information sheet (Appendix B) was provided to participants which they were given time to look over and to take away from the study if desired. All necessary ethical standards were adhered to. The project was approved by the ethics committee of the National University of Ireland, Maynooth.

Results

Data preparation

The data from twelve participants were removed prior to data analysis. Four participants were unable to reach the criteria required to transition from the practice to the test blocks. An additional four participants maintained criteria through the practice and test blocks of their first IRAP but failed to pass practice blocks for the second IRAP presented to them. A further four participants failed to maintain criterion throughout the test-blocks of both IRAPs.

The primary datum recorded by the IRAP was response latency. This is defined as the time in milliseconds (ms) that elapsed between the onset of a trial and the input of a correct response by a participant. In line with previous analyses of IRAP data, the response latency data for each participant were transformed into D-IRAP scores to control for the potential individual variations of responding which may confound when analysing between group differences. This process of calculating D-IRAP scores is done by the IRAP program through the following steps: (1) response-latency data from all practice blocks are excluded from analysis; (2) trials with latencies exceeding 10,000ms are removed from the dataset; (3) if in excess of 10% of test-block trial latencies were below 300ms for a single participant dataset, the data of that participant was removed from analyses; (4) Four standard deviations were calculated for the response latencies of test-blocks 1 and 2, four more were calculated

from test-blocks 3 and 4, and a further four with calculated from test-blocks 5 and 6, resulting in twelve standard deviations for the four trial types; (5) an average response-latency was calculated for the four trial types in each test block, resulting in 24 mean latencies; (6) by subtracting the mean latency of the pleasant-positive test-block from the mean latency of the corresponding unpleasant-negative test block difference scores for each of the four trial types were calculated for each pair of test-blocks; (7) these difference scores were then divided by their corresponding standard deviation, calculated in step 4, producing one *D*-IRAP score for each trial-type for each pair of test blocks; (8) *D*-IRAP scores were calculated for each of the four trial types by averaging the scores for each trial-type across the three pairs of test blocks; (9) by averaging these 12 trial-type *D*-IRAP scores an overall *D*-IRAP score was calculated for each of the four trial-types. This method is an adaptation of the Greenwald, Nosek, and Banaji (2003) *D*-algorithm.

For participants who exceeded a response latency of 2100ms or who fell below 75% in accuracy[1] on just one test block, that participant's analyses were conducted on the remaining two pairs of test blocks (as per Nicholson et al., 2012). Specifically, the test block pair that did not reach the required criteria was removed from analysis and the *D*-IRAP score for that participant was recalculated. In the current study ten sets of participant data underwent this treatment prior to analysis. If a participant failed to reach criteria across two or more test block pairs, her or his entire dataset was removed from analysis.

Data Analysis

The overall *D*-IRAP scores for both IRAPs of Study 1 indicate that participants more rapidly affirmed consistent relations rather than inconsistent (see figure 2 for graphic representation).

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[1] Accuracy and latency criteria amended to avoid high attrition rates as per Barnes-Holmes, Murphy, & Barnes-Holmes, & Stewart (2010)

Specifically, the overall mean *D*-IRAP score for the C$_{rel}$-IRAP was .27 (SD = .28) and was

.18 (SD= .24) for the RCI-IRAP. Thus, the IRAP effect was produced.
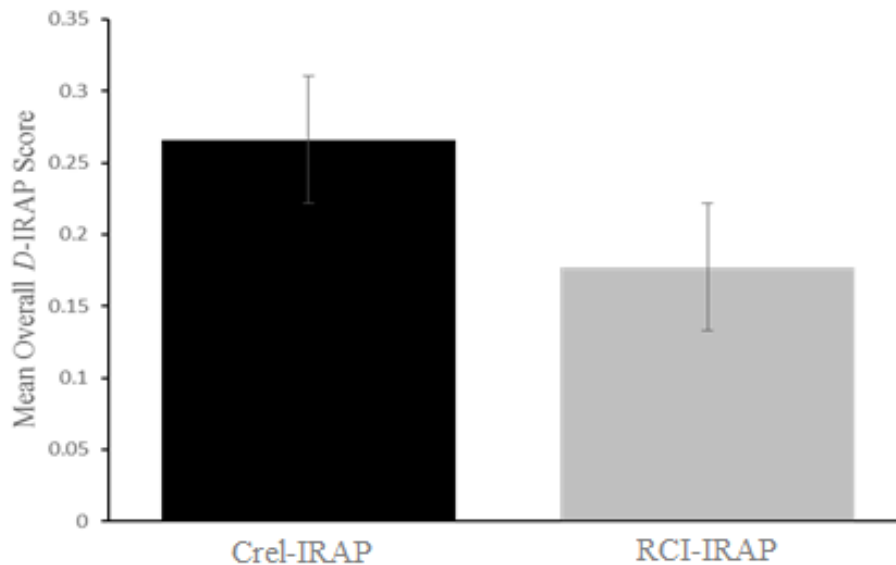

Figure 2. Bar graph showing overall mean *D*-IRAP scores (with standard error bars) for both

IRAPs. The graph indicates a pattern of responding biased towards congruent relations (i.e.,

Pleasant-Positive-Same, Pleasant-Positive-Accurate).

Main Analysis. Eight one sample t-tests were then conducted to determine which of

the mean overall *D*-IRAP scores for each of the four trial-types for participants in both the

C$_{rel}$-IRAP and the RCI-IRAP were statistically significant (see Table 2 and Table 3).   For

both the C$_{rel}$-IRAP and RCI-IRAP the *D*-IRAP score was found to be statistically significant

relative to zero for all but the Unpleasant-Positive trial-type. Results for the C$_{rel}$-IRAP were

as follows: Pleasant-Positive (M=.48, SD=.37, $F(39) = 8.21$, $p < .005$); Pleasant-Negative (M

= .24, SD = .24, $F(39) = 3.70$, $p < .005$); Unpleasant-Positive (M = .08, SD = .46, $F(39) =$

1.1, $p = .26$); Unpleasant-Negative (M = .25, SD =.37, $F(39) = 4.36$, $p < .0005$). The

resulting data for RCI-IRAP followed a similar pattern: Pleasant-Positive (M=.42, SD = .38,

$F(39) = 7.12$, $p < .0005$). Pleasant-Negative (M=.19, SD = .39, $F(39) = 3.02$, $p < .005$);

Unpleasant-Positive (M =-.07, SD = .41, $F(39) = -1.11$, $p = .27$); Unpleasant-Negative (M=
.16, SD = .35, $F(39) = 2.95$, $p < .005$).

Table 2.

Statistical significance (*p <.05) for the 4 IRAP Trial-Types in the RCI-IRAP, with mean D-IRAP scores per trial-type, standard deviations (SD), F, and P values presented.

Trial-Type	C_{rel}-IRAP			
	Mean	SD	F	p value
Pleasant-Positive	.48*	.37	F(39) = 8.21	<.0005
Pleasant-Negative	.24*	.41	F(39) = 3.70	<.0005
Unpleasant-Positive	.08	.45	F(39) = 1.1	.26
Unpleasant-Negative	.26*	.37	F(39) = 4.36	<.0005

Table 3.

Statistical significance (*p <.05) for the 4 IRAP Trial-Types in the RCI-IRAP, with mean D-IRAP scores per trial-type, standard deviations (SD), F, and P values presented.

Trial-Type	RCI-IRAP			
	Mean	SD	F	p value
Pleasant-Positive	.42*	.38	F(39) = 7.12	<.0005
Pleasant-Negative	.19*	.39	F(39) = 3.02	<.0005
Unpleasant-Positive	-.07	.40	F(39) = -1.11	.27
Unpleasant-Negative	.16*	.33	F(39) = 2.95	<.0005

Statistical analysis was conducted using a mixed between-within 2 x 2 x 2 x 4
analysis of variance (ANOVA) on participant ($N = 40$) *D*-IRAP scores to assess the impact of
the type of response options used in the IRAP program (C_{rel}-IRAP v. RCI-IRAP) and the

order in which both IRAPs were completed on participant performance across the four trial-types of the IRAP. Block-Order (i.e., presenting consistent v. inconsistent trial-blocks first) was also analysed, with IRAP Trial-Type as the within-participant dependent variable (DV). This analysis produced a statistically significant main effect for Response-Option-Type, Wilks' Lambda = .87, $F(1, 36) = 5.24$, $p = .03$, $\eta_p^2 = .14$, indicating that participant responding was significantly different on the two IRAPs (C_{rel}-IRAP and RCI-IRAP). A statistically significant main effect was also revealed for trial-type: Wilk's Lambda = .38, $F(3, 34) = 18.37$, $p < .005$, $\eta_p^2 = .618$. Figure 3 presents the mean overall D-IRAP scores for each of the four trial-type conditions across the C_{rel}-IRAP and the RCI-IRAP. There was no significant two-way interaction between the order in which participants completed both IRAP-types (e.g., C_{rel}-IRAP first or RCI-IRAP first) and the two different IRAPs (e.g., C_{rel}-IRAP or RCI-IRAP): $p = .32$. There was, however, a statistically significant three-way interaction evident between the order in which the two IRAPs were presented, the type of response option used and the order of consistent and inconsistent trial-blocks: Wilk's Lambda = .86, $F(1, 36) = 5.66$, $p = .02$, $\eta_p^2 = .14$. No other significant effects were produced (all p's > 0.6).[2]

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[2] Bonferroni corrections were not applied here due to the exploratory nature of this analysis (see discussion for further detail).
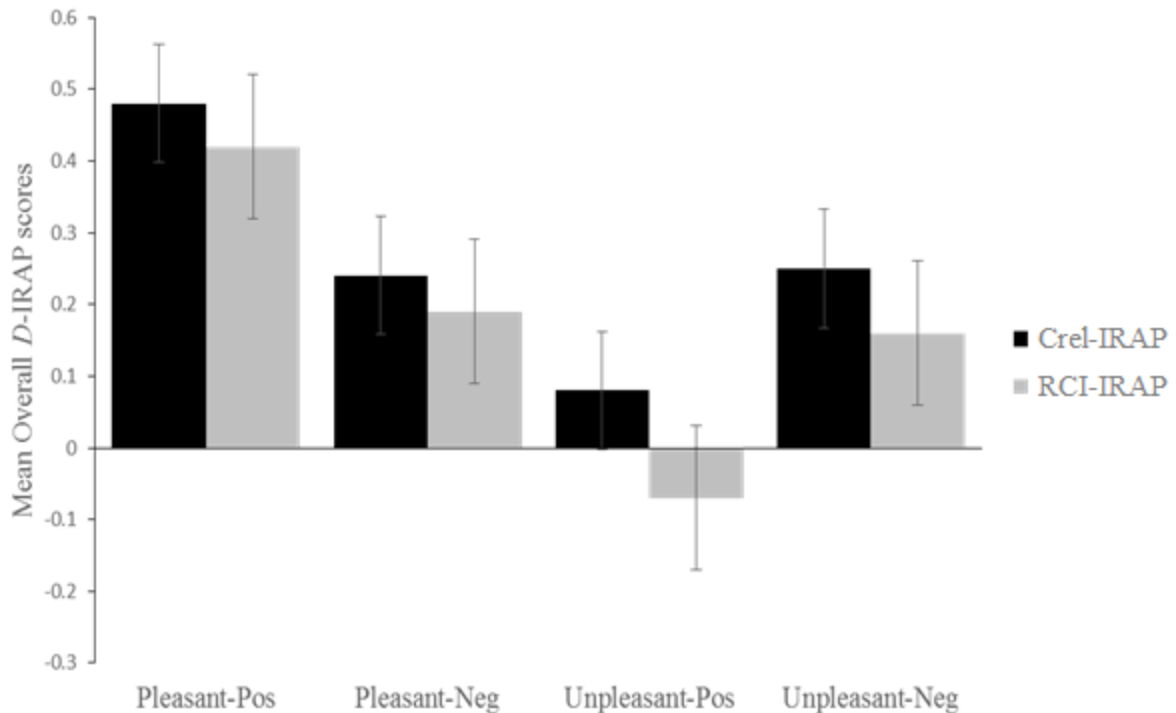
Figure 3. The mean participant *D*-IRAP scores (*N*=40), with standard error bars, for the four trial-types of both the C_{rel} and RCI IRAP

Summary and Discussion

The primary aim of Study 1 was to assess the impact of the RCI response options "Accurate" and "Inaccurate" v. "Same" and "Opposite" (C_{rels}) on participant IRAP responding. Another key manipulation involved the sequence of the two IRAPs (i.e., C_{rel}-IRAP first, RCI-IRAP second or RCI-IRAP first, C_{rel}-IRAP second) and of trial-blocks (consistent v. inconsistent presented first). The results revealed that responding was mediated by a positive IRAP effect (bias) for both IRAPs. Critically, the results also indicated that responding on the two IRAPs was significantly different. It can be seen that the C_{rel}-IRAP produced stronger IRAP effects compared with the effects shown for the RCI-IRAP (see figure 2). Order of presentation alone did not have a significant influence on the *D*-IRAP scores, but there was an interaction on certain conditions between the order of presentation,

Block-Order and the response option type. Specifically these three factors in combination had a significant impact on participant performance.

The significant difference detected between the two IRAPs is likely due to the different response options used. Thus, it is possible to speculate from this study that the type of response option presented in the IRAP exerts some influence on IRAP outcomes. The three-way interaction revealed also suggests the sensitivity of the IRAP to the response options used and the order in which they are employed. However, it should be noted that this impact could, potentially, be a spurious interaction resulting from the design and approach to analysis of this study. Alternatively it could be connected to some artefact of the procedure. Further investigation using appropriate post-hoc analyses will be required to clarify the matter. Future research could address this issue using a more concise analysis. Specifically, a 4x4 ANOVA, examining trial-type as the within participant independent variable and 'group' as outlined in Table 1, would effectively allow for an analysis of the impact of the presentation or response options and block order on trial-type scores.

Anecdotal evidence gathered from discussions with participants during the course of this study indicated that the length of the terms "Accurate" and "Inaccurate" and their similarity could have had an impact on responding. In short, some participants reported that they found differentiation of the terms difficult when responding under time pressure on the IRAP. Thus, the length and similarity of the terms used as response options could be a viewed as a potential limitation of Study 1. Study 2 attempted to address this possibility directly by employing the terms "Right" and "Wrong". It was felt that these terms bear a greater similarity to the terms "True" and "False", which are regularly presented as response options, and are readily differentiated from one another.

Chapter 3

Study 2: An investigation of effects using RCIs ("Right"/"Wrong") versus C$_{rels}$

("Same"/"Opposite") as response options in the IRAP

Experiment 2

Study 2 in the current series continued to investigate whether response options such as "True/False" (RCIs) may be used interchangeably with relational terms such as "Same/Different" (C_{rels}) in an IRAP. Theoretically, the former are not considered strictly to be exemplars of relational responding and are termed "Relational Coherence Indicators (RCIs)", whereas the latter are considered to be relational terms (C_{rels}; Hayes et al., 2001). This implies an assumption that response options which are defined as RCIs will have the same impact on participants' IRAP data as response options which are defined as relational terms. Whether or not the assumption is warranted needs to be tested empirically, and the current programme of research has been commenced with this purpose. The results of Study 1 indicated a statistically significant difference in participant IRAP data resulting from the type of response options used, and suggested that participant responding may be sensitive to order interactions with the type of response options used. Maloney and Barnes-Holmes (2016) previously and importantly indicated that response option type (C_{rels}. v. RCIs) could impact IRAP effects shown in participant responding when presented in a particular order.

Study 2 of the current research was designed with an aim to further research this area using RCIs "Right/Wrong" v. C_{rels} "Same/Opposite". Similar to Study 1, this experiment sought to determine if the use of RCIs as response options in the IRAP and the sequence in which that IRAP was presented to participants (i.e., before or after an IRAP with C_{rels} as response options) had an effect on IRAP outcomes. It is proposed that "Right" and "Wrong" are RCIs as they are synonyms of "True" and "False" and function as a means of confirming relations (i.e., the relations presented are coherent). The C_{rel} response options of Study 1 ("Same" and "Opposite") were repeated in study 2 so that the emphasis of the project remained on RCIs and their role in the IRAP. All other stimuli presented remained unmodified from Study 1 and procedures were conducted in a similar fashion, examining

effects of IRAP response option type, order of IRAP-type completed, and block-order effects (i.e., consistent trial-blocks first v. inconsistent trial-blocks first). As this area of research is quite novel and preliminary results are difficult to interpret, the current study was considered a further exploration, and no predictions were made.

Methods

Participants

A sample of forty (N=40) participants were recruited from the student population of NUI, Maynooth for Study 2. This number was divided among 19 males and 21 females with ages ranging from 18 to 24 years (M=20). All participants were native English speakers and completed the task individually in the Department of Psychology at NUI, Maynooth. No inducements were offered for participation in this study. Forty-nine individuals commenced the experiment but prior to data analysis the datasets of nine participants were removed as those persons had failed to reach or maintain the pre-determined IRAP criteria.

Apparatus/Materials

The apparatus and materials were similar to those employed in Study 1, except that one of the two IRAP procedures presented to participants availed of the response options "Right" and "Wrong" in place of "Accurate" and "Inaccurate" from the previous study. All instructions were adjusted to reflect this change.

Procedure

The experimental sequence was unchanged from that in Study 1. Participants were randomly allocated to one of four experimental groups (see table 4 for tabular presentation). Group 1 first completed an IRAP with the response options of "Same" and "Opposite" (henceforth referred to C_{rel}-IRAP) which required responding consistent with natural language first, followed by an IRAP with "Right" and "Wrong" as response options

(henceforth referred to as RCI-IRAP) and the same order of responding. Group 2 were

presented with both IRAPs in the same order as Group 1 but were required to respond in a

manner deemed inconsistent with the English language first; Groups 3 and 4 both began with

RCI-IRAP followed by C_{rel}-IRAP. Group 3 were first required to emit responses deemed

consistent with natural language while Group 4 were presented with inconsistent trials first.

Table 4.

A tabular representation of the four experimental groups for Study 2.

| Group	Response Option Order	Block Order
1	C_{rel}-IRAP first	Consistent relations first
2	C_{rel}-IRAP first	Inconsistent relations first
3	RCI-IRAP first	Consistent relations first
4	RCI-IRAP first	Inconsistent relations first

Results

Data preparation

Nine participant datasets were excluded from analysis. Three of these participants

failed to reach the practice criteria (i.e., $\geq 80\%$ accurate responding with an average response

latency $\leq 2000ms$), and thus did not proceed to the test portion of the IRAP. The remaining

six datasets were removed from analysis as the accuracy of the related participants had fallen

below 75% or their median response latency had exceeded 2100ms on more than one set of

test blocks. The remaining response latencies were prepared using the same procedures as

outlined in study 1. Ten participants failed to maintain criteria in one test block or test block

pair of one of both of the IRAPs. To adjust for this the data from the failed test block pairs

were discarded and the *D*-IRAP scores recalculated from the remaining two test block pairs (as per Nicholson et al., 2012).

Data Analysis

Following data transformation, the overall mean *D*-IRAP score was calculated for both the C_{rel}-IRAP and the RCI-IRAP to determine whether responses, on average, were faster during blocks of trials that required responding in a manner that was consistent with natural verbal relations (e.g., Pleasant-Positive-Same) or on inconsistent trial-blocks (e.g., Pleasant-Positive-Opposite). The overall mean *D*-IRAP scores for both IRAPs indicate that participants more rapidly affirmed consistent relations rather than inconsistent (see figure 4 for graphic representation). Specifically, the overall mean *D*-IRAP for the C_{rel}-IRAP was .24 (SD = .27) and was .11 (SD= .24) for the RCI-IRAP. Thus, the IRAP effect was produced.
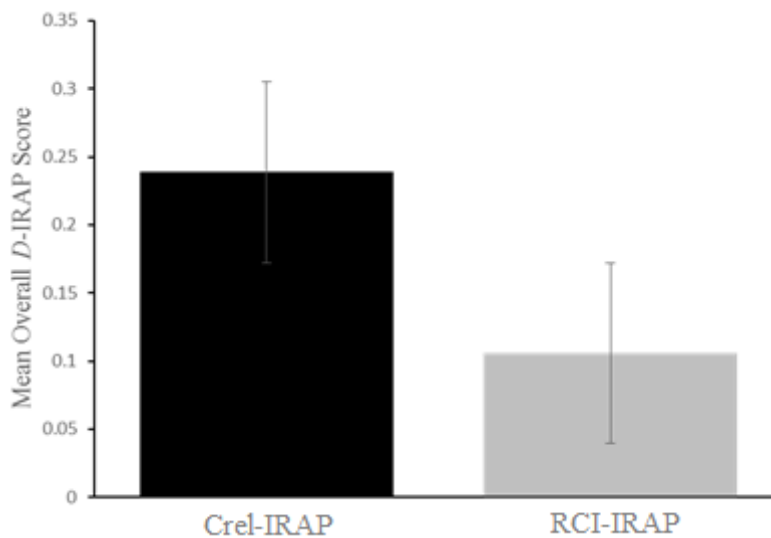
Figure 4. Bar graph showing overall mean *D*-IRAP scores (with standard error bars) for both IRAPs. The graph indicates a pattern of responding biased towards congruent relations (i.e., Pleasant-Positive-Same, Pleasant-Positive-Right).

Main Analysis. Eight one sample *t*-tests were conducted to identify if the overall *D*-IRAP score for each condition of the C_{rel}-IRAP and of the RCI-IRAP differed significantly

from zero. The resultant data is presented in Tables 5 and 6. In the C_{rel}-IRAP the overall D-

IRAP scores were statistically significant for all but the Unpleasant-Negative trial-type:

Pleasant-Positive ($M = .47$, SD $= .42$, $F(39) = 7.19$, $p < .0005$); Pleasant-Negative ($M = .19$,

SD $= .39$, $F(39) = 3.1$, $p = .004$); Unpleasant-Positive ($M = .21$, SD $= .48$, $F(39) = 2.82$, p

$= .008$); Unpleasant-Negative ($M = .08$, SD $= .36$, $F(39) = 1.38$, $p = .18$). Three conditions of

the RCI-IRAP had overall D-IRAP scores which were statistically significant: Pleasant-

Positive ($M = .31$, SD $= .30$, $F(39) = 6.64$, $p < .0005$); Pleasant-Negative ($M = .13$, SD $= .36$,

F(39) $= 2.2$, $p = .03$); Unpleasant-Negative ($M = -.13$, SD $= .38$, $F(39) = -2.17$, $p = .04$). The

overall D-IRAP score for the Unpleasant-Positive ($M = .12$, SD $= .45$, $F(39) = 1.67$, $p = .104$)

condition did not differ significantly from zero.

Table 5.

Statistical significance (*p <.05) for the 4 IRAP Trial-Types in the C_{rel}-IRAP, with mean D-IRAP scores per trial-type, standard deviations (SD), F, and P values presented.

| Trial-Type | C_{rel}-IRAP | | | |
	Mean	SD	F	p value
Pleasant-Positive	.47*	.42	F(39) = 7.19	<.0005
Pleasant-Negative	.19*	.39	F(39) = 3.1	.004
Unpleasant-Positive	.21*	.48	F(39) = 2.82	.008
Unpleasant-Negative	.08	.36	F(39) = 1.38	.18

Table 6.

Statistical significance (*p <.05) for the 4 IRAP Trial-Types in the RCI-IRAP, with mean D-IRAP scores per trial-type, standard deviations (SD), F, and P values presented.

| | RCI-IRAP | | | |
Trial-Type	Mean	SD	F	p value
Pleasant-Positive	.31*	.30	$F(39) = 6.64$	<.0005
Pleasant-Negative	.13*	.36	$F(39) = 2.2$	.03
Unpleasant-Positive	.12	.45	$F(39) = 1.67$	.104
Unpleasant-Negative	-.13*	.38	$F(39) = -2.17$	.04

Statistical analysis was conducted using a mixed between-within 2 x 2 x 2 x 4 ANOVA on participant (*N* =40) *D*-IRAP scores. The purpose of this analysis was to assess the impact of the type of response options employed in the IRAP and the order in which these two different IRAP programmes are completed on participant performance across the four IRAP trial-types. The type of response option used (i.e., C_{rel}-IRAP v. RCI-IRAP), the order in which the two IRAP types were completed (i.e., C_{rel}-IRAP first v. RCI-IRAP first), and the Block-Order (i.e., consistent v. inconsistent trial-blocks presented first) served as the between-participant independent variables (IVs) with the IRAP Trial-Type as the within-participant dependent variable (DV). A significant main effect was detected for Response-Option-Type: Wilk's Lambda = .86, $F(1, 36) = 6.05$, p = .02, $\eta_p^2 = .14$. This result indicates that there was a statistically significant difference between participant responding on the C_{rel}-IRAP and the RCI-IRAP. The analysis also revealed a statistically significant main effect for IRAP Trial Type: Wilk's Lambda = 0.37, $F(3,34) = 19.68$, p < .005, $\eta_p^2 = .64$. Figure 5 presents the overall D-IRAP scores for each condition of both IRAPs. No other interactions in this analysis were statistically significant (all p's > .16).
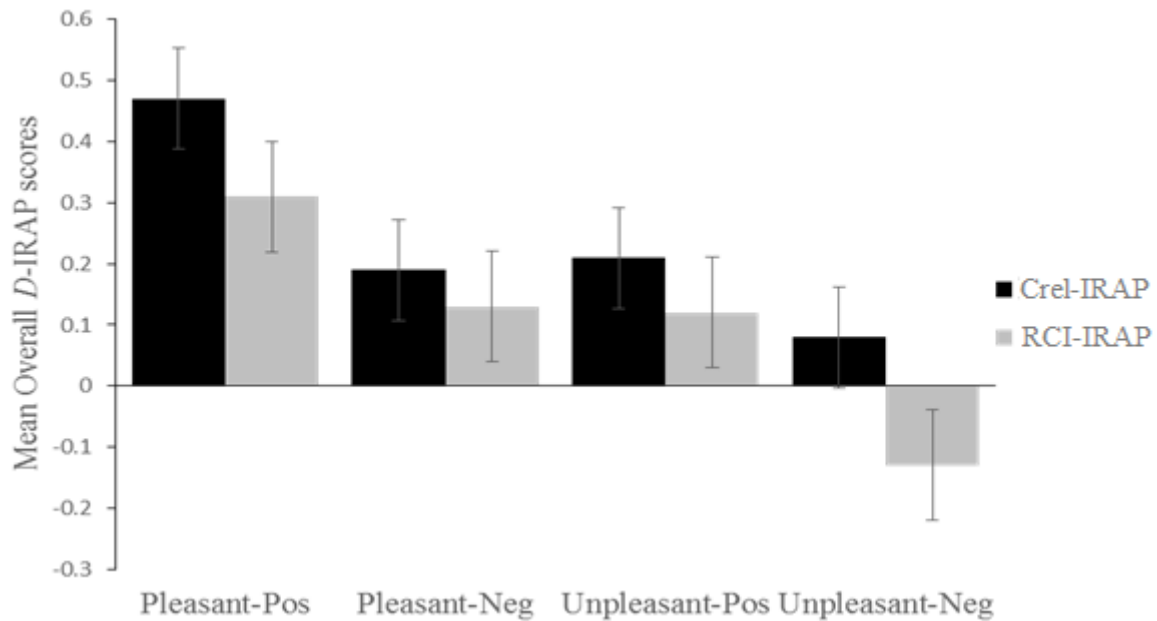
Figure 5. Overall mean *D*-IRAP scores for the four trial-types across both IRAPs of Study 2.

Discussion

The primary aim of Study 2 was to assess the impact of the RCI response options, "Right" and "Wrong" in the IRAP. The findings indicated that participant responding on both IRAPs (RCI v. C_{rel}) was mediated by a congruent bias. That is, pleasant-positive relations were more rapidly affirmed by participants than pleasant-negative overall. There was a statistically significant difference between participant IRAP data shown across both IRAPs. As in Study 1, the current findings suggest stronger IRAP effects for the C_{rel}-IRAP compared to RCI-IRAP (see Figure 4). Thus, both Study 1 and 2 of the current research have demonstrated a significant difference in participant IRAP responding potentially resulting from the IRAP response option types employed (i.e., C_{rels} or RCIs). A key difference between the studies is that in Study 2 there was no interaction effect shown between the type of response options employed and the sequence of IRAP-type or trial-block presentation.

Having ascertained, through study one and two, that the response options used impact on the

IRAP effect; study 3 was designed to partially replicate and, thus, further support, the

findings of Maloney and Barnes-Holmes (2016).

Chapter 4

Study 3: An investigation of the impact of using RCIs ("True"/"False") versus C$_{rels}$

("Same"/"Opposite") as response options in the IRAP

Experiment 3

The findings in Studies 1 and 2 provided some support for the results in Maloney and Barnes-Holmes (2016), and for the theoretical distinction made between C_{rels} and RCIs (Hayes et al., 2001), in that there was a statistically significant difference between IRAP effects shown in participant data resulting from manipulation of type of response options used. The issue of interactions between the type of response option used and the sequence of IRAP type completed remains unclear however, and results in Study 2 did not support the previous preliminary findings showing such interactions. In all sciences, replication is considered a means of verifying the validity of findings in psychological research (Roediger, 2012; Cohen, 1994). Thus, Study 3 of the current series was a partial replication of previous studies and aimed to provide further clarification regarding these issues. The primary manipulation was once more the type of IRAP response used (i.e., RCIs "True"/"False" v. C_{rels} "Same"/ "Opposite", and procedures were conducted in a similar fashion as the previous studies, examining effects of order of IRAP-type completed, and block-order effects (i.e., consistent trial-blocks first v. inconsistent trial-blocks first).

Study 3, thus, continued the current exploratory research theme investigating the IRAP methodology with particular regard to effects shown in participants' IRAP data resulting from the type of response options employed. Specifically, the sequencing question was that if presenting two IRAPs, the first of which uses C_{rels} terms as response options and the second which employs RCI terms as response options, would result in interaction effects as shown before. For example, Maloney and Barnes-Holmes (2016) found that when participants (N=52) completed an IRAP with RCIs as response options immediately after an IRAP with C_{rels} as response options, the IRAP effect was significantly diminished for the RCI-IRAP when compared to the C_{rel}-IRAP. The alternate sequence (i.e., the RCI-IRAP followed by the C_{rel}-IRAP) did not produce the same effect. It was speculated that this result

could potentially be related to an elaboration of participants' response patterns. In short, it was suggested that completing the C_{rel}-IRAP first impacted responding on the subsequent RCI-IRAP so that it potentially involved two responses: the consideration of the appropriate relation followed by the confirmation or denial of said relation dependent on whether a consistent or inconsistent trial was presented (i.e., responding Pleasant-Positive-(Similar)-True).

Methods

Participants

A sample of twenty-four students of NUI, Maynooth were recruited to participate. Ten males and twelve females participated with ages ranging from 18 to 35 (*M*=22). All participants reported English to be their first language, as was required for participation. The study was conducted in the Department of Psychology. Each participant completed the study individually in quiet laboratory cubicles. No incentives were offered for participation in the study. Forty-one individuals commenced the experiment but the data for 17 participants were removed prior to analysis due to the failure of these participants or achieve the pre-determined criteria for the IRAP.

Apparatus and Materials

The apparatus and materials used were identical in format to Study 1. Again, the sample stimuli were the words "Pleasant" and "Unpleasant". The target stimuli were terms readily categorised as positive or negative. However, the response options of Study 4 were "Same" and "Opposite" (henceforth referred to as C_{rel}-IRAP) or "True" and "False" (henceforth referred to as RCI-IRAP). Instructions presented to the participant on how to complete the procedure were altered to reflect this change of response option.

Procedure

The procedure was conducted similarly as Study 1 in the current series, except that the RCI response options were "True"/"False" rather than "Accurate"/"Inaccurate". Participants were again randomly allocated to one of four experimental groups which determined the order in which the IRAPs and blocks were presented (see Table 7 for a tabular representation).

Table 7.

A tabular representation of the four experimental groups for Study 3.

Group	Response Option Order	Block Order
1	C_{rel}-IRAP first	Consistent relations first
2	C_{rel}-IRAP first	Inconsistent relations first
3	RCI-IRAP first	Consistent relations first
4	RCI-IRAP first	Inconsistent relations first

Ethical Considerations

The ethical considerations described in Study 1 were also in place for this study.

<div align="center">

**Results**

</div>

Data preparation

Seventeen participant datasets were excluded from analysis. Fourteen of these participants failed to reach the criteria required for the practice blocks. The additional three participant datasets were excluded from analysis because the accuracy levels in these data fell below 75% or the median response latency surpassed 2100ms for more one test block pair. The same data preparation procedures as used in Study 1 were used to prepare the remaining data. The method described by Nicholson et al., (2012) and outlined in the above studies was

used to recalculate the overall trial-type D-IRAP scores of two participant datasets prior to analysis in this study.

Data Analysis

Following data transformation, the overall mean D-IRAP score was calculated for both the C_{rel}-IRAP and the RCI-IRAP to determine whether responses, on average, were faster during blocks of trials that required responding in a manner that was consistent with natural verbal relations (e.g., Pleasant-Positive-Same) or on inconsistent trial-blocks (e.g., Pleasant-Positive-Opposite). The overall mean D-IRAP scores for both IRAPs indicate that participants more rapidly affirmed consistent relations rather than inconsistent (see figure 6 for graphic representation). Specifically, the overall mean D-IRAP for the C_{rel}-IRAP was .18 (SD = .20) and was .05 (SD= .23) for the RCI-IRAP. Thus, the IRAP effect was produced.
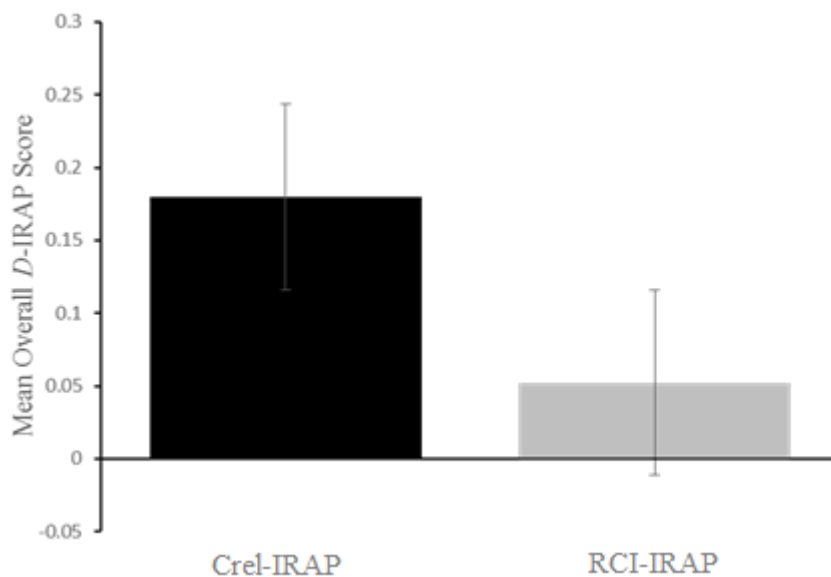
Figure 6. Bar graph showing overall mean D-IRAP scores (with standard error bars) for both IRAPs. The graph indicates a pattern of responding biased towards congruent relations (i.e., Pleasant-Positive-Same, Pleasant-Positive-True).

Main Analysis. Eight one sample t-tests were conducted to assess participant responding across trial-types in both IRAPs. The resultant data are presented in Tables 8 and 9. In the C_{rel}-IRAP the mean D-IRAP score differed significantly from 0 on the Pleasant-Positive (M = .43, SD = .32, $F(23)$ = 6.22, p < .0005) and Unpleasant-Positive trial-types only (M = .33, SD = .34, $F(23)$ = 4.84, p = <.0005). There was no significant difference for the remaining two trial-types of the C_{rel}-IRAP: Pleasant- Negative (M = .004, SD = .45, $F(23)$ = .04, p =.97); Unpleasant-Negative (M = -.05, SD = .32, $F(23)$ = -.79, p = .44). Only the Pleasant-Positive trial-type of the RCI-IRAP yielded a mean D-IRAP score that was statistically significant (M = .31, SD = .42, $F(23)$ = 3.53, p = .002). The remaining results for the RCI-IRAP were as follows: Pleasant-Negative (M = -.06, SD = .42, $F(23)$ = -.67, p = .51); Unpleasant-Positive (M = .07, SD = .28, $F(23)$ = 1.20, p = .16); Unpleasant-Negative (M = -.11, SD = .36, $F(23)$ = -1.46, p = .24). The mean overall D-IRAP scores for each trial-type across both the C_{rel} and RCI IRAPs are presented in Figure 7.

Table 8.

Statistical significance (*p <.05) for the 4 IRAP Trial-Types in the C_{rel}-IRAP, with mean D-IRAP scores per trial-type, standard deviations (SD), F, and P values presented.

Trial-Type	C_{rel}-IRAP			
	Mean	SD	F	p value
Pleasant-Positive	.43*	.34	F(23) = 6.22	<.0005
Pleasant-Negative	.0038	.45	F(23) = .041	.97
Unpleasant-Positive	.33*	.34	F(23) = 4.84	<.0005
Unpleasant-Negative	-.05	.32	F(23) = -.79	.44

Table 9.

Statistical significance (*p <.05) for the 4 IRAP Trial-Types in the RCI-IRAP, with mean D-IRAP scores per trial-type, standard deviations (SD), F, and P values presented.

Trial-Type	RCI-IRAP			
	Mean	SD	F	p value
Pleasant-Positive	.31*	.42	$F(23) = 3.53$	.002
Pleasant-Negative	-.06	.42	$F(23) = -.67$	.51
Unpleasant-Positive	.07	.28	$F(23) = 1.20$	.24
Unpleasant-Negative	-.11	.36	$F(23) = -1.46$	.16

The participant *D*-IRAP scores were subjected to a mixed between-within 2 x 2 x 2 x 4 ANOVA to assess the impact of the type of response options used in the IRAP programme (C_{rel}-IRAP v. RCI-IRAP) and the order in which both IRAPs were completed on participant performance across the four trial-types of the IRAP. The type of response option used, the order in which the response option types were presented to participants, and the Block-Order (i.e., presenting consistent v. inconsistent trial-blocks first) served as the between-participant independent variables (IVs) with IRAP Trial-Type as the within-participant dependent variable (DV). The results revealed a significant main effect for Response-Option-Type (Wilk's Lambda = .79, $F(1, 20) = 5.58$, $p= .028$, $\eta_p^2 = .22$). There was also a statistically significant main effect for Trial-Type: Wilk's Lambda = .31, $F(3,18) = 13.36$, $p < .0005$, $\eta_p^2 = .69$. However, the interaction effect for response option type and sequence was non-significant (Wilk's Lambda = .95, $F(1, 20) = 1.14$, $p = .30$, $\eta_p^2 = .54$). There were no other significant interactions (all p's > .16).
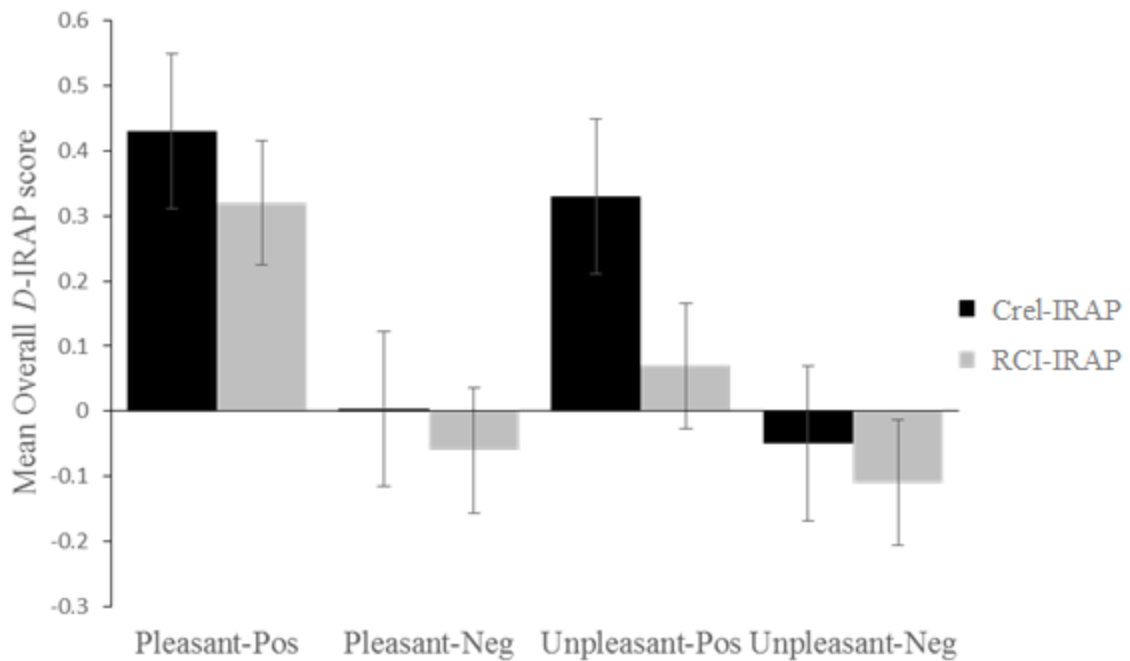
Figure 7. Bar graph overall mean *D*-IRAP scores for the trial-types across both IRAPs in Study 3.

Summary and Discussion

One of the primary aims of Study 3 was to replicate the previous studies demonstrating the impact of two different forms of response options (C_{rels} v. RCIs) employed in the IRAP on IRAP outcomes, and in particular to provide greater clarity regarding sequence effects or interactions with the type of response options employed. Specifically, that if presenting two IRAPs, the first of which uses C_{rel} terms as response options and the second which employs RCI terms as response options, a statistically significant interaction effect would be demonstrated. The data revealed that responding on both IRAPs was mediated by a congruent bias overall. That is, participants more rapidly affirmed consistent relations (e.g., Pleasant-Wonderful-Same) than inconsistent (e.g., Unpleasant-Positive- Same).

Consistent with the findings of Study 1 and 2 of the current research, a significant difference between participant data for both IRAPs was revealed. On this occasion also, IRAP effects differed between the RCI-IRAP (which produced a weaker effect) and the C_{rel}-

IRAP (which produced the stronger effect; see Figure 6). This suggests that the type of response options employed in the IRAP had an influence on IRAP outcomes. Critically, in contrast to the findings of study 1 and of Maloney and Barnes-Holmes (2016), the results of this study did not indicate that the sequence of presentation had an effect on participant responding. Another noteworthy aspect of this study is that the sample size was reduced to N=24 due to very high attrition rates, the cause of which remains unclear at this point. Future research may be required to provide greater clarity, and as previously stated, replication is desirable as a cornerstone of science.

Chapter 5

Study 4: A further exploration of potential sequencing effects on participant responding via two identical consecutive IRAPs.

Experiment 4

Findings in Study 3 provided support for the theory that the type of response option used in the IRAP (i.e., C_{rels} v RCIs) should be given careful consideration when designing IRAP investigations. This was also indicated by the previous studies of the current research programme, however, the research findings are thus far inconsistent regarding the impact of sequence and response options type. This is important, as a potential criticism of research which involves the completion of two consecutive IRAPs in one sitting, thus, any effect on participant performance could simply be explained either by a practice effect on the IRAP, or by participant fatigue from engaging in a repetitive procedure. While there has been some discussion as to practice effects in the IRAP and means of prevention (e.g., Levin, Hayes &Waltz, 2010; Cullen et al., 2010), a diminished IRAP effect (bias) resulting from completing two consecutive IRAPs has received less attention. In light of this, it seemed necessary to determine whether completing two immediately successive IRAPs would in itself impact participant data resulting in different IRAP effects shown in the second IRAP compared to the first, when all other aspects are held constant. This was the focus of study 4. The C_{rels} "Same" and "Opposite" were chosen as response options in both IRAPs, as they have the greatest precedent for use in reported studies in the IRAP literature. This choice is further supported as the current research has indicated that RCIs may not produce similarly robust IRAP effects as C_{rels} in participant data. Due to the exploratory nature of this study no firm predictions were made as to the outcome of analysis.

Methods

Participants

A sample of twenty participants (*N*=20) agreed to participate in Study 4, six of whom were male and 14 female. Their ages ranged from 18 to 42 years (*M*= 22). All participants

were students of NUI, Maynooth and were native English speakers. The study was completed by participants individually in the Lab cubicles with no distractions in the Department of Psychology. Participants were offered no incentives for their involvement in the study. Twenty-six individuals began the experiment however six sets of participant data were removed prior to analysis as they failed to achieve pre-determined performance criteria on the IRAP.

Apparatus and Materials

The apparatus and materials in this study were unchanged from those in Study 1. However, only the IRAP programme presenting "Same" and "Opposite" as response options was used.

Procedure

The procedure for Study 4 was similar to that of Study 1 with the exception that participants completed the IRAP with C_{rels} as response options twice. Thus, participants completed one IRAP with "Same" and "Opposite" as response options (henceforth referred to as $C_{rel}1$-IRAP) and then repeated the procedure ($C_{rel}2$-IRAP). For this reason there were only two experimental groups in Study 4; those who were presented with consistent trial-blocks first (Group 1) and those presented with inconsistent trial-blocks first (Group 2).

Ethical Considerations

Please see Ethical Considerations addressed in Study 1, which are relevant to Study 4 also.

Results

Data preparation

Six participant datasets were excluded from data analysis. Four of these datasets were removed as participants were unable to achieve the required speed and accuracy criteria to progress from the practice to the test phase of the IRAP. The data for two additional participants were excluded as in one case the participant's response latency data exceeded 2100ms and for another participant response accuracy data fell below 75% on more than one test block. The remaining participant data (N=40) were subjected to the same data preparation procedures as were utilised for Study 1. As per Study 1, for each participant three pairs of trial-block data were analysed; if one of the trial-blocks failed to meet the criteria, the data for that pair of trial-blocks were removed, and data for the remaining two pairs of trial-blocks were used; data for five participants were addressed in this manner. If more than one pair of trial-blocks failed to meet criteria, all of that participants data were removed from the analyses (Nicholson et al., 2012).

Data Analysis

Following data transformation, the overall mean D-IRAP score was calculated for both the $C_{rel}1$-IRAP and the $C_{rel}2$-IRAP to determine whether responses, on average, were faster during blocks of trials that required responding in a manner that was consistent with natural verbal relations (e.g., Pleasant-Positive-Same) or on inconsistent trial-blocks (e.g., Pleasant-Positive-Opposite). The overall mean D-IRAP scores for both IRAPs indicate that participants more rapidly affirmed consistent relations rather than inconsistent (see figure 8 for graphic representation). Specifically, the overall mean D-IRAP for the $C_{rel}1$-IRAP was .05 (SD = .27) and was .11 (SD= .24) for the $C_{rel}2$-IRAP. Thus, the IRAP effect was produced.
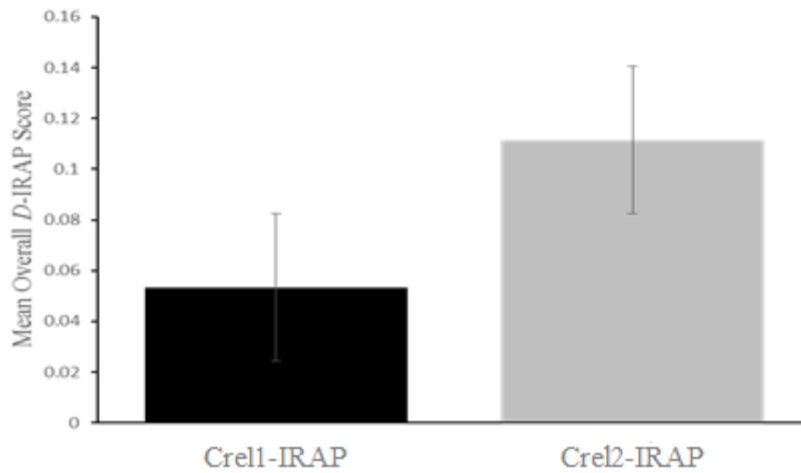
Figure 8. Bar graph showing overall mean *D*-IRAP scores (with standard error bars) for both IRAPs.   The graph indicates a pattern of responding biased towards congruent relations (i.e., Pleasant-Positive-Same).

Main Analysis. Eight one sample *t*-tests (one per trial-type for each IRAP) were conducted to determine if the mean overall *D*-IRAP scores of participants for each trial-type, across both the $C_{rel}1$-IRAP and $C_{rel}2$-IRAP, differed significantly from zero. The resultant data is presented in Tables 10 and 11. For two conditions of the $C_{rel}1$-IRAP, this was the case: Pleasant-Positive (M = .39, SD = .32, $F(19) = 5.45$, $p < .0005$); Unpleasant-Positive (M = -.34, SD = .34, $F(19) = -4.36$, $p < .0005$). The mean overall D-IRAP score for the Unpleasant-Negative (M = .13, SD = .43, $F(19) = 1.40$, $p = .18$) and the Pleasant-Negative (M = .02, SD = .36, $F(19) = .31$, $p = .76$) conditions were not statistically significant. Three conditions of the $C_{rel}2$-IRAP had overall *D*-IRAP scores which differed significantly form zero: Pleasant-Positive (*M* = .35, SD = .30, $F(19) = 5.28$, $p < .0005$); Pleasant-Negative (*M* = .20, SD = .36, $F(19) = 2.49$, $p = .02$); Unpleasant-Positive (*M* = -.23, SD = .40, $F(19) = -2.55$, $p = .02$). The *D*-IRAP score for Unpleasant-Negative was not statistically significant (*M* = .12, SD = .39, $F(19) = 1.38$, $p = .19$).

Table 10.

Statistical significance (*p <.05) for the 4 IRAP Trial-Types in the $C_{rel}1$-IRAP, with mean D-IRAP scores per trial-type, standard deviations (SD), F, and P values presented.

Trial-Type	$C_{rel}1$-IRAP			
	Mean	SD	F	p value
Pleasant-Positive	.39*	.32	$F(19) = 5.45$	<.0005
Pleasant-Negative	.02	.36	$F(19) = .31$	.76
Unpleasant-Positive	-.34*	.34	$F(19) = -4.36$	<.0005
Unpleasant-Negative	.13	.43	$F(19) = 1.40$	.18

Table 11.

Statistical significance (*p <.05) for the 4 IRAP Trial-Types in the $C_{rel}2$-IRAP, with mean D-IRAP scores per trial-type, standard deviations (SD), F, and P values presented

Trial-Type	$C_{rel}2$-IRAP			
	Mean	SD	F	p value
Pleasant-Positive	.35*	.30	$F(19) = 5.28$	<.0005
Pleasant-Negative	.20*	.36	$F(19) = 2.49$	.02
Unpleasant-Positive	-.23*	.40	$F(19) = -2.55$	.02
Unpleasant-Negative	.12	.39	$F(19) = 1.38$	.19

Statistical analysis was conducted using a mixed between-within 2 x 2 x 4 ANOVA on participant (N =20) D-IRAP scores to assess the impact of completing two consecutive IRAPs across the four trial-types of the IRAP. The IRAP exposure ($C_{rel}1$-IRAP v $C_{rel}2$-IRAP) and the order in which consistent and inconsistent trial-blocks were presented (block-order) served as the between-participant independent variables (IVs) with IRAP Trial-Type

as the within-participant dependent variable (DV). The analysis produced a significant effect for trial-type: Wilks Lambda = .10, $F(3,16) = 47.17$, $p < .005$, $\eta_p^2 = .90$. Figure 9 presents the mean overall D-IRAP scores for each of the four trial-type conditions across both IRAPs. No other main or interaction effects were detected (all p's > .12).
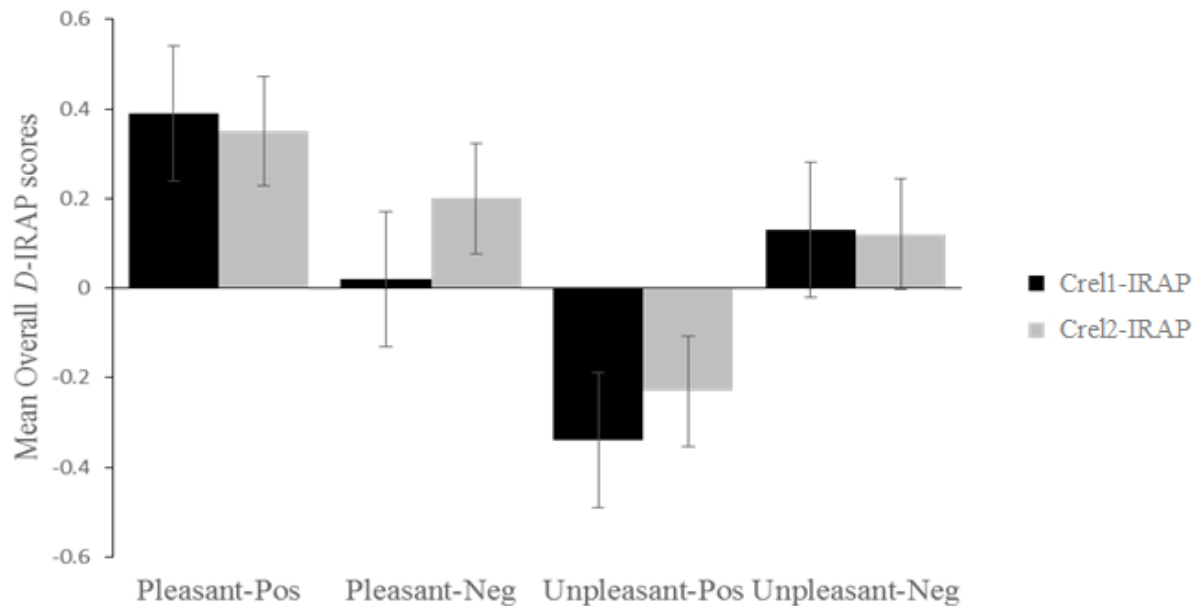

Figure 9. Overall mean D-IRAP scores for the trial-types across both IRAPs in Study 4.

Summary and Discussion

The primary aim of Study 4 was to assess the effect of completing two consecutive IRAPs on IRAP outcomes. The data indicated a significant IRAP effect (bias) favouring 'consistent' verbal relations, as expected, in both IRAPs. Notably, the analysis also revealed that when the data from the two identical successive IRAPs were compared there was no statistically significant difference in responding demonstrated. This was the intended result for Study 4 as both IRAPs were identical. In short, it does not appear that the completion of two IRAPs in one sitting *per se* had any influence on participant responding.

Chapter 6

General Discussion

General Discussion

The aim of the current research programme was to extend the existent literature discussing the behavioural dynamics of the IRAP. Specifically, this research explored the effect of type of response options (C_{rels}. v. RCIs) used in the IRAP. Over three studies, the type and order of two forms of response options (C_{rels} and RCIs) were manipulated to assess their impact on IRAP outcomes. The goal of the fourth study was to determine the impact of completing two identical consecutive IRAPs in one sitting on participant responding. This was to clarify if order interactions were related to the type of response option used, or if the completion of two successive IRAPs *per se* resulted in order interactions. The major findings of the four studies will now be summarised. Subsequently, the results will be discussed in detail and compared to previous research where appropriate. A discussion of the possible wider implications of the research will follow, along with an acknowledgement of possible limitations, and suggestions for future research.

Overview of Findings

Findings in Study 1. The first empirical investigation of the current programme of research manipulated the presentation of two types of response options in the IRAP. Typically, IRAP studies employ one set of response options without explicit discussion as to why those response options were chosen. Often these response options fall neatly into the category of C_{rels} as defined in RFT (see Hayes et al. 2001), yet occasionally researchers have chosen terms which diverge from this definition (i.e., RCIs) without empirical evidence to suggest that the two types of response options would function similarly. Thus, the aim of Study 1 was to develop and expand the speculations proposed by Maloney and Barnes-Holmes (2016) by further examining whether the type of response option presented in the procedure had an influence over IRAP data outcomes. Participants (*N*=40 college students)

were presented with two IRAPs of differing response options (the C_{rels} "Same"/"Opposite" and the RCIs "Accurate"/"Inaccurate"). The results showed that an IRAP effect, consistent with expectations, was demonstrated across both IRAPs. That is, responding on both IRAPs was mediated by a congruent bias (i.e., participant responding was faster, on average, during blocks of trials that required affirming consistent rather than inconsistent relations). Critically, the analysis also revealed that there was a statistically significant difference between responding across the two IRAP types. Furthermore, there was a three-way interaction shown between the independent variables; specifically, the type of response option used, the order of trial-blocks (consistent v. inconsistent) and the order of IRAP type, which appeared to impact some IRAP trial-types. This finding could, potentially, be a spurious interaction or one which is connected to some artefact of the procedure and further investigation (perhaps availing of a different design or approach to analysis) will be required to clarify the matter.

Taken overall, the results of Study 1 were consistent with the theory that the type of IRAP response options used in the procedure (C_{rel} v. RCI) may have an impact on IRAP effects shown. Moreover, the three way interaction shown (type/order of type/order of trial-type) could be viewed as an indicator that multiple aspects of the IRAP presentation are potentially relevant to the participant performance. Overall the findings of Study 1 highlight the need for a systematic analysis of the potential relevance of features in the IRAP methodology that have not hitherto been subjected to rigorous empirical analysis in their own right.

It may be relevant also that there was anecdotal evidence from discussions with participants in Study 1 that participants who studied science-based subjects had a preference for the RCI response options ("Accurate" v. "Inaccurate") compared to C_{rel} ("Same" v. "Opposite"). In addition, other participants suggested that the similarity of the former stimuli

made the distinction a little difficult when trying to respond rapidly, and that responding may have been less than optimal as a result. In order to address these potentially confounding variables in Study 1, and to further explore the IRAP methodology related to type of response options and resultant impact on IRAP effects shown, Study 2 used a different set of RCI response options (i.e., "Right" and "Wrong") for comparison of effects but otherwise kept procedures and stimuli consistent with those used in Study 1.

Findings in Study 2. The results of Study 2 demonstrated an IRAP effect in participant (*N*=40) responding, with participants overall more rapidly affirming Pleasant-Positive relations than the converse (i.e., Unpleasant-Positive relations). Importantly, the results of this study again indicated that the data from the two IRAP types (C_{rel} v. RCI) were different and this was statistically significant, suggesting that the type of response options used impacted IRAP data. There was no statistically significant effect for order of IRAP type, or for trial-block order, and no interaction effects were demonstrated on this occasion. Taken overall, the results of Study 2 (like those of Study 1) are consistent with the suggestion that the response options employed in the IRAP may have an effect on IRAP data outcomes.

Findings in Study 3. The third study aimed to continue the exploration of effects of type of response options used in the IRAP. The main difference between study 3 and earlier studies of this research programme was the use of "True" and "False" as RCI response options. Thus, this study could be viewed as a partial replication of Maloney and Barnes-Holmes (2016) which also employed "True" and "False" as RCI response options. The study, again, compared results of two IRAPs subsequent to manipulating the type of response option (first with C_{rels} "Same" and "Opposite" then with RCIs). The IRAP data for participants in Study 3 (*N*=24, college students) indicated that responding on both IRAPs was mediated by a congruent bias overall, consistent with expectations. The results also revealed that the data from the two IRAP types were significantly different from one another, with a

higher overall D-IRAP for the C_{rel}-IRAP, suggesting the type of response options used influenced participant IRAP performance. Critically, in terms of replicating the effects shown in Maloney & Barnes-Holmes, there was no effect for IRAP order of IRAP type, or for trial-block order, and there was no interaction effects produced from these analyses. Thus, the responding pattern reported by Maloney and Barnes-Holmes (2016) was not replicated in this study.

In Study 3, the failure to replicate the order effect found that Maloney and Barnes-Holmes (2016) may be a result of the C_{rel} response options being altered from those used in the original study. That is, the original study availed of "Similar/Different" as C_{rel} response options whereas Study 3 of the current research used "Same/Opposite". The latter C_{rels} were used because a review of the available IRAP literature indicated that "Same" and "Opposite" are the relational terms most commonly used. Thus, the "Same" and "Opposite" relational terms were seen as response options with the greatest precedence in IRAP research; furthermore, these relational terms may be viewed as more distinctive and indicative of greater bipolarity compared to the terms "Similar" and "Different" used in the original study. Notwithstanding these points, an exact replication of the procedures in Maloney and Barnes-Holmes may be needed to exactly replicate findings, but the results of Study 3 provide further support for the impact of type of response options used in the IRAP.

Findings of Study 4. Given the results in the current research programme and those of Maloney and Barnes-Holmes (2016), the issue of whether or not completing two immediately successive IRAPs might influence participant responding warranted investigation (i.e., would fatigue from completing a repetitive task with mundane stimuli, or practice effects from completing a similar task twice, result in findings of statistically significant differences). Thus, the two IRAPs used in Study 4 employed similar stimuli and relations as those of Studies 1, 2, and 3, but both IRAPs on this occasion used the same set of

response options (i.e., the C_{rels} "Same" and "Opposite"). The results indicated that participant responding (N=20) was similar across both IRAPs. That is, both IRAPs produced results which showed that responding was faster, on average, for trials deemed consistent than trials to the converse (inconsistent). Notably, the data analyses in Study 4 did not reveal any statistically significant difference between participants responding across the two IRAPs; further, there was no statistically significant order effects shown, and interaction effect shown. Thus, completing two IRAPs in succession in one sitting was not shown to impact participant responding, which result may provide tentative support for previous findings that response option type, or an interaction of order of completion and IRAP-type, may exert influence on IRAP effects shown for participants.

Summary of Results

Taken overall, the three experiments of the current thesis, which aimed to examine the impact of type of response options (i.e., C_{rel} v. RCI) used in the IRAP, produced results which indicate that type of response option may indeed exert some influence over participant responding. Furthermore as stated previously, an analysis of the data from Study 1 suggested that order may interact with response option type, as was also suggested in findings by Maloney & Barnes-Holmes (2016). The results of Study 4 showed that the act of completing two consecutive IRAPs *per se* (without manipulating response options) had no significant impact on participant responding. However, the exploratory nature of this research must be stressed and as such no firm conclusions can be drawn from the resulting data, except that overall, the current research programme points to the need for a greater level of systematic analysis of the behavioural dynamics of the IRAP.

In discussing the results of this current research, it should be noted perhaps, that although multiple analyses were conducted, Bonferroni corrections were not applied. It was

felt that the exploratory and preliminary nature of the research warranted a normative P-value (p<.05); this was to lower the rate of type II error that may result from such corrections, especially when conducted with research results with small sample sizes. This ensured that potentially salient variables influencing the data were not undermined or undetected (for discussion see Bender and Lange, 2001).

The Current Results in Relation to Previous Research on Response Options

Although the matter of C_{rels} and RCIs has received some attention in the theoretical RFT literature, the potential influence of type of response options used in the IRAP has received little systematic analysis. In fact, the current programme of research has but one precedent in a study aimed to develop an understanding of response options in the IRAP. A previous preliminary study (Maloney & Barnes-Holmes, 2016) manipulated type of response options used in the IRAP to determine any impact on participant data (N=52), and identified an interaction between response option type and the order of completion of IRAP type. The IRAPs were completed successively, and when participants completed the RCI IRAP subsequent to the C_{rel} IRAP (but not vice versa) there was a statistically significant difference in the IRAP effect shown. The current findings provide some additional tentative support for different effects of RCI and C_{rel} response options in the IRAP, however, the order of completion was not shown to be significant in any of the current four studies. Nonetheless, it cannot be inferred from the current findings that the order of completion of response option type is irrelevant, and all of these matters will need further empirical investigation and indeed replication.

Wider Implications of the Research Findings

The current research represents an exploration of the impact of response option types using C_{rels} and RCIs in the IRAP to determine if these impinge on participant data. Overall

findings across the four IRAP studies presented in this thesis suggest that these issues are not irrelevant, and may impact participant responding and the demonstration of IRAP effects (bias). The nature and extent of influence exerted by response option type needs to be further elucidated, and more extensive research in the area will be required. This potential future research should, perhaps, also include a complete review of how prevalent C_{rel} versus RCI use is across IRAP research; as at present no such record exists.

It is important to note also that although this current research programme was exploratory it was not without theoretical basis. As discussed in the introduction, there has been some speculation as to the function of the terms commonly used as response options in the IRAP; more specifically, it has been proposed that certain terms (i.e., RCIs) do not speak directly towards a relation between stimuli, but rather indicate the coherence of a relational network (see Hayes and Barnes, 1997, for a full discussion). According to RFT, a relational network is deemed coherent if it is considered logical, or to be true in some way. For example, the statement "elephants are bigger than mice" coheres with wider patterns of relational responding in natural language and, as such, is considered to be "true" or "accurate". In contrast, the statement "elephants are smaller than mice" does not cohere with natural language practices and, thus, is considered "false" or "inaccurate". In this context, the terms "True" and "False" pertain to the veracity of the statement and are not strictly accurate in terms of relational responding as outlined in RFT theoretical and research literature, for example relations of coordination, comparison, distinction, opposition, temporality, or hierarchy. These types of relations, whether physically based or assigned by context or community, have received empirical support in the research literature (e.g., Dymond et al., 2008; Gil et al., 2012; Vitale et al., 2008). Although it might be speculated that "True", "Right" or "Accurate" would function similarly as "same-as" co-ordination relations, the current research findings (and those of Maloney and Barnes-Holmes, 2016) suggest that this

may not be the case, at least as this pertains to the use of response options in the IRAP procedure. Consequently, in this context (until proven otherwise), the response options "True" and "False" can be defined as RCIs and are, thus, distinguished from C_{rels} (i.e., "Same" and "Opposite"). On this account RCIs should not be expected to result in the same or similar findings as C_{rels}.

The findings of this current research programme may be seen to provide tentative support for an understanding that C_{rels} and RCIs have different functions within verbal language under certain circumstances, in that participant responding on both IRAPs (C_{rel}-IRAP v. RCI-IRAP) was significantly different across three studies, which would not be expected if the type of response option used was irrelevant. In this regard also, Study 4 which used an identical type of response option (C_{rels}) across two IRAPs provided some support for the proposition that if the response option type is held constant, then participant responding will not be significantly different across the two IRAPs.

In terms of explaining these results, it has been speculated that because relational terms such as "Same" and "Opposite" pertain directly to the relation presented, participants on a C_{rel}-IRAP are simply asked to respond to the stimuli on screen (i.e., Pleasant-Positive-Same, Pleasant-Negative-Opposite). In contrast, if the terms "True" and "False" function as RCIs (dependent on the verbal repertoire of the participant), then responding on the RCI-IRAP may have involved two steps: participants are first required to determine the relation, and then affirm or deny its coherence or otherwise to their relational networks. That is, the truth or falsity of a statement can only be determined if there exists some basic level of C_{rel} control in an individual's verbal repertoire. Thus, an individual must first be capable of identifying the relation between two terms (i.e., X is the *same as* Y; X is *opposite to* Y) before ascertaining if the relation proposed is coherent with natural language (for a more thorough account see Maloney and Barnes-Holmes, 2016). Therefore, it is possible that in

this context the RCI-IRAP may have involved more elaborative responding (e.g., see Hughes and Barnes-Holmes 2016b on BIRRs and EERRs) and this potential elaboration of the response pattern may be have contributed to the difference noted between IRAP outcomes throughout the current research. The foregoing, although based in theory, is nonetheless speculative; what is clear, however, is that a greater level of systematic analysis of the complex and dynamic variables involved in the IRAP procedure, including the response options, shall be required before a sophisticated level of understanding of these components is achieved.

Potential Limitations

IRAP effect. As previously noted, the aims of the current research were primarily to investigate methodological issues in the IRAP. For this reason, a simple IRAP format presenting either the word "Pleasant" or "Unpleasant" as sample stimuli with words that could be readily categorised as positive or negative as target attribute stimuli was employed in all four studies. Participants were expected to more rapidly affirm pleasant-positive relations when presented compared to unpleasant-positive relations; and the simple format was in order that participant responding to more evocative relations would not introduce confounding variables. It is perhaps a possibility that the presentation of such a mundane set of relations in the IRAP procedures, however, resulted in higher attrition rates and diminished participant performance across the research programme, but this remains speculative.

Overall the results of studies 1 and 2 revealed a significant IRAP effect which indicated responding that was consistent with natural language expectations (i.e., more rapidly affirming *Pleasant-Positive-Same* relations than the converse). However, the IRAP effect was less evident in studies 3 and 4. The smaller sample sizes may have been relevant here, as the first two studies had larger participant samples. Also the rate of attrition was

particularly problematic in Study 3, resulting in data from a total of 17 participants being excluded. Study 3 was conducted during a period of examinations for the college students who formed the cohort of participants, and it may be that this was a factor in attrition rates. Anecdotally, participants reported that they found it difficult to concentrate on anything but the examinations. Limitations related to psychological research have been well documented in regard to the use of samples of convenience such as psychology students as per the current research, which defeats the research ideal of randomisation and generalisability of research findings (e.g., Peterson & Merunka, 2014). Attrition rates for IRAP participants in earlier years were somewhat problematic but have been shown to be positively influenced by the use of a specific participant instructions protocol (see Hussey, Daly, & Barnes-Holmes, 2015), and future research may be well advised to follow this script to reduce participant attrition rates. The criterion for the test-blocks of all IRAPs across the current four studies was extended from a median response latency of 2000ms with an accuracy exceeding 80% (as trained in practice blocks) to a median response latency of 2100ms with an accuracy exceeding or equal to 75%., however, this did not appear to be effective in reducing attrition rates in the latter studies. Perhaps a response latency of 2500ms may have had more beneficial effects in reducing attrition rates, however, the reduction of speed in responding may reduce or eliminate the IRAP effect even while facilitating participants in completing the IRAP procedure (Barnes-Holmes, Barnes-Holmes, Stewart, & Boles, 2010).

It is also perhaps worth noting that the IRAP trial-type "Pleasant-Positive" was the only trial-type across all four studies to consistently produce a statistically significant IRAP effect. Overall, there was no clear trend for responding in the other IRAP trial-types across all four studies. It has been suggested that stimuli presented in trial-types such as "Pleasant-Positive" are more readily associated with positively valenced response options (i.e., "Right"/ "True"/ "Accurate"), thus, a positive bias could have potentially aided in IRAP effects shown

on this trial-type (O'Shea, Watson, & Brown, 2015; Bast & Barnes-Holmes, 2015); however, such contentions need to be subjected to empirical testing.

A final point regarding potential limitations in the current research programme pertains to the inclusion of moving response options (i.e., counterbalanced right-left location of response options across trial-blocks) as conducted in the current research programmes, have also been shown to have a slight effect on IRAP outcomes (Campbell et al., 2011). In truth, there are a number of variables which may have potentially influenced the current set of results across four studies. However, it was not within the remit of the current research to investigate all the IRAP features which may be relevant to participant responding, nor was it considered possible to control for all potential confounding variables, and this will require more extensive investigations in a number of IRAP aspects.

Conclusion

The current programme of research has added to an understanding of the importance of C_{rels} v. RCIs in the IRAP research literature, and points toward the importance of theoretical literature in directing research endeavours. The IRAP is a relatively recent development that has shown immense potential regarding behavioural investigations of complex phenomena previously thought to belong solely to the domain of cognitive psychology, notwithstanding this early promise, continued rigorous scientific investigation is required in order to understand and validate this behavioural measure of implicit stereotype.

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Appendix A: Consent Form

In agreeing to participate in this research I understand the following:

This research is being conducted by Emma Maloney, a post-graduate student at the Department of Psychology, Maynooth University under the supervision of Dr. Carol Murphy and Dr. Bryan Roche. The method proposed for this research project has been approved in principle by the Social Research Ethics Subcommittee (SRESC), which means that the Committee does not have concerns about the procedure itself as detailed by the student. It is, however, the above-named student's responsibility to adhere to ethical guidelines in their dealings with participants and the collection and handling of data. If I have any concerns about participation I understand that I may refuse to participate or withdraw at any stage before the completion of the experiment.

I have been informed as to the general nature of the study and it has been explained that there are no known expected discomforts or risks associated with participation. I am aware that all data will be analysed at a group level rather than individual level, and that the data will be coded from the outset, retaining no personal identifiers.

At the conclusion of my participation, any questions or concerns I have will be fully addressed. With this knowledge I agree voluntarily to participate.

In signing this form I confirm that I am at least 18 years of age, with English as my first language. I further confirm that I do not have impaired vision uncorrected by prescription lenses or photosensitive epilepsy/ a history of seizures. I do so with the knowledge that with any electronic device there exists a risk of potential seizures. Research regarding this issue and the IRAP indicates that this risk is minimal. However, participants with a history of seizures are advised to withdraw their participation from this study.

_____

Participant

Researcher:
Emma Maloney: emma.maloney@nuim.ie, 083 835 9020

Supervisor:
Dr. Carol Murphy, BCBA-D: carol.a.murphy@nuim.ie, 01-7086723

Dr. Bryan Roche: bryan.t.roche@nuim.ie, (01) 7086026

If during your participation in this study you feel the information and guidelines that you were given have been neglected or disregarded in any way, or if you are unhappy about the process, please contact the Secretary of the Maynooth University Ethics Committee at research.ethics@nuim.ie or +353 (0)1 708 6019. Please be assured that your concerns will be dealt with in a sensitive manner.

Appendix B: Information Sheet

INFORMATION SHEET

PLEASE KEEP THIS PAGE FOR YOUR INFORMATION

Research Topic: Exploring the Behavioral Dynamics of the Implicit Relational Assessment Procedure:

Information sheet for participants:

Thank you for agreeing to participate in this study which is being conducted as part of my Masters of Science in Psychology degree, in the Department of Psychology, in Maynooth University. My name is Emma Maloney and I am the primary researcher involved in this study. I am working under the supervision of Dr Carol Murphy and Dr Bryan Roche of the Department of Psychology, Maynooth University, with whom the contact details of each are available at the end of this sheet. The current study aims to explore the effect of response option choice on participant performance in the Implicit Relational Assessment Procedure (IRAP).

Why is this research being carried out?

The theoretical framework on which the IRAP was created suggests that certain words function differently. For example, the words bigger and smaller point to a direct relationship between two stimuli (i.e., the apple is different from the banana). The words true and false, serve a different function. Such words confirm a relation between two stimuli (i.e., it is true that the apple is different from the banana). Despite this functional difference both kinds of words, referred to as Contextual Relations (Crels) and Relational Coherence Indicators (RCIs) in IRAP literature, are interchangeably used as response options in IRAP studies. This research aims to assess whether the different kinds of words used have an effect on the results from the IRAP. If you would like more information on the theoretical framework on which the IRAP is based please contact me via the contact details provided below.

Specific aims:

- We aim to assess whether an IRAP using true and false as response options produces different results to one using similar and different as response options.
- We also aim to assess whether different examples of Crels (i.e., same/opposite) and RCIs (i.e., yes/no) produce the same results as above.

Who should participate?

Adults, older than 18 years, with English as their first language should participate in this study.

What does participation involve?

Participants will be required to complete a computer-based task called the Implicit Relational Assessment Procedure (IRAP). The IRAP measures a person's implicit attitude by providing participants with rules that they must follow when presented with certain words. Participants will be presented with pairs of words which are considered pleasant (i.e., positive, wonderful, lovely) or unpleasant (i.e., negative, awful, bad) or a combination (i.e., a positive word with a negative word). The participant must respond with the appropriate response option, based on the rule.

Length of study

The two IRAPs should take no longer than 50 minutes to complete. Participation is voluntary and participants can withdraw at any stage.

Confidentiality

No identifying information such as the name of individual participants or places of employment will be retained or published in any subsequent research article. All data are recorded using a code and not your name. Due to the anonymous nature of the data, once your data have been submitted they cannot be removed from the study. It should be noted that participation is entirely voluntary and you are not obliged to take part and can withdraw at any stage without penalty of any description. Data will be kept in a locked file in the department of psychology, in Maynooth University. Data will be retained for 10 years after completion of the study, after which time it will be destroyed.

It must be recognized that, in some circumstances, confidentiality of research data and records may be overridden by courts in the event of litigation or in the course of investigation by lawful authority. In such circumstances the University will take all reasonable steps within law to ensure that confidentiality is maintained to the greatest possible extent.

What will happen to the data?

The data will be used as part of a Masters Degree thesis and may be published in an academic journal. If this were the case, all information regarding all participants will still remain entirely anonymous. If you have any queries, please contact me via the details provided below.

Is there any risk in taking part in this experiment?

Due to the use of a computer programme and on-screen stimuli, it is recommended that any individuals with a history of photosensitive epilepsy or seizures do not partake in this

experiment. Otherwise it is not expected that there be any dangers in completing the experiment. If you do feel any discomfort during this experiment you are encouraged to cease participation immediately.

Contact details

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