INTUITION IN THE CONTEXT OF REVELATION:
A BIOFUNCTIONAL APPROACH

by

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A DISSERTATION

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ABSTRACT

Research on intuition is known for its numerous conceptualizations of intuition construct proposed by various theoretical camps for more than a century. In addition to this absence of a consensus over the definition, almost none of the many instruments developed over the years have been successful in measuring intuition especially in light of the findings of recent interdisciplinary research regarding crucial aspects of intuitive behavior. This is mainly because processes underlying intuitive decisions elude conscious awareness and therefore, remain unidentifiable. This elusiveness has in turn resulted in theories basing their objective measurement efforts on what intuition is not rather than what it is. This dissertation is an attempt to address this theoretical/conceptual problem by conducting three studies1. The first two are replication studies of two well-cited instruments, the waterloo gestalt closure task (WGCT) and the rational-experiential inventory (REI). Aside from popularity, the mainstream theoretical framework on which they are based – dual-process theories of mind – was pivotal in their selection for replication. In the third theoretical study, attempts were made to address the issues revealed by the two empirical studies by analyzing the nature of responses and the overall factor structure of subjects’ data collected by both measures. The results revealed that the wholetheme

1 The use of human participants in this dissertation was approved by the Institutional Review Board of the University Alabama. All subjects gave informed consent in accordance with the Declaration of Helsinki. The protocol was approved by The University of Alabama Institutional Review Board (IRB # 16-OR-342).
spiral of biofunctional understanding presents itself to be a fit model for the data, explaining a significant proportion of variation especially when it comes to subjects’ intuitive performance on both WGCT and REI. At the end, implications offered by the biofunctional theory of intuitive understanding as a unifying theoretical framework for research on intuition are discussed, particularly as it relates to the discipline of educational psychology.

Key Words: Intuition, Disembodied information processing, Waterloo gestalt closure task, Dual-process theories, Rational-experiential inventory, Conceptual understanding, Biofunctional understanding, Knowing-by-revelation, Understanding-by-reflection, Intuitive understanding, Iran-Nejad's wholetheme spiral of biofunctional understanding, Biofunctional model of intuition.
DEDICATION

This dissertation is dedicated to the memory of my father, Mostafa.
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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>$a$</td>
<td>Cronbach’s index of internal consistency</td>
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<td>$p$</td>
<td>Probability associated with significance value</td>
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<td>$t$</td>
<td>Computed value of t test</td>
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<td>$&lt;$</td>
<td>Less than</td>
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<td>Standard deviation</td>
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<td>$r$</td>
<td>Pearson product-moment correlation</td>
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<td>$CEST$</td>
<td>Cognitive-experiential self-theory</td>
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<tr>
<td>$PDT$</td>
<td>Picture discrimination task</td>
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<tr>
<td>$FOK$</td>
<td>Feeling of knowing</td>
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<tr>
<td>$OBA$</td>
<td>Ongoing biofunctional activity</td>
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<td>$MCF$</td>
<td>Momentary constellation firing</td>
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<td>$UBR$</td>
<td>Understanding-by-reflection</td>
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<td>$KBR$</td>
<td>Knowledge-by-revelation</td>
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<tr>
<td>$EFA$</td>
<td>Exploratory factor analysis</td>
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INTRODUCTION

The root of the word *intuition* in the English language comes from the Latin word *intueri* which means; to look within or inside (Merriam-Webster's, n.d.). This linguistic definition makes sense if we consider gut feeling as the other commonly used phrase. We all have heard the advice from the wise to listen to our gut feeling or follow our heart in many matters of daily life ranging from choosing a brand over another to overwhelming decisions. Yet, even though these gut feelings are so familiar to us, the scientific study of this common experience has not been quite successful in understanding their nature or underlying processes (Shirley & Langan-Fox, 1996). A brief glance at the literature of intuition research reveals that it is inundated with varying definitions and conceptualizations (Agor, 1989; Bastick, 1982; Epstein, Pacini, Denes-Raj, & Heier, 1996; Nisbett & Wilson, 1977; Nutt, 1989; Ray & Myers, 1986; Simonton, 1980; Vaughan, 1979). Having based the definition on certain aspects of some theory, each of these frameworks has presented an incomplete representation of the construct of intuition (Behling & Eckel, 1991; Osbeck, 2001). Part of this problem goes back to the elusive nature of intuition, as processes underlying intuitive decisions or behaviors occur too fast to be registered by conscious awareness. Sinclair (2011) pointed out that this elusiveness has, in turn, resulted in theories basing their objective measurement efforts generally on what intuition is not rather than what it is. A second problem, closely related to the first, is the fact that much of the recent experimental methodology pertaining to the study of intuition has typically focused on a single facet or manifestation of intuition at the expense of the other equally important aspects. This problem,
referred to as simplification by reduction or isolation (Bartlett, 1932; Iran-Nejad, McKeachie, & Berliner, 1990; Searle, Dennett, & Chalmers, 1997), has been a common theoretical and experimental approach when it comes to the scientific investigation of hard problems such as consciousness or intuition. Some examples of these reductionist operationalization efforts (instruments) which have reduced intuition to specific abilities include implicit pattern recognition tasks of Gestalt psychology, remote associate tasks of information processing theories or self-report attitude inventories of dual-system theories of mind.

As a result of applying the reductionist approach, spreading activation (Anderson, 1983) and dual-system accounts (Chaiken & Trope, 1999) have been the subject of considerable criticism (Evans & Stanovich, 2013; Fodor, 1983). The spreading activation account and its associated instruments such as gestalt closure and remote associate tasks have been criticized for measuring intuitive behavior only by means of memory networks and processes since these instruments have been constructed based on the idea of serial activation of stored knowledge in an interconnected network of associations in long-term memory. According to this account, if the spreading of successive memory activations is not sufficient to enter conscious awareness in the form of an explicit solution, then it will be sensed as an intuitive hunch (Bowers, Regehr, Balthazard, & Parker, 1990) or the feeling of knowing (Hart, 1965). Critics have argued that the gestalt account has failed to address the complexity involved in intuitive hunches by reducing them to mere activation of memory associations and thus, instruments such as WGCT and RAT apparently measure memory rather than intuitive ability.

Two-system theories assign mental processing to two independent systems with the first system labeled as experiential and the second system as rational. According to these accounts, the experiential system executes intuitive processes which are preconscious, automatic, fast and
affect-laden. The rational system, on the other hand, runs conscious processes such as analytic reasoning and deliberation and, therefore, is slow and free of affective influence (Evans, 2007; Evans & Stanovich, 2013; Smith & DeCoster, 2000; Stanovich, 1999; Stanovich & West, 2000). The first wave of criticisms has been directed to the inconsistency of features attributed to each system in recent years (Keren & Schul, 2009). The second wave emerged from the findings of two independent yet simultaneously developing lines of research in the areas of neuroscience of decision-making and biofunctional theory of understanding which questioned the idea of dividing the mind into two separate systems. As for the former, experiments using imaging technologies discovered that people with pathologies to the regions of the brain associated with intuition and emotions were unable to make logical decisions, which presented evidence that logical decision-making is based on emotional intuitions (Bechara, Damasio, Damasio, & Anderson, 1994; Bechara, Damasio, Tranel, & Damasio, 1997). These findings presented evidence that rational and intuitive processes do in fact share the same neural pathways depending on the decision-making situation and contradicted the main tenet of two-system theories that intuitive and rational processes are executed by distinct neural processes (Bechara, Damasio, & Damasio, 2000).

Another corollary of this discovery was the idea that active or conscious mental functions could be generated by intuitive processes, therefore, rejecting the long-held idea that intuitive decisions take place preconsciously. For instance, when it comes to implicit pattern detection in gestalt pictures, Dijksterhuis and Van Olden (2006) explain them in terms of deliberative pattern identification performed too fast to be noticed by active attentional resources. Other intuition researchers such as Sinclair (2011) also support the idea of the contribution of the intuitive system to the rational system and vice versa. In other words, rational decisions are not solely the
outcome of the logical system but a product of both systems in an integrative fashion. The main theme of all these recent findings was proposed almost two decades earlier at the time of the popularity of information processing and dual-system theories in what came to be known as the biofunctional theory of understanding. In the first paper from a series of papers published over a period of two decades Iran-Nejad and Ortony (1984) proposed that mental processes (intuitive or rational) are transient biological functions of the nervous system in a coherent fashion (vs. discrete). This theory was groundbreaking at a time when brain research and the associated theories were viewed as voodoo science due to the substantial influence of old Cartesian dualism on social psychology (Diener, 2010). This dualistic Cartesian demarcation still bears heavy influence on scientific research, manifesting itself in the form of mind-body division or the dualistic division of mental processes into intuitive versus rational systems (Garson, 2015).

Given the above controversy in the literature, this dissertation is an experimental attempt to offer a critical appraisal of these Cartesian accounts specifically directed at intuition research and current intuition instruments by replicating and problematizing two major studies (instruments) in the intuition literature. Moreover, due to a lack of a unifying theoretical framework in presenting a clear and unambiguous conceptual definition of intuition, the goal is to test whether the biofunctional model of understanding is a suitable framework for intuition based on the results obtained from the three studies conducted on two intuition instruments in this dissertation. The first instrument, Waterloo Gestalt Closure Task (WGCT), is a well-cited visual pattern recognition task developed by Bowers et al. (1990) based on the spreading activation account of information processing theory. The second instrument, Rational-Experiential Inventory (REI), was constructed by Epstein et al. (1996) based on cognitive-experiential self-theory (Epstein, 1998). As a well-cited inventory in studies of intuition in the
literature, REI was designed to target self-report attitudes of individuals’ reliance on intuitive or rational thinking.

In the two empirical articles that follow this introductory section, first, I present a review of objective measures developed based on these two paradigms as well as a summary of critiques and problems associated with them. Next, I present the methodology and the reported findings of the original studies which developed WGCT & REI intuition instruments along with a comparative analysis of the results obtained from the present experiments. Finally, I present article three which is a theoretical integration of the first two articles from the biofunctional theory of understanding perspective. This will be illustrated by presenting three evidence-based accurate predictions: (a) data structure of each experiment including the original studies, (b) subjects’ responses to both instruments, (c) correspondence of the main factors in the data structure to the components of wholetheme spiral of biofunctional understanding (Iran-Nejad & Irannejad, 2017).
ARTICLE 1 CONCEPTUAL AND OPERATIONAL DEFINITION OF INTUITION: ACCOUNTING FOR A FAILURE TO REPLICATE GESTALT CLOSURE STUDY

Abstract
Proponents of constructivist information-processing perspective assume that intuition is a joint dual-control function of an input-elaboration-output process of spreading activation in semantic long-term memory aimed at the construction of a domain-specific gestalt or schema. According to this constructivist perspective, activation spreads first as a function of unconscious automatic control to tacit or implicit parts of a domain-specific object (e.g., a teapot) before reaching the whole gestalt or schema for the object. Then, as the spread of activation builds up, it reaches the level of the gestalt closure and the second type of conscious control. To test this theory, the waterloo gestalt closure task (WGCT) was built. This task consisted of two sets of picture frames, one experimental and one control to be used forced choice by the subjects in a sequence of randomly paired choice-versus-chance test items. For most of their subjects and items, the original investigators expected the choice picture frame to represent the automatic unconscious activation control without crossing the threshold to the conscious control and gestalt closure, even though some of the participant and/or items were likely to cross the threshold. The authors reported that subjects who were unable to name the correct object could select the choice
picture frames significantly above chance. In this article, a study\(^2\) was conducted that employed their methodology but the original findings were not replicated. Then, the study was repeated, this time using a more open correctness criterion which included alternative revelations and the original findings were replicated. This paper reports experiment one failure to replicate and speculate about some of the reasons for the successful replications of original findings in experiment two and three. Among these, this paper explores whether the conceptual definition, WGCT methodology or something else is the culprit behind the initial difference between the original and experiment one findings.

*Key Words*: Disembodied input-elaboration-output processing, Spreading activation, Waterloo gestalt closure task, Identification-by-revelation, Momentary constellation firing, Ongoing biofunctional activity, Biofunctional intuition.

There is no consensus on a conceptual definition or a unified model of intuition in the literature as each model has focused on specific aspect(s) regarded to be essential to intuition (Sinclair, 2011). In addition to this absence of consensus over the definition, almost none of the many instruments developed over the years have been successful in measuring intuition especially in light of the findings of recent interdisciplinary research regarding what counts as intuitive behavior (Vaughan, 1979). This is mainly because processes underlying intuitive decisions occur too fast to be registered by conscious awareness and, therefore, remain unidentifiable (Järvilehto, 2015). This elusiveness has resulted in theories basing their objective

\(^2\) The use of human participants in this dissertation was approved by the Institutional Review Board of the University Alabama. All subjects gave informed consent in accordance with the Declaration of Helsinki. The protocol was approved by The University of Alabama Institutional Review Board (IRB # 16-OR-342)
measurement efforts on what intuition is not rather than what it is (Gigerenzer, 2007; Kruglanski & Gigerenzer, 2011). A second issue is the problem of simplification by reduction or isolation (Bartlett, 1932; Iran-Nejad, 1990; Searle, Dennett, & Chalmers, 1997) in intuition research in the sense that some of the recent methodological efforts pertaining to intuition research have typically focused on a single aspect in a specific context of intuition as a dual-process or dual-control function.

The purpose of this paper is to evaluate the waterloo gestalt closure task (WGCT) as an example of one of these efforts to measure a single aspect of intuition in a specific context. Using a constructivist information-processing perspective, Bowers, Regehr, Balthazard, and Parker (1990) proposed that intuition is the outcome of activation spreading through semantic memory networks in an input-elaboration-output system. According to this constructivist perspective, this spreading activation is initially under the control of the unconscious system in the form of tacit knowledge of a domain-specific object (e.g., a teapot) before reaching the whole gestalt or schema for the object. Then, as the spread of activation accumulates, it reaches the level of the whole gestalt closure and crosses the threshold of awareness, emerging as a hunch under the conscious control system.

To test this proposal, the authors constructed a gestalt closure task which consisted of two sets of picture frames, one experimental (representing a real object) and one control (meaningless pattern). For most of their subjects and items, the investigators expected the choice picture frame to represent the automatic unconscious activation control without crossing the threshold of the conscious control, resulting in gestalt closure. Some of the items, however, were likely to cross the conscious threshold and participants could identify (name) the object. The authors reported
that subjects who did not identify the correct objects, could select the meaningful picture frames significantly above chance.

One of the areas of concern related to WGCT is the likelihood that subjects might not make the same identification of gestalts as the researchers intended. To give a specific example, the pilot phase of the present study employing the methodology of Bowers et al. (1990) showed that many subjects did not make the same identifications for some of the items as intended by the original researchers (e.g., identifying a gestalt as hand mirror instead of the intended tennis racket). In this paper, I report the results of two experiments that employed a computerized version of WGCT to explore, in more detail, the nature and the likelihood of gestalt identifications that were different from those intended by Bowers et al., as well as their contribution to the conceptual definition of intuition and the WGCT methodology.

**Review of Literature**

**The Original Gestalt Closure Study**

Bowers et al. (1990) combined principles from two predominant paradigms of constructivism and gestalt psychology to investigate intuitive learning and problem solving. From constructivism, they adopted principles of discovery learning approach which proposed that discovery learning takes place in problem solving situations where the learners draw on their own experience and prior knowledge (Bruner, 1961). From the gestalt theory, they adopted its main tenet of the unified whole is more than the sum of its constituting parts to create what they believed to be the appropriate problem-solving situation for discovery learning to take place. Along the same lines, they defined intuition as judgment made through discovery, arguing that the previous accounts of intuition had mostly focused on ex post facto justifications of erratic intuitive behavior. Based on this view of intuition, they concluded that closure gestalts were
suitable candidates to serve as the context for discovery in order to examine the role of intuition in informing judgment in problem-solving situations.

Therefore, to construct a problem-solving context with the above features, Bowers et al. (1990) asked art students at the University of Waterloo to draw two sets of gestalt pictures. For the first set of gestalts, the artists draw what they judged to be pictures of ordinary objects in the real world. Next, using the same gestalt elements, the artists were asked to draw a second set of meaningless gestalts to serve as control stimuli for each of the original meaningful gestalts. Each of the picture pairs were then presented to subjects on a widescreen slide-show for 5 seconds, followed by an 8-second interval during which they completed a form with the following prompts: (a) the name of the object pictured, (b) a forced-choice question asking which one of the pictures (A or B) was a real object and, (c) level of confidence in their choice on a 5-point Likert scale.

To analyze subjects’ responses, the researchers measured the proportion of correctly identified gestalts (labeled as solution score) and the proportion of unsolved items that were, nevertheless, selected as real objects (labeled as guiding index). The results showed that subjects across the samples gave the same names intended by the researchers to almost one-third of the items. They also reported that the average proportion of unsolved gestalts correctly selected as real objects was the higher than chance value of .60. Based on this finding, Bowers et al. concluded that “people more often than not choose unsolved coherent gestalts” (p. 82).
Bowers et al. (1990) explained the higher than chance distinction of the implicit patterns in gestalts to be the outcome of the incremental accumulation of clues to patterns which subsequently triggers subjects’ relevant semantic and network of associations. This accumulation, they speculated, eventually causes the activation to cross the threshold of consciousness in the form an informed guess. According to their proposed model, this process occurs in two successive stages. The first stage, the guiding stage, involves an implicit
perception of patterns that guides thought towards a more explicit perception of the pattern in question by a process of spreading activation which automatically activates relevant semantic networks of associations. The second stage, the integrative stage, involves integrating into consciousness a plausible representation of the pattern in question when sufficient activation has accumulated to cross the threshold of awareness. In other words, during the guiding stage, informational cues from partial gestalt stimulus start building up which results in a sense of pattern. This sense of pattern spreads through relevant networks (spreading activation) until accumulation of clues are strong enough to be sensed as an intuitive hunch.

Proponents of the spreading activation theory posit that information is encoded into cognitive units and the strength of these units increases with practice and decays with delay (Anderson, 1983; Collins & Loftus, 1975). These cognitive units, in turn, form an interconnected network through which retrieval is performed by cumulatively spreading throughout this network. It is at this integrative stage that people are usually able to consciously reason about their decisions, although often, their reasoning is justification after-the-fact based on the context and their previous experiences with the stimulus. Utilizing the same theoretical framework, Bowers et al. (1990) proposed that it is the spreading activation of semantic networks during the guiding stage which causes the information to build up and eventually inform subjects’ judgment as to which gestalt choice represents a meaningful object. In the literature, there exists several replication studies of gestalt closure task which have modified the original gestalts or the procedure to investigate related phenomena (e.g., unconscious priming). For example, Bolte and Goschke (2008) replaced the original gestalt drawings with a set of meaningful versus random fragmented lines to examine subjects’ implicit object perception. They reported that the obtained intuiting index (guiding index) was equal to the chance value (.50). In another study, Lazerus
(2012) classified participants into intuitive and non-intuitive groups based on their performance on picture discrimination task (PDT). Then, she presented both groups with gestalts pictures to test whether more intuitive subjects as determined by PDT would also select meaningful gestalts more than non-intuitive subjects. The results showed that more intuitive subjects performed better than the other group in selecting meaningful gestalts, but the difference between the two groups did not reach statistical significance. In other words, intuitive participants showed a slight tendency to be more accurate at selecting the meaningful images than non-intuitive participants.

The Present Study

In the present study, a modified (computerized) version of gestalt closure task was constructed to examine whether this procedural modification offers any insight into resolving the mixed findings of gestalt closure studies in the literature. Before discussing the methodology, two features – one methodological and one contextual – that distinguish the present investigation from the original study, are discussed. These two features may hold the potential to examine if gestalt closure task provides a context of discovery for intuition as claimed in the original study.

Methodological differences with Bowers et al. (1990) study.

The original study was conducted in a hands-on fashion where the researchers were physically present during the experiment and directly involved in providing instructions to ensure that participants meet the obligation of either producing a hunch or a solution for gestalts. If subjects were unable to come up with an object name or a coherence choice, then they were obliged to produce some sort of solution. In the present study, the original procedure was modified into a hands-off experiment by developing a computerized version of the gestalt closure task. The main purpose of this modification was to create more response-time for gestalt
identifications and coherence discriminations. This enabled the present study to examine certain responses types which could not be obtained via the original procedure.

For instance, the computerized WGCT did not involve experimenter-subject interaction for task instruction and response collection as in the original study. In lieu of an in-class experiment (presentation of gestalt slides and task instructions to participants on a screen), an online link containing task instructions and item presentations was emailed to participants. This hands-off experiment offers two advantages. First, it can reduce the degree of distress subjects might experience due to the experimenter’s presence and help subjects generate more natural responses. Second, it can eliminate any type of experimenter cognitive bias effect as a threat to the internal validity of the study (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). The online WGCT can also eliminate the observer-expectancy effect (Rosenthal, 1966) by which researchers subtly convey their desired responses to the subjects. In addition, although research on the comparison of online versus in-class testing is abundant, no research comparing online versus in-class (hand-run) psychological experiment exists to date. Therefore, it would be interesting to compare WGCT responses generated under two conditions: (a) the computerized WGCT in which respond to gestalts in a self-paced fashion, in a place/time of their choosing and with low stress level, (b) the manual WGCT conducted by researchers.

Moreover, the computerized WGCT provided subjects enough time to guess (identify) the name of the object after viewing the gestalt pairs for 5-seconds and before moving on to gestalt judgment (in the original study subjects were given only 8 seconds to either generate a solution or a hunch). This self-paced task progression feature would resolve a key issue in the original procedure especially for occasions where subject have some sort of guess about the object name, but then because of feeling uncertain about the correctness of the object name, they
would go for gestalt coherence judgment without verbalizing their guesses or reporting them. Under the self-paced progression, subjects would only go for gestalt judgment, had they not come up with any name whatsoever and, thus, could move on securely for coherence selection.

As noted above, in the original experiment, subjects were given only eight seconds to either generate the object name or coherence judgment and, therefore, they would probably avoid verbalizing the object names that they were either not confident about or those which occurred to them after the 8-second interval. Last but not the least is the opportunity to verbalize the solution names under no time constraint and regardless of their confidence level which allowed subjects to creatively generate excellent alternative solutions other than the strict object names intended as correct by Bowers et al. (1990). This, in turn, allowed the researchers of the present experiment to be able to use a more open criterion for classifying these object names (both correct and excellent alternatives) under the new class of solutions labeled as revelations.

**Contextual differences with Bowers et al. (1990) study.**

Having reviewed responses to some of the gestalt pictures, I realized that the generational time difference between subjects in our experiments and those who participated in the original study, nearly three decades ago, had influenced object identifications or coherence discriminations in the gestalts. As noted earlier in the method section, WGCT items were fragmented drawings of daily common objects in 1990s and these common objects would inevitably vary in the course of time with lifestyle changes and introduction of new technologies (e.g., smartphones replacing traditional photography cameras). As a result, a common object in the 1990s can be an obsolete or uncommon object in 2017 (e.g., audio/video cassettes).

Beside this generation difference, the online computerized method of WGCT delivery presented subjects the chance to feel less obligated to guess the exact correct response. As a
result, subjects were able to provide more open-ended and creative responses. For example, some of the responses included words which were in hierarchical or prototypical relationship with the solution word. For other of the gestalt pairs, subjects provided object names (words) which were in superordinate (hypermyns), subordinate (hyponyms), or prototypical relations with those listed by Bowers et al. (1990) as correct names. For instance, in response to a gestalt picture, beside elephant (the correct name), words in superordinate (animal) and subordinate (African elephant) relationships as well as prototypical relationship (dog as a prototype of a quadrupedal animal) were found to be among subjects’ identifications;

Another category of subjects’ responses consisted of creative or revelatory object names other than the intended correct solutions. These names were insightful in the sense that they revealed objects in the gestalts hitherto unknown to us, yet, obvious upon looking a second time at either of the coherent or incoherent fragmented pictures. For example, quite a few subjects had identified an incoherent fragmented gestalt as a sundae glass which, upon second viewing, did indeed reveal itself as a sundae glass (a common object in present time) while the coherent fragmented gestalt was supposed to represent the object oil lamp per original list of correct object names. Thus, the two categories of excellent alternative object names as well as their corresponding inherent coherence in fragmented gestalts were not disqualified and accepted as correct names.

Given the above description of the response types and for the purpose of the current investigation, instead of the two dependent variables of solution score and guiding index used in the original study to analyze subjects’ responses under conservative correct criterion, two more inclusive dependent variables of identification-by-revelation and intuitive coherence understanding were defined as measures. Next, three experiments were conducted with two
groups of subjects to test if these two new dependent measures better represent subjects’ intuitive performance. Experiment 1 reports the results of analysis of subjects’ WGCT data with the same dependent variables used in the original study under the strict correctness criterion. Experiment 2 reports the results of analysis of the same data from the first group using the new more inclusive dependent variables of knowing-by-revelation and intuitive coherence understanding. Experiment 3 reports the result of a study conducted with a second group of subjects to test if experiment 2 results can be replicated using the new more inclusive variables of revelation and intuitive understanding.

Experiment 1

Method

Participants.

Eighty-two \((N = 82)\) undergraduate students (49 females and 33 males) were recruited from courses within the College of Education at the University of Alabama. Subjects’ age ranged from 19 to 27 years old \((M_{age} = 23, SD = 2.50)\). All subjects gave informed consent in accordance with the Declaration of Helsinki. The experiment was approved by The University of Alabama Institutional Review Board (Appendix).

Procedure.

The computerized waterloo gestalt closure task (WGCT) was constructed using the Qualtrics online survey software. The WGCT online link was then sent via email to subjects. Clicking on the link would first take subjects to the instruction page in which they would read information about WGCT followed by an example item and chronological description of events. At the end of the instructions, subjects were encouraged to relax, approach the task as a puzzle game and trust their gut feelings. Figure 1-3 illustrates a step-by-step flowchart of the computerized WGCT experiment as experienced by subjects.
After the instructions, a 5-second preparation countdown would alarm subjects of an incoming gestalt stimulus, followed immediately by a 5-second presentation of the gestalt pair on the screen. After each gestalt pair presentation, a page would appear asking subjects to identify (name) the object that they just viewed. If subjects were able to identify the object, then clicking on the next tab would direct them to the next gestalt stimuli. However, if subjects were unable to name the object, then they would be presented with a forced-choice question, asking which of the two pictures (A or B) was a real object, followed by a 5-point Likert scale asking subjects to rate their confidence in their choice.

**Measures.**

A short version of waterloo gestalt closure task (Bowers et al., 1990) consisting of 20 gestalt pairs was used to conduct experiment 1. Subjects’ responses were scored with the following four dependent measures the proportions of which were computed using descriptive statistics’ frequency distribution application in IBM SPSS Statistics (version 22.0).

*Correctly identified objects (CIO).*

CIO is the number (frequency) of correct names out of the total of names (both correct and incorrect) generated by subjects for the gestals. These names were classified as correctly
identified objects only if they exactly matched those listed by Bowers et al. (1990) as correct object names. For example, if a subject provides names for 9 of the 20 gestalt pairs that were presented to her (11 unnamed) and 6 of those names are correct per Bowers et al. list (3 incorrect), then her CIO score would be 6.

Correct coherence discrimination (CCD).

For the rest of the gestalts which were not identified, CCD score was calculated by counting the number (frequency) of those whose coherence were correctly selected by subjects. For example, if the above-mentioned subject correctly selects coherence in 4 of the 11 gestalts which she did not name, then her CCD score would be 4 (7 incorrect coherence choices). Bowers et al. (1990) considered this measure as the key indicator of intuitive judgment.

Incorrect coherence discrimination (ICD).

Opposite to CCD, ICD score was the number (frequency) of incorrect coherence selections in the unidentified gestalts. Therefore, our subject’s ICD score would be 7 as she only selected coherence correctly in four of the 11 gestalts that she did not name.

Coherence discrimination confidence (CDC).

As noted in experiment 1 procedure section, after each forced-choice coherence question, subjects were asked to rate the degree of their confidence in their choice. In the present study, instead of a 3-point scale, a 5-point Likert scale (1 = not confident at all and 5 = very confident) was used in order to increase confidence rating accuracy and reliability.

Data Analysis.

One-sample t-test was run with IBM SPSS Statistics to determine whether subjects’ average discrimination of correct coherence in gestalts (CCD as the marker of intuitive judgement) in experiment 1 was significantly higher than population mean (50% chance value).
CCD scores were normally distributed, as assessed by Shapiro-Wilk's test \((p > .05)\) and there were no outliers in the data, as assessed by inspection of a boxplot.

**Results**

In this section, the results are reported based on list of correct object names and correct coherence choices intended by Bowers et al. (1990) as the criteria for scoring subjects’ performance on WGCT. Based on this correctness criterion, subjects, on average, correctly identified (CIO) 5.12 \((SD = 2.68)\) of gestalts. From the average of 11.82 \((SD = 3.21)\) of the gestalts that were not identified, subjects correctly discriminated coherence (CCD) in 6.06 \((SD = 2.20)\) of the gestalts while incorrect discrimination rate was 5.76 \((SD = 2.14)\). A one-sample t-test was run to determine whether CCD average score was different from chance discrimination value of 5.91 calculated by dividing the above unidentified gestalts average rate by two \((11.82/2)\). The result of one-sample t-test showed that CCD average rate was not significantly different from chance discrimination, \(t(81) = 0.619, p = .537\). Moreover, most of coherence choices in experiment 1 were accompanied by relatively low confidence ratings \((M = 1.34, SD = 0.38)\). There was a relatively strong correlation between correct coherence discrimination and coherence confidence rating, \(r(80) = 0.47, p < .001\)

Table 1-1 illustrates a cross-comparison of the results of Bowers et al. and experiment 1 of the present study.

<table>
<thead>
<tr>
<th>Study</th>
<th>Identified objects (M (SD))</th>
<th>Correct coherence (M (SD))</th>
<th>Coherence confidence (M (SD))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bowers et al. (1990)</td>
<td>18</td>
<td>0.60 (0.07) *</td>
<td>--</td>
</tr>
<tr>
<td>(Total gestalts, (N = 53))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiment 1</td>
<td>5.12 (2.26)</td>
<td>6.06 (2.20)</td>
<td>1.34 (0.38)</td>
</tr>
<tr>
<td>(Total gestalts, (N = 20))</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Above chance level \((p < .001)\).
Discussion

In experiment 1, a computerized version of waterloo gestalt closure task was administered to subjects and responses were analyzed using variables and correct solution list of Bowers et al. (1990). The results showed that people could not detect the gestalts which they could not solve above chance level. Further examination of alternative objects’ names that subjects used for identifying gestalts revealed that using the original study criterion for correctness for scoring CIO and CCD variables was the reason behind failure to replicate. The original study did not report on the quantity and quality of by subjects’ alternative object identifications since the focus was solely on certain fixed objects to serve as the correct criterion for coherence discrimination in gestalts. One area of concerns in the present study was whether it is fair to use the original study strict (fixed object names) criterion to evaluate subjects’ responses to intergenerational differences between our subjects and those who participated in Bowers et al.’s study, which in turn, might affect the coherence discrimination to fall below or above chance level. On the hand, the online collection of the subjects’ responses for both object names and coherence discriminations as well as their corresponding confidence ratings presented the current study with the opportunity to use a more open correctness criterion for correct object identification and coherence discrimination to quantify the proportions and examine the qualitative nature of the alternative responses. This more open (less conservative) criterion would include hierarchical/prototypical and creative/revelatory identifications otherwise excluded using Bowers et al.’s strict correctness criterion. In experiment 2, new dependent measures were defined based on this more open criterion and applied to the same responses collected from subjects in experiment 1. The methodology and results are reported in the following section.
Experiment 2

Method

Participants.

The same WGCT responses collected from 82 undergraduate students (49 females and 33 males) in experiment 1 were used for experiment 2. Subjects’ age ranged from 19 to 27 years old ($M_{age} = 23$, $SD = 2.50$). All subjects gave informed consent in accordance with the Declaration of Helsinki. The experiment was approved by The University of Alabama Institutional Review Board (Appendix B). The purpose of experiment 2 was test new measures defined by an alternative theoretical model.

Measures.

Identification-by-revelation.

The alternative object identifications collected in experiment 1 was used to define the dependent measure identification-by-revelation (revelation for short) and serve as the basis for the new more open correctness criterion. According to this new criterion, both correct names intended by Bowers et al. (1990) and the alternative names provided by subjects for each gestalt pair were characteristically regarded as 1st person revelations and, therefore, correct.

Subsequently, in calculating the revelation score, one point was given not only to identifications that were identical to the intended solutions, but also to those which were identical to alternative identifications. For instance, for the first gestalt item, a subject would receive one point had she identified the object to be any of the following: *a tennis racket* (intended solution), *a magnifying glass* (alternative name), or *a hand mirror* (alternative name). To ensure that the alternative names could indeed be seen in their corresponding gestalt pictures, two independent judges (education doctoral candidates) with no knowledge of intended solutions evaluated the appropriateness and accuracy of alternative names for each gestalt pair (i.e., If they could see the
object whose name was just read to them in any of the two gestalts in each pair). Next, to create a list of revelation to serve as the scoring criterion when combined with the intended solutions, both judges sat together for a final round of consensus judgment over the alternative names.

**Intuitive coherence understanding.**

Having the list of revelations described above to serve as the scoring criterion presented the advantage of being as conservative as possible in classifying subjects’ responses as unidentified in order to exclude gestalt coherence choices which were not the outcome of intuitive judgement. The remaining coherence choices correctly selected to be coherent based on the new revelation criterion were labeled as intuitive coherence understanding to serve as the measure of intuitive judgement in this experiment. To calculate the proportion of this measure, the total number of unidentified gestalts was determined by first excluding identification-by-revelations from subjects’ responses. Next, the frequency of unidentified coherent gestalts that were correctly selected as coherent was calculated. As an example, for the first gestalt pair in Figure 1-1., coherence choice associated with any of the three responses of tennis racket, magnifying glass, or hand mirror were counted as correct.

**Coherence understanding confidence.**

This dependent variable would measure subjects’ level of confidence in their coherence choices on a 5-point Likert scale (1 = not confident at all to 5 = very confident).

**Data Analysis.**

One-sample t-test was run with IBM SPSS Statistics to determine whether subjects’ average intuitive understanding of coherence in gestalts was significantly higher than population mean (chance value). Shapiro-Wilk's test was used to test the normal distribution of coherence scores ($p > .05$) and inspection of a boxplot showed no outliers in the data. A paired t-test was
also conducted to test whether there is a significant difference between subjects’ average coherence confidence rating based on the revelation criterion and confidence ratings based on the original, intended criterion. The goal was to determine whether confidence ratings based on revelations are tied more to feelings of warmth and confidence or not. Pearson correlation was run between coherence understanding score and revelation confidence rating to measure the strength of any existing association.

**Results**

Subjects identified by revelation, on average, 6.07 of the gestalt pairs ($SD = 2.36$). For the rest of the unidentified gestalts ($M = 11.62, SD = 2.19$), subjects, on average, intuitively discriminated coherence in 6.64 ($SD = 2.34$) of gestalts. A one-sample t-test was run to determine whether this average rate of coherence discrimination was different from chance discrimination value of 5.81 calculated by dividing the unidentified gestalts average rate by two (11.62/2). The results showed that intuitive coherence discrimination value was significantly higher than chance value, $t(81) = 3.225, p = .002$ in experiment 2. In addition, the average coherence understanding confidence rating based on the revelation criterion was 1.77 ($SD = 0.68$). The results of paired t-test statistics showed a significant difference between average coherence confidence rating based on the revelation criterion and confidence rating based on the intended criterion, $t(81) = -8.637, p < .001$. There was a significant correlation between coherence understanding score and coherence confidence rating, $r(80) = .35, p < .001$.

**Discussion**

The results of analysis of subjects’ responses in experiment 2 showed that, under the new revelation criterion, participants detected the coherent gestalts which they could not solve above chance level. Therefore, the results reported by Bowers et al. (1990) were replicated when both
intended solutions and subjects’ alternative solutions (revelations) were combined to serve as the new criterion. Beside the generational difference in terms of common daily objects, the failure to replicate Bowers et al.’s results in experiment 1 could be associated to the use of a fixed set of solutions for qualifying subjects’ responses as correct.

As mentioned before, these intended solutions were determined by Bowers et al. and drawn based on the subjective perception of the artists. Therefore, using them as the correct benchmark in determining what counts as coherent or incoherent could be a source of bias to those subjects whose subjective perception of coherence in gestalts are different from the intended perceptions. Furthermore, due to the nature of the gestalts, there were times when one or both of meaningful or meaningless gestalts in each pair seemed to be representing multiple meaningful objects which were excellent alternatives solutions. In the original paper, Bowers et al. (1990) also made a brief note of this issue:

Occasionally, a particular gestalt was seen something quite distinct from the intended object. For example, a picture of a frog was frequently seen as a baby chick, which in truth, was an excellent alternative. (p. 35)

Figures 1-5 & 1-6 illustrate two examples of gestalt items along with names intended by Bowers et al. (1990) and two alternate objects identified by subjects in experiment 1.
As seen in the Figure 1-5, beside *tennis racket* as the intended correct object name for the first pair, subjects in experiment 1 identified picture B (coherent) as either a *hand mirror* or a *magnifying glass*, both of which can be regarded as reasonable alternatives solutions. Similarly, subjects provided two alternative names of *cocktail* and *sundae* for picture A beside *oil lamp* as the solution for picture A (coherent) in the second pair.
Experiment 3

Method

Participants.

Eighty \((N = 80)\) undergraduate students (52 females and 28 males) taking an educational psychology course in a research university in the southeast participated in experiment 3. Participants’ average age was 22.5 \((SD = 3.50)\) with their age ranging from 19 to 26. All subjects gave informed consent in accordance with the Declaration of Helsinki. The experiment was approved by The University of Alabama Institutional Review Board (see Appendix).

Procedure.

The same computerized gestalt closure task with the same experimental procedure used in experiment 1 was adopted and administered to subjects in experiment 3.

Measures.

The same WGCT gestalt pairs \((N = 20)\) used in experiment 1, were employed for experiment 3. Since the purpose of experiment 3 was to test the replication experiment 2 results, the same dependent measures defined in experiment 2, namely, identification-by-revelation, intuitive coherence understanding and coherence understanding confidence were adopted. Measures proportions were also calculated using similar frequency analysis described in the measures section of experiment 1.

Data Analysis.

The same statistical tests performed in experiment 2, namely, one-sample t-test, paired-sample t-test and Pearson correlation were conducted to examine if experiment 3 replicates the results of experiment 2.
Results

Subjects in experiment 3 identified, on average, 5.12 ($SD = 2.66$) of the gestalt pairs. As for the unidentified gestalts ($M = 11.33$, $SD = 2.17$), subjects’ average intuitive coherence discrimination rate was 6.55 ($SD = 2.19$). One-sample t-test results showed that this rate was significantly above chance value mean of 5.66, $t(79) = 3.631$, $p < .001$ in experiment 3. Based on the revelation criterion, experiment 3 subjects’ average coherence understanding confidence rating was 1.61 ($SD = 0.69$). Paired t-test statistics also showed a significant difference between subjects’ average coherence confidence rating based on the revelation criterion and ratings based on the intended criterion $t(79) = -5.234$, $p < .001$. The correlation between coherence understanding scores and coherence confidence ratings was $r(78) = .310$, $p = .005$. Table 1-2 summarizes coherence discrimination results and Table 1-3 summarizes coherence confidence ratings results obtained in experiments 1, 2 and 3.

Table 1-2.

<table>
<thead>
<tr>
<th></th>
<th>Coherence discrimination $M (SD)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment 1 (based on Bowers et al., 1990 criterion)</td>
<td>6.06 (2.20)</td>
</tr>
<tr>
<td>Experiment 2 (based on revelation)</td>
<td><strong>6.64</strong> (2.34)</td>
</tr>
<tr>
<td>Experiment 3 (based on revelation)</td>
<td><strong>6.55</strong> (2.19)</td>
</tr>
</tbody>
</table>

*Note.* Numbers in bold indicate significantly above chance level, $p < .001$.

Table 1-3.

<table>
<thead>
<tr>
<th></th>
<th>Experiment 1 $M (SD)$ (Bowers et al., 1990 criterion)</th>
<th>Experiment 1 $M (SD)$ (revelation criterion)</th>
<th>Experiment 2 $M (SD)$ (revelation criterion)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.34 (0.48)</td>
<td><strong>1.77</strong> (0.68)</td>
<td><strong>1.61</strong> (0.69)</td>
</tr>
</tbody>
</table>

*Note.* Numbers in bold indicate significantly different at $p < .001$.  

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Discussion

The results of experiment 3 replicated the results of analysis in experiment 2, that under the new the revelation criteria for correctness, subjects detected, above chance, coherent gestalts that they could not name (identify). Experiment 3 also revealed that for almost half of the WGCT items, subjects’ alternative revelations comprised a fair portion of the responses across both samples. Moreover, the analysis of the confidence ratings associated with coherence choices showed that subjects placed significantly more confidence in the coherence choices which were based on the revelations than coherence choices based on Bowers et al. (1990) solutions.

Therefore, 1st person revelation coherence selections were tied more to feelings of warmth and confidence. Table 1-4. contains the most common alternative object names subjects provided for 10 gestalt items based on which the revelation criterion was defined and constructed.

Table 1-4. 
Subjects’ Alternative Object Names vs. Intended Solution Names

<table>
<thead>
<tr>
<th>Item</th>
<th>Intended solution names</th>
<th>Subjects’ 1st alternative name</th>
<th>Subjects’ 2nd alternative name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tennis Racket (B)*</td>
<td>Magnifying Glass (B)</td>
<td>Hand Mirror (B)</td>
</tr>
<tr>
<td>2</td>
<td>Briefcase (A)</td>
<td>Suitcase (A)</td>
<td>Laptop (A)</td>
</tr>
<tr>
<td>3</td>
<td>Camera (B)</td>
<td>Elephant/Horse (A)</td>
<td>Animal (A)</td>
</tr>
<tr>
<td>4</td>
<td>Tea Pot (A)</td>
<td>Person/Figure (A)</td>
<td>Duck (B)</td>
</tr>
<tr>
<td>5</td>
<td>Desk lamp (B)</td>
<td>Light Post (A)</td>
<td>Ceiling Lamp (A)</td>
</tr>
<tr>
<td>6</td>
<td>Ring (B)</td>
<td>Bird (B)</td>
<td>Crab (A)</td>
</tr>
<tr>
<td>7</td>
<td>Door Knob (B)</td>
<td>Light Switch (B)</td>
<td>landscape (A)</td>
</tr>
<tr>
<td>8</td>
<td>Elephant (A)</td>
<td>Lion/Tiger (B)</td>
<td>Dragon (B)</td>
</tr>
<tr>
<td>9</td>
<td>Fire Hydrant (A)</td>
<td>Domed Building (A)</td>
<td>Castle (B)</td>
</tr>
<tr>
<td>10</td>
<td>Trash Can (A)</td>
<td>Cup (A)</td>
<td>Bucket (A)</td>
</tr>
</tbody>
</table>

*Letters A and B in parentheses indicate objects’ associated coherence choices.
Overall Conclusion

This paper reported the results of three experiments conducted with waterloo gestalt closure task originally developed by Bowers et al. (1990). Experiment 1 results showed that people could **not** detect the gestalts which they cannot solve *above the chance level*. However, when both the intended solutions and subjects’ alternative solutions (revelations) were combined and analyzed under the new the revelation criteria in experiment 2, Bowers et al.’s results were replicated. In other words, subjects could detect the coherent gestalts which they cannot solve above chance level. A third experiment conducted with another group of subjects following the same procedure in experiment 2 replicated and confirmed the results obtained based on revelation criterion. Moreover, it was found that revelations were tied more to feelings of warmth and confidence. These results may indicate that although Bowers et al.’s account of intuition may present a reasonable cognitive account of how subjects came up with the *intended solutions* (incremental accumulation of implicit activation in memory networks eventually bursting into consciousness), it does not predict or explain subjects’ unintended revelations and the intuitive coherence understanding associated with these revelations revealed in experiments of the present paper.

To explain revelations or other unintended/spontaneous thoughts, it may prove useful to look at other ideas of intuition that try to investigate it at the physiological level. For instance, viewing intuition as expertise in a domain as a result of long-term training, Wan et al. (2012) compared brain activity of 15 subjects playing Shogi (Japanese chess) at two times to localize the neural mechanisms of intuition; first at the beginning of the training when subjects had no experience of the game (novice) and second time, after 15 weeks of training when they had become experts in swiftly guessing the next best move. fMRI results showed increasing generation of activity in the head of caudate nucleus in the course of 15 weeks concurrent with
development of their skill in rapidly producing the best move in the game, while cortical activity responsible for step-by-step learning remained the same. Their results highlighted the special role of the head of caudate nucleus area of the brain in automatizing slow and heavy processing, otherwise, known as expertise intuition.

In another neuroimaging study more relevant to the topic of the present paper (coherence detection), Bilalić, Turella, Campitelli, Erb, and Grodd (2012) demonstrated the essential role of expertise in regulating the neural mechanisms of pattern/object recognition in a particular setting (what WGCT has been designed to measure). Using fMRI and eye-tracking machines, they compared brain activity and eye-movement patterns of novice and expert chess players while playing a game of chess (resembling real life situations and objects) to investigate the neural correlates of object and pattern recognition. The fMRI results revealed that in experts, beside areas that are engaged in novices’ brain, experts employed extra new areas of the brain that grants them superiority in object recognition (bilateral posterior temporal) and pattern recognition (bilateral retrosplenial cortex along with bilateral collateral sulci). Bilalić et al. particularly highlighted the importance of their study when it comes to tasks that contain or adopt real life objects, patterns and scenarios since people are naturally experts in object and pattern recognition (instantaneous and effortless). The important implication of these findings along with the findings of the three experiments of the present paper is that any classification or categorization of certain patterns and responses as correct based on the performance or intuition of certain group of individuals can misinform the evaluation of intuitive performance of another group of individuals on a pattern recognition tasks in a different time or context.

References


ARTICLE 2 EVIDENCE FOR THE INDEPENDENCE/INTERACTION OF THE INTUITIVE-EXPERIENTIAL AND ANALYTIC-RATIONAL SYSTEMS

Abstract

Epstein’s cognitive-experiential self-theory proposes that the mind processes information by means of two independent yet interactive rational and experiential systems. In the literature, evidence for the independence of the two systems has been presented by development and construct-validation the rational-experiential inventory (REI), a self-report questionnaire designed to determine an individual’s dominant mode of information processing. However, evidence for the interaction of the two systems remained to be explored as it is dependent on specific contexts and individual differences. In this paper, a construct-validation study\(^3\) of REI was conducted to test both assumptions of independence and interactivity of the rational and experiential systems. Factor analysis results revealed that while most of the REI items loaded exclusively around one of the two extracted factors (independence), some showed significant correlation with both factors of rationality and experientiality (interaction). Therefore, both assumptions of independence and interactivity were confirmed. At the end, the theoretical contribution and implications of this finding are discussed regarding how the two systems operate both independently and interactively in guiding intuitive and rational thought.

\(^3\)The use of human participants in this dissertation was approved by the Institutional Review Board of the University Alabama. All subjects gave informed consent in accordance with the Declaration of Helsinki. The protocol was approved by The University of Alabama Institutional Review Board (IRB # 16-OR-342).
A substantial body of research over the past three decades has been dedicated to investigating human decision-making, reasoning, and intuition from the perspective of dual-process theories (Barrett, Tugade, & Engle, 2004; Chaiken & Trope, 1999; Evans, 2003; Evans & Frankish, 2009; Evans & Stanovich, 2013; Pacini & Epstein, 1999; Reyna, 2004; Wason & Evans, 1975). The crux of dual-system approaches, however, is not a recent theoretical proposition. More than a century has passed since Wundt – under the influence of Cartesian dualism – proposed associative vs. intellectual theory of thinking in 1896. Half a century later, a parallel account resurfaced by Kris (1952), this time under the new label of primary vs. secondary process theory of mind. Since then, similar dualist accounts of mind have been proposed every so often under different names (e.g., cognitive-experiential self-theory (Epstein, 1991)). According to these dual-system theories, system 1 (the old mind) is fast, automatic, emotion-laden and characteristically biased. System 2 (the new mind), on the other hand, has been characterized as slow, capacity-limited, analytic/rational and insusceptible to emotions (Evans, 2007; Evans & Stanovich, 2013).

A parallel theoretical framework well-known in social psychology and psychoanalysis also classifies mental functioning into two conscious vs. unconscious control systems. According to this framework, the conscious mind acts on the surface as the main agent in charge of most of the mental life while the unconscious mind operates beneath the surface of awareness (Bargh & Morsella, 2008; Dijksterhuis, 2004; Posner & Rothbart, 1992; Posner, Snyder, & Solso, 2004).
Despite the existence of plethora of theoretical and experimental research on the features and functioning of the two systems (Evans, 2007; Evans & Stanovich, 2013; Smith & DeCoster, 2000; Stanovich, 1999; Stanovich & West, 2000), only few have examined the relationship (if any) between the two systems. One of these research endeavors was an article published by Pacini and Epstein (1999) in which they presented evidence for the independence of the two systems by developing and construct-validating the rational-experiential inventory (REI), a self-report questionnaire designed to determine an individual’s dominant mode of information processing. However, evidence for whether the two systems interact remained to be explored further as it was argued that the interaction of the two systems is more dependent on the specific context as well as individual differences.

The purpose of the present paper is to fill this gap in the literature. Using the methodology of the original study, a construct-validation of REI was conducted to examine both assumptions of independence and interactivity of the rational and experiential systems. The results confirmed the original studies’ finding that the two systems are independent as most REI items loaded around one of the two extracted constructs. Moreover, factor-loading results also showed evidence of the interaction of the two systems as some of the items had significant interactions with both rationality and experientiality constructs. At the end, the theoretical contribution of these finding in terms of how the two systems interact based on contextual factors such as individual differences in thinking style are discussed. In the following section, first, a brief review of literature of dual-process accounts is presented along with criticisms directed at them followed by an overview of the theory underlying rational-experiential inventory (REI).
Review of Literature

Two-process accounts propose that the mind operates by means of two main systems or processes: system one executes intuitive processes attributed to be unconscious, automatic, fast and affect-laden. System two, on the other hand, runs analytic processes such as reasoning, deliberation, reflection and, therefore, can be slow and free of affective influences (Evans, 2007). In the literature, however, the features attributed to each system have not always been as clear as characterized above and the inconsistency among various dual-process accounts in attributing features to each system has been the subject of much criticism (Keren & Schul, 2009). These criticisms center around three major themes: (a) multiple theories exist in the literature with each one presenting an unclear account while attempts to bring the models together have been mostly unsuccessful (Evans & Stanovich, 2013; Stanovich, 1999); (b) the features attributed to each system are not consistent across and within the theories (i.e., Keren and Schul (2009) argued that some of the features of system one & system two have been reported to cluster under the opposite system); (c) recent interdisciplinary findings have sketched an embodied model of the mind that incorporates mind, body and the brain in a unified continuum as opposed to discrete functioning (Iran-Nejad & Gregg, 2001; Newstead, 2000; Osman, 2004).

The conscious-unconscious perspective has also not been immune to criticisms. Some have problematized the obscure line drawn to distinguish the two processes in the sense that these theories do not clearly explicate or define what constitutes a conscious process and what renders a process unconscious. More importantly, recent research findings are revealing frequently that both conscious and unconscious processes take part in the workings of system one and system two in an integrative and dynamic fashion (Churchland, 2002; Daniel, 1991; Iran-Nejad & Chissom, 1992).
Research in neuroscience of decision-making has also presented evidence that the two systems are dynamically integrated as much as they are independent depending on contextual and individual differences (Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trötschel, 2001; Bechara, Damasio, Tranel, & Damasio, 1997; Gershon, 1999; Posner, 1994). For instance, in a series of neuroimaging experiments, Bechara, Damasio, and Damasio (2000) discovered that subjects with pathologies to the regions of the brain attributed to emotional intuitions were unable to make appropriate logical/rational decisions, thus, concluding that emotional intuitions are integral to most rational or logical computations. This finding indicated that rational and intuitive processes are not always executed independently and do in fact share some neural pathways depending on the type of decision or the situation in which it is made.

One major implication of the systems choice of interactive vs. independent processing is related to the evolutionary developed cost-benefit prioritization feature of the brain and the nervous system (Kurzban, Duckworth, Kable, & Myers, 2013). The choice of which system to take over the decision or processing need (prioritization) depends on the cost (e.g., mental effort) and the benefits gained from this prioritization which, in turn, depends on a whole range of other factors. These factors include other active or non-active brain regions, contextual urgency, available processing capacity, speed, efficiency and the survival advantage of processing and so on and so forth (Bechara, Damasio, Damasio, & Anderson, 1994; Bechara et al., 1997).

For instance, gestalt experiments have often correctly explained the split-second detection of patterns implicit in gestalt pictures to be the outcome of the fast experiential-intuitive system. However, Dijksterhuis and Van Olden (2006) argued that occasionally, depending on the availability of processing capacity, identification of the pattern/coherence is performed deliberatively by the logical system. However, this processing is performed too fast.
that it cannot be noticed by conscious attentional resources. Along the same line, other intuition researchers such as Sinclair (2011) emphasize assigning as much credit to the assumption of the interaction of intuitive and rational systems as to their independence. In other words, rational decisions are sometimes not the sole outcome of only one system, but the outcome of interaction and contribution of the two independent systems.

**Cognitive-Experiential Self-Theory (CEST)**

CEST is a well-cited dual-process theory of cognition which proposes that individual differences in rational and experiential processing result in individuals relying on one of the two systems as the dominant medium of processing/thinking (Epstein, 1980). The main thesis of CEST is that people process information by two parallel yet independent experiential and rational systems. The experiential system operates by means of networks of associations of stored knowledge constructed through experience and, therefore, is fast and automatic. The rational system operates at the conscious level and is analytic, intentional, and slow in computations (Epstein, 1983).

According to CEST, these two independent systems interact in shaping thought and behavior. However, they sometimes conflict which manifests itself as the contradictory feelings between the heart and the mind (Epstein, 1991, 1998). In the literature, evidence in support of the assumption of independence is well-established in a series of construct-validation studies conducted on rational-experiential inventory, a self-report questionnaire designed to determine individuals’ intuitive vs. analytic processing style (Epstein, Pacini, Denes-Raj, & Heier, 1996; Pacini & Epstein, 1999). However, the results obtained to support the assumption of the interaction between the two systems were more mixed and, therefore, more replication studies of REI instrument are needed to settle the controversy (Pacini & Epstein, 1999).
Rational-Experiential Inventory (REI) Construct Validation

One of the areas of concerns in developing a self-report instrument such as REI is to determine whether the experiential and rational modes are best measured by two unipolar scales or a single bipolar scale (Epstein et al., 1996). In the case of the former, two sets of unipolar items need to be developed in order to measure each pole (construct) separately. In the case of the latter (a single bipolar scale), one set of items needs to be developed in order to tap into both poles of a single construct. Based on the two-system assumption of CEST, Pacini and Epstein (1999) determined to construct two separate/independent unipolar scales of rationality and experientiality. Their goal was to test the CEST prediction that the rational and the experiential systems are independent constructs and, therefore, both rational and experiential items should exclusively load around one of the constructs (poles). In other words, to demonstrate the CEST assumption of the independence of the two systems, the loadings of the items around one constructs must show no or nonsignificant correlations with the second construct.

To test this assumption, Pacini and Epstein conducted a principal component analysis (PCA) on the REI (40 items) and reported extracting two independent and orthogonal components which, together, accounted for 34% of variation through varimax rotation in the data. Table 2-1 and Table 2-2, on the next page, display factor loading values for some of the items of both scales (5 rationality items and 5 experientiality items) adopted from the original study. Both tables show that the first component contained almost exclusively the rationality items and the second component contained exclusively the experientiality items. As a result, the researchers concluded that this orthogonal relationship (exclusivity) between rationality and experientiality scales present evidence for the independence of the intuitive and rational thought processes or systems.
Table 2-1.  
*Factor Loadings of Rationality Items (Pacini & Epstein, 1999).*

<table>
<thead>
<tr>
<th>Rationality Items</th>
<th>Rationality component</th>
<th>Experientiality component</th>
</tr>
</thead>
<tbody>
<tr>
<td>I’m not that good at figuring out complicated problems.</td>
<td>.74</td>
<td>.10</td>
</tr>
<tr>
<td>I prefer complex problems to simple problems.</td>
<td>.61</td>
<td>-.01</td>
</tr>
<tr>
<td>I have a logical mind.</td>
<td>.56</td>
<td>-.19</td>
</tr>
<tr>
<td>I don’t reason well under pressure.</td>
<td>.57</td>
<td>.04</td>
</tr>
<tr>
<td>I try to avoid situations that require deep thinking in depth about something.</td>
<td>.75</td>
<td>.07</td>
</tr>
</tbody>
</table>

Principal component analysis.

Table 2-2.  
*Factor Loadings of Experientiality Items (Pacini & Epstein, 1999).*

<table>
<thead>
<tr>
<th>Experientiality Items</th>
<th>Rationality component</th>
<th>Experientiality component</th>
</tr>
</thead>
<tbody>
<tr>
<td>If I were to rely on my gut feelings, I would often make mistakes.</td>
<td>.08</td>
<td>.54</td>
</tr>
<tr>
<td>I generally don’t depend on my feelings to help me make decisions.</td>
<td>-.15</td>
<td>.51</td>
</tr>
<tr>
<td>Using my gut feelings usually works well for me in figuring out problems in my life.</td>
<td>-.11</td>
<td>.65</td>
</tr>
<tr>
<td>I suspect my hunches are inaccurate as often as they are accurate.</td>
<td>.15</td>
<td>.35</td>
</tr>
<tr>
<td>My snap judgements are probably not as good as most people.</td>
<td>.37</td>
<td>.46</td>
</tr>
</tbody>
</table>

Principal component analysis.

As for the component analysis within the scales of rationality and experientiality, Pacini and Epstein (1999) conducted a confirmatory two-component factor analysis on items of each scale. The analysis for the rationality items generated the expected two-factor solution of ability and engagement. The PCA on the experientiality items, however, did not yield the same two-
component solution as positive and negative items loaded on separate factors and produced rotations different from the expected ability-engagement solution. Moreover, the obtained component structure for the experientiality items explained a nonsignificant variation in the data, indicating a low discriminatory power regarding the classification of items into engagement and ability subscales. The investigators highlighted this finding as one of the limitations of REI and called for more replication studies on REI factor structure with data from other subject populations.

The Present Study

As noted in the previous section, Pacini and Epstein (1999) used principal component analysis as the factor extraction method of choice to construct validate REI instrument. Many statistical scientists view PCA as only a method for data reduction and do not recommend it for factor extraction mainly because PCA does not specify the underlying latent variables and the structure associated with them (Gorsuch, 1990; Loehlin, 1990; MacCallum & Tucker, 1991; Mulaik, 1990; Snook & Gorsuch, 1989; Widaman, 1990, 1993). Consequently, the component solutions that are generated by PCA contain all the variance associated with the variables in question. Exploratory Factor analysis (EFA), on the other hand, discloses the covariances caused by these latent variables. In other words, the great advantage of EFA over PCA is that it separates the unique variance, the shared variance and the error variance caused by a certain variable and presents only the shared variance in the extracted factor solution. Therefore, EFA is a helpful technique in preventing variance inflation which has been noted as a common problem in many instrument validation studies.

A second important issue is related to the choice of factor extraction method. According to Fabrigar, Wegener, MacCallum, and Strahan (1999), under the assumption of normal
distribution of data, maximum likelihood should be selected as the extraction method since it offers multiple calculations such as factor loading significance, existence of correlation among factors and finally the goodness-of-fit model. Based on this recommendation in the literature, maximum likelihood was also used in the present study as the extraction method for analyzing the REI factor structure. Last but not the least is the choice of rotation method – the focus of the present investigation – to clarify and simplify our REI data structure. From the two choices of orthogonal (to generate uncorrelated factors) and oblique rotation (to test if factors are correlated) methods, orthogonal has been the most popular because this rotation method produces uncorrelated factors which are easy to interpret and make sense. Nonetheless, the findings of the most social and psychological investigations have shown that, in reality, most of the factors are in mutual relationship (correlated) and cannot be segmented into independent and distinct units. In the words of Costello and Osborne (2005):

> In the social sciences, we generally expect some correlation among factors, since behavior is rarely partitioned into neatly packaged units that function independently of one another. Therefore, using orthogonal rotation results in a loss of valuable information if the factors are correlated, and oblique rotation should theoretically render a more accurate, and perhaps more reproducible, solution. If the factors are truly uncorrelated, orthogonal and oblique rotation produce nearly identical results. (p. 3)

Given the above information on the importance of correct method of factor analysis as well as the need for an exploratory factor analysis of REI, the present paper aims to test the following hypotheses: (a) whether experientiality and rationality scales are significantly related (correlated), and, (b) whether evidence can be found for the two CEST assumptions of
independence and interactivity of processing modes using the oblique rotation factor extraction method on REI data.

Method

Participants

A total of 164 undergraduate students (98 females and 66 males) were recruited for this study. Participants’ average age was 22 years ($SD = 2.6$) with their age ranging from 19 to 25 years old. All subjects gave informed consent according to the Declaration of Helsinki. The study was approved by The University of Alabama Institutional Review Board (Appendix B).

Procedure

The REI questionnaire was constructed in Qualtrics survey software and the survey link was sent via email to the participants. Clicking on the link would, first, direct subjects to the consent form followed by a brief passage describing the REI survey and the scaling information. The passage instructed the subjects to try to rate statements such as *When it comes to trusting people, I can usually rely on my gut feelings* (experiential) and *I enjoy solving problems that require hard thinking* (rational), as rapidly as they can, on a 5-point Likert scale ($1 = \text{definitely false}$ and $5 = \text{definitely true}$).

Measures

In the replication study, the online version of rational-experiential inventory (REI) was constructed using Qualtrics Survey Software. REI is a 40-item questionnaire on 5-point Likert scales ($1 = \text{definitely false}$ and $5 = \text{definitely true}$) developed to identify individuals’ reliance on rational and experiential thinking. The inventory is comprised of two 20-item scales of rationality to assess rational thinking and experientiality to assess intuitiveness. Each of the scales contains two smaller 10-item subscales designed to produce the two indexes of thinking style and ability for each of the subscales. The sum of thinking style and ability indexes within
each scale would yield a rationality score and an experientiality score. Higher score on either one would mean that the individual is dominant in that mode of processing for thinking and decision-making (Pacini & Epstein, 1999). In the present study, both rationality and experientiality scales displayed a good level of internal consistency and, therefore, were found to be reliable scales. Table 2-3 presents Cronbach’s alpha reliability coefficients obtained in the original study and the present investigation. It is to note that some of the items in both scales were negative statements and, therefore, reverse-coding was performed before calculating subjects’ scores on both scales.

<table>
<thead>
<tr>
<th>Table 2-3.</th>
<th>Comparative REI Reliability Analysis in the Original &amp; the Present Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability ($a$)</td>
<td>Rationality scale</td>
</tr>
<tr>
<td>Pacini and Epstein (1999)</td>
<td>.90</td>
</tr>
<tr>
<td>The present study</td>
<td>.88</td>
</tr>
</tbody>
</table>

*Note. Significance level ($p < .01$)*

**Data Analysis**

An exploratory factor analysis was the main data analysis conducted on the REI data. Pearson correlation was also run between the two scales of rationality and experientiality as well as between subscales of engagement and ability within each scale. To evaluate the feasibility of the EFA, the following tests were selected and performed prior to conducting the EFA:

*Correlation matrix determinant.* The value of the correlation matrix determinant must be greater than .00001 to prevent multicollinearity and the problem of highly correlated items in questionnaires such as REI used in this study. A matrix determinant value ranges from 0 to 1.

*Kaiser–Meyer–Olkin (KMO) test.* KMO test was selected to evaluate the adequacy of sampling for using EFA and suitability of the data structure for factor extraction. KMO test
produces a value ranging from 0 to 1 and a value higher than .60 can indicate that factors account for a fair or high proportion of variance and therefore, factor analysis is suitable to be conducted.

*Bartlett's test of sphericity.* Bartlett’s test is used to examine whether the correlation matrix of the data is an identity matrix which takes place when the variables are not correlated (independent). Therefore, significant values less than .05 indicate that the correlation matrix is not an identical matrix and therefore, factor analysis is appropriate.

After all the above assumptions were confirmed, EFA was conducted using IBM SPSS Statistics version 22.0. Maximum likelihood with oblique oblimin rotation was performed to extract factors in the dataset. The reason for selecting maximum likelihood was to explore all the latent factors that might be contributing to the variation of the data. Oblique oblimin rotation was performed to examine any correlation among the factors.

**Results**

**Correlation between REI Scales**

In the present study, a significant correlation \( r(162) = .18, p = .019 \ (p < .05, \text{two-tailed}) \) was found between the two scales of rationality and experientiality. In addition, significant correlations were found between subscales of engagement and ability within each scale with the value of these inter-subscale correlations being much lower than the value of reliability coefficients (Tables 2-3 & 2-4).

<table>
<thead>
<tr>
<th>Table 2-4. Replication Study Correlations Between Subscales of Ability and Engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pearson correlation (( r ))</strong></td>
</tr>
<tr>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Rational engagement</td>
</tr>
<tr>
<td>Experiential engagement</td>
</tr>
</tbody>
</table>

*Note.* Significance level at \( p < .05 \) (two-tailed).
**Factor Extraction Results**

Before conducting EFA, necessary statistical tests were run to evaluate the possibility of application of exploratory factor analysis. The KMO test confirmed the adequacy of the sample (KMO = .78) and Bartlett's test rejected the null hypothesis of identical matrix $\chi^2 (780) = 2664.945, p < .001$. Moreover, no multicollinearity was detected as the determinant of the correlation matrix showed acceptable value.

Exploratory factor analysis (maximum likelihood) was conducted and oblique rotation was performed to test for the correlation of factors. Two robust factors were extracted. The first factor had a high eigenvalue of 9.30 and accounted for 23.26% of variance in the data. The second factor’s eigenvalue was 7.71 accounting for a 19.30% further variance in the data. These two factors were the only major factors with large eigen values and the rest of the extracted factors had eigen values less than 1. As a result, they were not included in data structure interpretation.

Factor correlation matrix showed a slight correlation value of .10 between the two factors. Pattern matrix results showed that except for few items, the overall loading pattern was robust. Almost all the experientiality items loaded around the first factor and almost all the rationality items loaded around the second factor (two orthogonal factors). As noted, there were few items such as *My snap judgments are probably not as good as most people's* (experientiality scale) or *I have a logical mind* (rationality scale) which had relatively equal loading around both factors or items such as *I generally don't depend on my feelings to help me make decisions* which displayed nonsignificant loadings around both factors.

Pattern matrix tables (Table 2-5 & Table 2-6) on next page display item loading values of all experientiality and rationality items for both extracted factors.
Table 2-5.  
*Pattern Matrix for Rationality Scale.*

<table>
<thead>
<tr>
<th>Rationality Items</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>I try to avoid situations that require thinking in depth about something. (-)</td>
<td>.31</td>
<td>.52</td>
</tr>
<tr>
<td>I enjoy intellectual challenges.</td>
<td>.13</td>
<td>.77</td>
</tr>
<tr>
<td>I am not good at solving problems that require careful logical analysis. (-)</td>
<td>.05</td>
<td>.71</td>
</tr>
<tr>
<td>I don't like to have to do a lot of thinking. (-)</td>
<td>.06</td>
<td>.62</td>
</tr>
<tr>
<td>I enjoy solving problems that require hard thinking.</td>
<td>.06</td>
<td>.75</td>
</tr>
<tr>
<td>Thinking is not my idea of an enjoyable activity. (-)</td>
<td>-.02</td>
<td>.60</td>
</tr>
<tr>
<td>I'm not that good at figuring out complicated problems. (-)</td>
<td>.43</td>
<td>.32</td>
</tr>
<tr>
<td>I am not a very analytical thinker. (-)</td>
<td>-.09</td>
<td>.57</td>
</tr>
<tr>
<td>Reasoning things out carefully is not one of my strong points. (-)</td>
<td>-.05</td>
<td>.64</td>
</tr>
<tr>
<td>I prefer complex problems to simple problems.</td>
<td>.36</td>
<td>.47</td>
</tr>
<tr>
<td>Thinking hard about something gives me little satisfaction. (-)</td>
<td>-.07</td>
<td>.51</td>
</tr>
<tr>
<td>I don't reason well under pressure. (-)</td>
<td>.38</td>
<td>.23</td>
</tr>
<tr>
<td>I am much better at figuring things out logically than most people.</td>
<td>.06</td>
<td>.59</td>
</tr>
<tr>
<td>I have a logical mind.</td>
<td>.34</td>
<td>.38</td>
</tr>
<tr>
<td>I enjoy thinking in abstract terms.</td>
<td>.08</td>
<td>.47</td>
</tr>
<tr>
<td>I have no problem thinking things through carefully.</td>
<td>.17</td>
<td>.78</td>
</tr>
<tr>
<td>Using logic usually works well for me in figuring out problems in my life.</td>
<td>-.01</td>
<td>.55</td>
</tr>
<tr>
<td>Knowing the answer without understanding the reasoning it is good enough for me.</td>
<td>-.05</td>
<td>.78</td>
</tr>
<tr>
<td>I usually have clear, explainable reasons for my decisions.</td>
<td>.06</td>
<td>.71</td>
</tr>
<tr>
<td>Learning new ways to think would be very appealing to me.</td>
<td>.02</td>
<td>.63</td>
</tr>
</tbody>
</table>

Note. Minus sign (-) means the item has been reverse-scored.
Table 2-6. 
*Pattern Matrix for Experientiality Scale.*

<table>
<thead>
<tr>
<th>Experientiality Items</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like to rely on my intuitive impressions.</td>
<td>.74</td>
<td>.16</td>
</tr>
<tr>
<td>I don't have a very good sense of intuition. (-)</td>
<td>.65</td>
<td>.12</td>
</tr>
<tr>
<td>Using my gut feelings usually works well for me in figuring out problems in my life.</td>
<td>-.51</td>
<td>.47</td>
</tr>
<tr>
<td>I believe in trusting my hunches.</td>
<td>.60</td>
<td>.09</td>
</tr>
<tr>
<td>Intuition can be a very useful way to solve problems.</td>
<td>.71</td>
<td>.02</td>
</tr>
<tr>
<td>I often go by my instincts when deciding on a course of action.</td>
<td>.71</td>
<td>-.16</td>
</tr>
<tr>
<td>I trust my initial feelings about people.</td>
<td>.55</td>
<td>-.01</td>
</tr>
<tr>
<td>When it comes to trusting people, I can usually rely on my gut feelings. (-)</td>
<td>.77</td>
<td>-.08</td>
</tr>
<tr>
<td>If I were to rely on my gut feelings, I would often make mistakes.</td>
<td>.56</td>
<td>-.23</td>
</tr>
<tr>
<td>I don't like situations in which I have to rely on intuition. (-)</td>
<td>.70</td>
<td>.17</td>
</tr>
<tr>
<td>I think there are times when one should rely on one's intuition.</td>
<td>.65</td>
<td>.12</td>
</tr>
<tr>
<td>I think it is foolish to make important decisions based on feelings. (-)</td>
<td>.51</td>
<td>-.06</td>
</tr>
<tr>
<td>I don't think it is a good idea to rely on one's intuition for important decisions.</td>
<td>.66</td>
<td>.03</td>
</tr>
<tr>
<td>I generally don't depend on my feelings to help me make decisions. (-)</td>
<td>.16</td>
<td>-.33</td>
</tr>
<tr>
<td>I hardly ever go wrong when I listen to my deepest gut feelings to find an answer.</td>
<td>.57</td>
<td>.09</td>
</tr>
<tr>
<td>I would not want to depend on anyone who described himself or herself as intuitive.</td>
<td>.52</td>
<td>.07</td>
</tr>
<tr>
<td>My snap judgments are probably not as good as most people. (-)</td>
<td>.39</td>
<td>.42</td>
</tr>
<tr>
<td>I tend to use my heart as a guide for my actions.</td>
<td>.54</td>
<td>-.17</td>
</tr>
<tr>
<td>I can usually feel when a person is right or wrong, even if I can't explain how I know.</td>
<td>.61</td>
<td>.01</td>
</tr>
<tr>
<td>I suspect my hunches are inaccurate as often as they are accurate. (-)</td>
<td>-.39</td>
<td>-.44</td>
</tr>
</tbody>
</table>

Note. Minus sign (-) means the item has been reverse-scored.
Discussion

The findings of the present study indicated that, similar to findings of the original study reported by Pacini and Epstein (1999), REI items loaded around two separate constructs which corresponded to analytic and intuitive modes of thinking. In other words, almost all the experientiality items loaded around the first factor and almost all of the rationality items loaded around the second factor with significant loading values. This result confirmed the CEST assumption of the independence of rational and experiential (intuitive) systems. In addition, a significant correlation was found between the two scales rationality and experientiality which can indicate that the analytic and intuitive modes of processing are interacting with each other. This was supported by the loading patterns of some items in both scales which had relatively equal loading around both factors as well as the slight correlation found between the two factors shown by the factor correlation matrix results. In the original study, however, Pacini and Epstein did not find a correlation between the two scales of rationality and experientiality and, therefore, they did not confirm the CEST assumption of interaction of the two systems.

In addition, the construct validity of the subscales of engagement and ability for the replication study was confirmed as a moderate correlation was found between the subscales which justified both their retention as separate subscales and their combination to form the larger scales rationality and experientiality. However, the results of the present study also revealed that the two separate scales of rationality and experientiality (and therefore, the two modes) are in interaction with each other as the there was a correlation between the two scales. This finding was supported by results of REI factor analysis which revealed the existence of two independent unipolar constructs of rationality and experientiality which were slightly correlated. Therefore, both CEST assumptions of the independence and interactivity of the two constructs/processing
modes were confirmed (Shiloh, Salton, & Sharabi, 2002). Tables of item loadings of the results section show the exclusive loading of majority of the items on the relevant factors (independence assumption), while some items had loading around both factors (interaction assumption). In sum, the present study replicated for the most part the findings regarding the construct validity of the REI instrument developed by Pacini and Epstein (1999).

**Conclusion**

The results of the present investigation provided evidence for both features of the mental processing, namely, functional independence and wholistic integration/interaction of the two processing modes of the mind (Smith & DeCoster, 2000). These results are in line with the recent interdisciplinary research findings at the level of psychology as well as physiology which suggest that both psychological and biofunctional processes integrate and contribute to mental computations (Bargh et al., 2001; Bechara et al., 1997; Gershon, 1999; Iran-Nejad, 2000; Posner, 1994). The role of psychological processes and their functioning have been already investigated and established in the literature (Evans & Stanovich, 2013; Stanovich, 1999). However, experimental research on the role and contribution of the biofunctional processes are still in progress (Bechara et al., 1994; Bechara et al., 2000; Bechara et al., 1997).

The focus of some of these investigations is on documenting variations in bodily systems such as enteric (gastrointestinal) and peripheral (sympathetic or parasympathetic) nervous systems in intuitive or rational decision making. In the case of the enteric nervous system, for instance, recent research has discovered the gut-brain axis that connects the gut and the brain. Their findings have presented evidence that the type and activity of the gastrointestinal microorganisms (microbiota) directly regulate personality, mood and complex behaviors such as rational or intuitive processing and decision-making (Mayer, Knight, Mazmanian, Cryan, & Tillisch, 2014; O’Mahony, Clarke, Borre, Dinan, & Cryan, 2015; H. Wang, Lee, Braun, & Enck,
As for the peripheral nervous system indicators, electrophysiological research of intuition has documented significant changes in cardiovascular, respiratory and skin conductance responses at the moment of intuitive decision or behavior (McCraty, Atkinson, & Bradley, 2004; McVey Neufeld, Mao, Bienenstock, Foster, & Kunze, 2013). The results of these research efforts combined with the results of the present investigation regarding independence and interactivity of the processing modes are promising in bringing the mind and learning sciences a step closer towards a unified theory of the mind.

References


ARTICLE 3 INVESTIGATING INTUITION BEYOND GESTALT AND SELF-REPORT: THE BIOFUNCTIONAL MODEL OF INTUITIVE UNDERSTANDING

Abstract

In this paper, first, a brief report of the results of a series of experiments\(^4\) conducted on two well-cited intuition instruments of waterloo gestalt closure task (WGCT) and rational-experiential inventory (REI) is presented. Next, to explain and account for some of the unique patterns of responses collected from subjects by both instruments, the biofunctional theory of understanding is adopted to redefine the measures and examine whether the factor analysis of experimental data structure under the new biofunctional model can offer a more accurate representation of participants’ intuitive and analytic performance on both WGCT and REI instruments, especially in regards to the underlying roots of the unique responses revealed through the data analysis. At the end, implications of the new biofunctional model for a more robust conceptual and operational definitions of intuition are discussed.

*Key Words:* Intuition instruments, Gestalt closure task, Self-report questionnaire, Rational-experiential inventory, Ongoing biofunctional activity, Momentary constellation firing, Knowing-by-revelation, Understanding-by-reflection, Biofunctional model of intuition, Iran-Nejad’s wholetheme spiral of biofunctional understanding.

\(^4\)The use of human participants in this dissertation was approved by the Institutional Review Board of the University Alabama. All subjects gave informed consent in accordance with the Declaration of Helsinki. The protocol was approved by The University of Alabama Institutional Review Board (IRB # 16-OR-342, see Appendix)
A burgeoning number of studies in social psychology, cognition and neuroscience in recent years are presenting evidence that the mind is not a dual-process but a multi-source, multi-process entity. The main theme of all these recent findings is the need for a unifying theory of mind which encompasses not only the conscious, unconscious, and intuitive processes which originate from the central nervous system but also those originating from other equally important bodily systems such as enteric and peripheral nervous systems. Regarding the enteric nervous system, for example, recent research has discovered the gut-brain axis – the superhighway that connects the brain to the gut – and the critical role of the gut microbiota in regulating the state of the mind, mood and emotions (Mayer, Knight, Mazmanian, Cryan, & Tillisch, 2014; O’Mahony, Clarke, Borre, Dinan, & Cryan, 2015; H. Wang, Lee, Braun, & Enck, 2016; Y. Wang & Kasper, 2014). As for the peripheral nervous system, electrophysiological research on intuition has documented significant changes in cardiovascular, respiratory and skin conductance responses in intuitive decision or behavior (McCraty, Atkinson, & Bradley, 2004; McVey Neufeld, Mao, Bienenstock, Foster, & Kunze, 2013). Furthermore, in contrast to traditional accounts, intuition has been argued to be the highest form of intelligence (Gigerenzer, 2007), mainly because this evolutionary feat has become capable of discarding the irrelevant or insignificant information in the environment such that the living organism detects the relevant information essential for survival (Iran-Nejad & Bordbar, 2013; Johnson, 2007, 2013, 2015).

Despite the mounting experimental evidence on the mind-body inseparability and the mind’s multisource biological nature, most theoretical accounts have and still are employing the same modus operandi of simplification by reduction to account for complex behaviors such as intuition. For example, some of the seminal research in defining and measuring intuitive thought and behavior have defined intuitive thought or behavior in terms of implicit activation of
memory associations (e.g., gestalt closure task) (Bowers, Regehr, Balthazard, & Parker, 1990). Others have investigated the intuitively constructed judgment of the self and others in reference to conscious attention, thus, using the same cognitive tools used to examine intuitive phenomena (Epstein, Pacini, Denes-Raj, & Heier, 1996; Pacini & Epstein, 1999).

The main theme of all these recent findings, however, was proposed almost two decades earlier at the time of the popularity of information processing and dual-system theories in what came to be known as the biofunctional theory of understanding. In the first paper from a series of papers published over two decades, Iran-Nejad and Ortony (1984) highlighted mental processes (including intuitive or rational) as transient biological functions of the nervous system. The biofunctional approach emerged at a time when research in cognitive and social psychology was under substantial influence of old Cartesian dualism. This dualistic Cartesian demarcation still bears heavy influence on scientific research by dividing the mind into the dualistic intuitive versus rational systems or processes. The assumption of dual-process theories is that any processing that uses neural pathways for deliberation should not to be considered intuitive. Recent neuroscience discoveries, however, indicate that reasoning will be flawed if neural pathways for emotions and intuitions are compromised (Bechara, Damasio, & Damasio, 2000; Bechara, Damasio, Tranel, & Damasio, 1997). These findings necessitate another theoretical framework that defines intuition from the broader perspective of viewing the mind and body as a whole. In this paper, the biofunctional theory of understanding as an appropriate whole theme approach towards research on intuition is presented and discussed. It is argued that, contrary to the problematic dualist division of the mind into rational and intuitive systems by dual-process approaches, the biofunctional theory views the mind as a whole system grounded in biology (Iran-Nejad, 1994). In this embodied perspective, the ongoing intuitive understanding serves as
the figure-ground for two distinct yet complementary types of processes of intuitive understanding and psychological understanding which interact and integrate in the whole theme spiral of biofunctional understanding. In this spiral, processes such as intuitive decisions, knowledge or insight are not created by exclusive neural pathways but are the outcome of collective and momentary firing of various constellations of neurons from distinct areas of the nervous system. As a result, this model does not presume any neural boundary or mental demarcation. In the remainder of this article, a brief literature review of the biofunctional theory of understanding will be presented. Next, problems identified through the experiments with WGCT and REI instruments are reported and the solutions offered by the results of the analysis based on the biofunctional model are discussed, followed by a brief discussion of implications for providing a more accurate representation of the intuitive thought and behavior are discussed.

**Review of Literature**

**The Biofunctional Theory of Understanding**

In several papers published decades before the rise of embodied cognition in the 1990s and subsequent burgeoning of the cognitive neuroscience after the turn of the 21st century, Iran-Nejad and collaborators critically evaluated the first-generation research following the cognitive revolution and published the first draft of their biodunctional theory (Iran-Nejad, 1980, 1983; Iran-Nejad & Ortony, 1984). According to this theory, the inherent self is the hub of intuition as ongoing self-awareness of biofunctional understanding, hereafter called intuitive understanding or intuition (Iran-Nejad & Ortony, 1984). With intuition as ongoing self-awareness in the background, the biofunctional account describes attention as a distributed phenomenon in the sense that, depending on the internal or external stimuli, any constellation of neurons can function independently and become the spotlight of conscious attention (Iran-Nejad & Ortony, 1982). This account of attention was confirmed by the neuroscience research of the time in
which attention orientation was shown to be regulated by means of simultaneous activation of
different regions of the brain triggered by exogenous and endogenous processes (Posner, 1980).

Recent findings in cognitive neuroscience have also described similar accounts regarding the
nature of self, intuition and conscious attention. For instance, Damasio (2005) expresses his
dissatisfaction with the existing theories of consciousness for missing to consider the singularity
of the organism and the integrated/unified nature of the purported higher or lower-order
processes in the following:

A theory of consciousness should not just be a theory of how memory, reason and
language help construct, from top down, an interpretation of what goes on in the brain
and mind. A theory of consciousness should account for simpler, foundational kind of
phenomena which occur close to unconscious representation of the organism. (p. 18)

According to biofunctional theory, intuitive understanding is grounded in biology as a
visceral and inherent function of the nervous system, tantamount to breathing as the biological
function of the respiratory system (Iran-Nejad & Bordbar, 2013; Johnson, 2015). Along the same
lines, Damasio (1999) characterizes consciousness as the critical biological function that enables
the organism to get to know its internal and external environment through intuition and
emotions. In this framework, the same biofunctional relationship exists between intuitive
understanding and knowing in the form of a figure-ground which metaphorically illustrates the
mind-body-brain spiral of interdependence. In this model, the ground represents the ongoing
biofunctional activity (OBA) while the figure represents the momentary constellation firing
(MCF) of the neurons (Iran-Nejad, Mash II, & Clements, 1992). In other words, OBA is the
online and wholetheme integration of the activity of brain and body subsystems including the
regulatory activities of autonomic and enteric nervous systems.
This OBA is the nest of implicit, pre-representational, thematic knowledge, or the intuitive gut feelings as we know it. In other words, it is the source of the knowing-that in the absence of knowing-how which can be illustrated by statements such as *I know that I feel pain when I have toothache even though I do not know how I feel the pain.* It is from this ongoing biofunctional activity that momentary constellation firing of neurons arises. MCF, on the other hand, is the source of various representational knowing processes or the explicit-procedural knowledge that we are consciously aware (e.g., knowing that one can drive and knowing how to drive) (Iran-Nejad, 2000). As discussed in the above, OBA is the hub of inherent self. The inherent self, in turn, is the source of intuitive gut feelings or intuition. As these OBA-fueled gut feelings become stronger, they acquire more potential in triggering moment-to-moment constellation firings of various clusters of neurons which form the acquired sense of self.

Damasio (1999) also illustrated the workings of the conscious knowing along the same lines by arguing that consciousness consists of two kinds of biological selves. One is characteristically fleeting and endlessly regenerated (intuitive feelings), while the other is a non-transient ensemble of experience-based knowledge:

Incidentally, the two kinds of consciousness correspond to two kinds of self. The sense of self which emerges in core consciousness is the core self, a transient entity, ceaselessly recreated for each object with which the brain interacts. Our traditional notion of self, however, is linked to the idea of identity and corresponds to a non-transient collection of facts and ways of being which characterizes a person. (p. 17)

Johnson (1999) also characterized the current view of the understanding as a disembodied conception inherited from western philosophies of the mind such as Cartesian dualism and highlights the biofunctional view as a suitable theory of human understanding:
Biofunctional understanding is an especially apt expression for the way we should approach a theory of human understanding. It reminds us that we need to see how our capacities for understanding and reasoning are grounded in biological processes of organism-environment interaction. The “bio” component refers to the fact that we are biological organisms evolved both to sustain in our person the conditions of life and to enhance its quality. The functional component refers to the fact that our activities as biological organisms give rise to our capacity to perform a wide range of cognitive and affective functions. (p. 2)

The biofunctional model is also compatible with the work of prominent intuition theorists such as Sinclair and Ashkanasy (2005) and Klein (2004). Dismissing the previous accounts of intuition such as dual-process theories, they conceptualized intuition in the broad sense of direct knowing. This direct knowledge, they theorized, could become available using either processes of reasoning or pattern-matching which occur too fast to be registered by the conscious attentional resources. An important implication of their view, also aligned with the biofunctional model and backed by neuroscience findings, was the dismissal of the common myth in the literature that processes known as intuitive are qualitatively different – sometimes even opposites – from those that are deliberative such as logical reasoning or analytic reflection. In other words, both types of processes could very well utilize the same neural pathways previously believed to be exclusive to intuition or rationalization. Furthermore, proponents of unconscious thought theory have also emphasized that information processing (including rational/analytic processing) occurs even when the conscious attention is directed elsewhere (Dijksterhuis & Van Olden, 2006). Two major research findings in neuroscience of reasoning and decision-making also render the biofunctional view of intuition promising. The first finding is the discovery that
reasoning will be flawed if neural pathways for emotion/intuition are compromised (Bechara, Damasio, Damasio, & Anderson, 1994; Bechara et al., 2000; Bechara et al., 1997). The second finding suggests that humans are capable of fast-paced complex behavior and processing (inclusive of analytic reasoning) even in the absence of conscious awareness (Dijksterhuis & Aarts, 2010). This finding casts doubt on the commonly-held assumption that deliberation requires conscious awareness and vice versa. In the remainder of this paper, the nature and patterns of unique responses observed in the replication studies of WGCT and REI intuition instruments will be reviewed from the biofunctional perspective with the aim of finding solutions and implications for a model of intuition.

**First-Person Solutions to Gestalt Closure Task**

The results of gestalt closure study revealed a latent limitation in the original study conducted by Bowers et al. (1990). The limitation was that individual participants had to provide specific predetermined object names as solutions to each of the visual puzzles (gestalt pairs). These solution names had already been premeditated by some artists who drew the pairs (first picture was supposed to be an incomplete representation of a real object and second picture was a random and meaningless combination of the elements of the first picture). In other words, the gestalts and their associated solution names were the mental construction of the artists, and therefore, could be regarded as second source solutions (as opposed to first person solutions). Moreover, sometimes, it seemed that either one or both gestalts in each pair would reveal itself as a different object other than the ones considered as correct solutions, which could be excellent alternatives. However, Bowers et al. (1990) only considered the predetermined object names as correct solution and did not take into account other alternative responses provided by subjects. To illustrate the point more clearly, Figure 3-1 and Figure 3-2 on the next page display two items
along with the alternative solution names provided by subjects of the WGCT replication experiment as well as the intended second person solutions. It is to note that these alternative names have been provided under procedural time constraint (5 seconds).

*Figure 3-1.* Subjects’ alternative solution: magnifying glass, hand mirror; Intended solution: tennis racket (Bowers et al., 1990).

*Figure 3-2.* Subjects’ alternative solution: cocktail, sundae; Intended solution: lantern (Bowers et al., 1990).

As seen in the above figures, beside tennis racket, subjects also visualized the pairs as a *hand mirror* and a *magnifying glass*, which are in fact excellent alternatives. Subjects provided
similar alternative solutions to almost all WGCT items. Interestingly, these alternative solutions were nearly identical across the two replication groups of subjects. A review of solution patterns indicated a likely relationship between item difficulty (easy vs. difficult) and solution type (intended solution vs. alternative names) in that for most of easy items, the intended solutions consisted more than half of the total identifications. A viable explanation for this response pattern can be the fact that these gestalts resemble the *stereotypical representations or exemplars* of target objects in real world and, as result, subjects were able to recall them almost automatically from memory (Smith, 1998). From the perspective of spreading activation theory (Anderson, 1983), this resemblance of gestalts to the relevant memory exemplars activates respondents’ semantic and mnemonic networks of associations already stored in long-term memory, resulting in automatic retrieval of object names respectively. For the difficult items, on the other hand, the average proportion of alternative identifications were either equal or sometimes higher than the intended solutions, even though the majority of subjects had not been able to identify the difficult items and had selected the coherence choice option.

Qualitative and quantitative analysis of subjects’ alternative solutions revealed two forms of solutions to the gestalt pairs: (a) words in hierarchical/prototypical relationship with the solution words; For some of the gestalt pairs, subjects provided object names which were in superordinate (hypermym), subordinate (hyponym) or prototypical relations with the intended solution names; (b) creative object names; At times subjects had provided insightful names, other than the intended solutions, which revealed previously unnoticed objects in the gestalt pictures. Table 3-1 presents the intended solutions and subjects’ most common alternative solutions to the gestalt items as well as their corresponding coherence choices for comparison.
<table>
<thead>
<tr>
<th>Item</th>
<th>Intended solution</th>
<th>First alternative solution</th>
<th>Second alternative solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tennis Racket (B)*</td>
<td>Magnifying Glass (B)</td>
<td>Hand Mirror (B)</td>
</tr>
<tr>
<td>2</td>
<td>Briefcase (A)</td>
<td>Suitcase (A)</td>
<td>Laptop (A)</td>
</tr>
<tr>
<td>3</td>
<td>Camera (B)</td>
<td>Elephant/Horse (A)</td>
<td>Animal (A)</td>
</tr>
<tr>
<td>4</td>
<td>Tea Pot (A)</td>
<td>Person/Figure (A)</td>
<td>Duck (B)</td>
</tr>
<tr>
<td>5</td>
<td>Desk lamp (B)</td>
<td>Light Post (A)</td>
<td>Ceiling Lamp (A)</td>
</tr>
<tr>
<td>6</td>
<td>Ring (B)</td>
<td>Bird (B)</td>
<td>Crab (A)</td>
</tr>
<tr>
<td>7</td>
<td>Door Knob (B)</td>
<td>Light Switch (B)</td>
<td>landscape (A)</td>
</tr>
<tr>
<td>8</td>
<td>Elephant (A)</td>
<td>Lion/Tiger (B)</td>
<td>Dragon (B)</td>
</tr>
<tr>
<td>9</td>
<td>Fire Hydrant (A)</td>
<td>Domed Building (A)</td>
<td>Castle (B)</td>
</tr>
<tr>
<td>10</td>
<td>Trash Can (A)</td>
<td>Cup (A)</td>
<td>Bucket (A)</td>
</tr>
<tr>
<td>11</td>
<td>Guitar (A)</td>
<td>Bird (A)</td>
<td>Socks (B)</td>
</tr>
<tr>
<td>12</td>
<td>Helicopter (B)</td>
<td>Chair/Couch (A)</td>
<td>Elephant (A)</td>
</tr>
<tr>
<td>13</td>
<td>Microscope (B)</td>
<td>Face/Man (B)</td>
<td>Violin (B)</td>
</tr>
<tr>
<td>14</td>
<td>Glove/Mitten (A)</td>
<td>Birds Flying (B)</td>
<td>Ballerina (A)</td>
</tr>
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<td>15</td>
<td>Moose (A)</td>
<td>Gorilla (A)</td>
<td>Elk (A)</td>
</tr>
<tr>
<td>16</td>
<td>Lantern/oil lamp (B)</td>
<td>Microscope (B)</td>
<td>Sundae/Cocktail (A)</td>
</tr>
<tr>
<td>17</td>
<td>Padlock (A)</td>
<td>Lamp (B)</td>
<td>Can (A)</td>
</tr>
<tr>
<td>18</td>
<td>Pineapple (B)</td>
<td>Bird/Peacock (A)</td>
<td>Plant (B)</td>
</tr>
<tr>
<td>19</td>
<td>Pliers/Wrench (A)</td>
<td>DNA (B)</td>
<td>Fish (B)</td>
</tr>
<tr>
<td>20</td>
<td>Sailboat (B)</td>
<td>Mountain (B)</td>
<td>Killer Whale (B)</td>
</tr>
</tbody>
</table>

*Letters A and B in parentheses indicate objects’ associated coherence choices.*
Overall, the preliminary analysis of WGCT responses showed that, due to the premeditated nature, the intended solutions list of Bowers et al. (1990) might be a restrictive criterion for correct identification and does not cover all of subjects’ viable object or coherence identifications. The present study shows the need for a more inclusive correct identification criterion that includes both the intended object names and subjects’ excellent alternative names as correct identifications since both identifications are, by nature, knowledge conceived momentarily without knowing-how on the part of the subjects. In the biofunctional model, this knowing-by-revelation is generated through momentary constellation firing of neurons, and, is one of the three main components of the wholetheme biofunctional understanding spiral. In the remainder of this section, a brief discussion of the understanding spiral and its components is presented.

**Knowing-by-Revelation in the Context of Biofunctional Understanding**

The wholetheme spiral of biofunctional understanding figuratively sketches the context for the biological embodiment of the mind in which two distinct yet complementary processes of knowledge-enabled understanding and biology-enabled understanding integrate in the larger spiral of understanding. Iran-Nejad (2000) used the scenario of a prey animal such as an impala grazing in an African savanna with potential predators in the surroundings to illustrate the interaction of knowledge conceived momentarily based on the happenstance of the environment (revelation) with the ongoing understanding. As long as the environment is safe and no warning sign is detected through the alert senses, the ongoing biofunctional activity (OBA) of the zebra maintains its homeostatic balance (e.g., normal heart rate, respiratory responses, body temperature) and psychological harmony. In this scenario, it is hard to think of the need for some sort of knowledge as the prerequisite to this ongoing state of bodily understanding. On the
contrary, it is fair to assume that this understanding is the necessary precondition for any knowledge conceived momentarily (e.g., spotting an approaching predator in the distant grass). Figure 3-3 is a graphical representation of the interaction of ongoing understanding with momentary-conceived revelations in the absence of symbolic knowledge.

![Figure 3-3. The Iran-Nejad’s spiral of biofunctional understanding. Reprinted by permission from Iran-Nejad and Irannejad (2017a).](image)

Iran-Nejad and Irannejad (2017a) explain the understanding spiral in the following:

Dark arrows moving clockwise represent ongoing biofunctional activity (OBA) of understanding as it happens in the alertly grazing animal over time. Multiple sources contribute perpetually to OBA and knowing is but one of those sources. Another source is the active I of the animal. Among other contributing sources to biofunctional understanding are diverse sensory modalities and other internal subsystems of the body (e.g., for hunger, thirst, fear, joy) all contributing perpetually to the OBA. The OBA collectively organizes contributions from multiple sources as the collective how, why, when, which, who, and what of these sources remain biofunctional secrets. (p. 3)
Given the above description of the understanding model, the momentary conceived alternative solutions to gestalt items in replication WGCT are also examples of knowledge conceived momentarily or knowing-by-revelation. Therefore, as one of the main components of the understanding spiral, Iran-Nejad and Irannejad (2017a) define knowing-by-revelation as the following:

The dark clockwise arrows rising suddenly upward to the right represent momentary constellation firing (MCF) in already alert neurons. MCF collectively announces revelatory knowledge and excitement (knowing-by-revelation in the figure). This happens when the shift in predator spots, as one source, alarms the already alert animal in the form of a momentary conception or revelation. (p. 4)

Finally, in the aftermath of this momentary conception of knowledge, the alert animal reflects on this momentary acquired knowledge (represented by the arrows moving in the left direction until they sink in the figure) to understand and take the appropriate action. This cycle continues as this situation develops on a momentary basis. In the following, the new dependent measures that include both the intended and subjects’ alternative responses to WGCT are defined based on the model described above.

**Defining Biofunctional Dependent Measures for Gestalt Closure Task**

Based on the definition of revelation discussed in previous section, both the intended solution words and subjects’ alternative identifications are forms of revelations and, therefore, can be considered as correct responses. Consequently, the gestalt coherence choices that correspond to these revelation identifications can also be considered correct coherence choices. As a result, instead of the traditional dependent measures of solution score and guiding score under the conservative correct criterion, three more inclusive measures of knowing-by-revelation
and intuitive coherence understanding and understanding-by-reflection were defined in order to make better sense of the data. In the following, each of the three variables are defined and discussed based on the understanding spiral model.

**Knowing-by-revelation.**

This variable covers both the intended/expected solutions and alternative identifications given by subjects for the gestalt items in paper 1. To calculate this score for each subject, one point was given not only to names that were identical to the solutions intended by Bowers et al. (1990), but also to those which were identical/similar to alternative identifications deemed acceptable. For instance, for the first gestalt item used in this study, a subject would receive one point had she identified the object to be any of the following: tennis racket (intended solution), magnifying glass (alternative name), or hand mirror (alternative name). To ensure that the alternative names could indeed be seen in their corresponding gestalt pictures, two independent judges evaluated the appropriateness and accuracy of alternative names for each gestalt pairs (if they could see the object name that was just read to them in any of the two gestalts in each pair).

**Intuitive coherence understanding.**

For those gestalts that subjects could not identify (name), they were asked if they could detect any meaningful coherence in them. According to the biofunctional model, this intuitive understanding of coherence occurs without any know-how on the part of the individual and, therefore, could serve as the measure of intuitive judgement in this experiment. This measure corresponds to the unidentified gestalt choices correctly selected as coherent based on both intended and revelation criteria. To calculate the relevant score, the total number of unidentified gestalts was determined by first excluding identification-by-revelations (sum of intended and alternative names) from subjects’ responses. Next, the frequency of unidentified coherent
gestalts that were correctly selected as coherent was calculated. As an example, for the first gestalt pair used in this study, coherence choices associated with any of the three responses of tennis racket, magnifying glass, or hand mirror were counted as correct.

**Understanding-by-reflection.**

This index corresponds to the frequency count of those gestalt identifications that neither matched the list of solutions intended by Bowers et al. (1990) or the alternative or acceptable revelations. According to the biofunctional model, the source of this construct is the active executive functioning processes which, due to their deliberative nature, are slow, effortful, exhaustive and prone to error.

**Method**

**Participants**

A total of 164 undergraduate students (99 females and 66 males) taking courses in the college of education at two research universities in the southeast completed two online surveys in exchange for course credit. Participants’ average age was 22 years old ($M = 22, SD = 1.88$). All subjects gave informed consent in accordance with the Declaration of Helsinki. The study was approved by The University of Alabama Institutional Review Board (Appendix B).

**Procedure**

An online Qualtrics link containing waterloo gestalt closure task and rational-experiential inventory was sent via email to subjects. Clicking on the link would first take subjects to the gestalt closure task. After the instructions, a 5-second preparation countdown would alarm subjects of an incoming gestalt stimulus, followed immediately by 5-second presentation of the gestalt pair on the screen. After each gestalt pair presentation, a page would appear asking subjects to identify (name) the object that they just viewed. If subjects were able to identify the object, then clicking on the next tab would direct them to the next gestalt stimuli. However, if
subjects were unable to name the object, then they would be presented with a forced-choice question asking subjects which of the two pictures (A or B) was a real object (coherent), followed by a 5-point Likert scale rating of their confidence in the choice they just made. After completing the gestalt closure task, participants would be directed to complete the REI survey in which, first, they would read a brief passage describing the survey and the scaling information. Then subjects would rate statements such as *when it comes to trusting people, I can usually rely on my gut feelings* (experiential) or *I enjoy solving problems that require hard thinking* (rational), as rapidly as they could, on a 5-point Likert scale (1 = *definitely false* and 5 = *definitely true*).

**Measures**

**Waterloo gestalt closure task.**

Survey 1 was a computerized version of waterloo gestalt closure task (Bowers et al., 1990) which consisted of 23 gestalt pairs and constructed in the form of a Qualtrics survey link. Of these 23 pairs, three easy pairs were used as trial items in the beginning of the survey to familiarize subjects with the nature of the task. Bowers et al. study employed the following variables in their study: (a) correct/incorrect name, (b) correct/incorrect coherence, (c) name confidence (d) coherence confidence. To explore WGCT data from the biofunctional perspective, the following variables were defined based on revelation criterion and the components of the wholetheme spiral of biofunctional understanding: (a) knowing-by-revelation (the proportion of correct names based on the revelation criterion), (b) intuitive coherence understanding (the proportion correct coherence choices based on revelation criterion), (c) incorrect coherence choice (the proportion incorrect coherence choices based on revelation
criterion), (d) understanding-by-reflection (the proportion incorrect names based on revelation criterion), (e) active reflection confidence, (f) coherence understanding confidence.

**Rational-experiential inventory.**

The second survey was an online (Qualtrics) version of rational-experiential inventory (REI) developed and construct-validated by Pacini and Epstein (1999). REI is a 40-item 5-point Likert scale (1 = *definitely false* and 5 = *definitely true*) questionnaire designed to identify individuals’ degree of reliance on rational and experiential thinking/decision-making. The inventory is comprised of two 20-item scales, with one scale aimed at assessing rationality and the other experientiality (intuitiveness). Each of the scales contains two smaller 10-item subscales designed to produce the two indexes of thinking style and ability for each of the subscales. The sum of thinking style and ability indexes within each scale would yield a rationality score and an experientiality score. Higher score on either one would mean that the individual is dominant in that mode of processing for thinking and decision-making (Pacini & Epstein, 1999). In the present study, both REI scales were found to be highly reliable with Cronbach's alphas of $\alpha = .88$ for rationality scale (20-item) and $\alpha = .84$ for experientiality scale (20-item).

**Data Analysis**

In the present investigation, exploratory factor analysis (EFA) was selected to be conducted as the main statistical procedure to evaluate and explore the psychometric properties of both tasks such as factor structure, dimensionality and the fit of the data to the proposed understanding model described in the literature section. To evaluate the feasibility of the EFA, some tests were selected and performed prior to conducting the EFAs. *Kaiser–Meyer–Olkin (KMO)* test was performed to evaluate the adequacy of sampling for using EFA and suitability of
the data structure for factor extraction. KMO test produces a value between 0 to 1 and a value higher than .60 can indicate that factors accounts for a fair or high proportion of variance and, therefore, factor analysis is suitable to be conducted. Bartlett's test of sphericity was run to examine whether the correlation matrix of the data is an identity matrix which takes place when the variables are not correlated (independent). Therefore, significant values less than .05 indicate that the correlation matrix is not an identical matrix and, therefore, factor analysis is appropriate to be conducted. In addition, to prevent multicollinearity and the problem of highly correlated items in questionnaires such as REI used in this study, the value of correlation matrix determinant (ranging from 0 to 1) was checked to ensure that it is greater than .00001.

After all the above assumptions were confirmed, exploratory factor analysis was conducted on WGCT and REI data using IBM SPSS Statistics version 22.0 in the following order: (a) EFA on WGCT data with original variables, (b) EFA on WGCT with original variables plus REI data, (c) EFA on WGCT data based on biofunctional variables, (d) EFA on WGCT based on biofunctional variables plus REI data. Maximum likelihood with oblique oblimin rotation was performed to extract factors in the dataset. The reason for selecting maximum likelihood was to explore all the latent factors that might be contributing to the variation of the data. Oblique oblimin rotation was performed to examine any correlation among the factors.

Results

EFA Results with Original WGCT Variables

All the assumptions were tested before conducting EFA on WGCT data with original variables. The KMO test confirmed the adequacy of the sample (KMO = .66) and Bartlett's test rejected the null hypothesis of identical matrix $\chi^2 (15) = 612.391, p < .001$. Moreover, no multicollinearity was detected as the determinant of the correlation matrix showed acceptable value. Exploratory factor analysis (maximum likelihood) was conducted and oblique rotation
was performed to test for the correlation of factors. Three factors with eigenvalues higher than 1 were extracted, explaining a total 85% variation and, therefore, were sufficient to explain the underlying structure of the WGCT data. The first factor had an eigenvalue of 2.43 and accounted for 41% of variance in the data. The second factor had an eigenvalue of 1.37 and explained 23.56% further variance in the data. The third factor’s eigenvalue was 1.17 which explained another 20.62% variance (Table 3-2).

Table 3-2. EFA 1. Total Variance Explained by Factors for WGCT Original Variables.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Initial eigenvalues</th>
<th>Total % of variance</th>
<th>Cumulative %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.43</td>
<td>40.99</td>
<td>40.99</td>
</tr>
<tr>
<td>2</td>
<td>1.37</td>
<td>23.56</td>
<td>64.55</td>
</tr>
<tr>
<td>3</td>
<td>1.17</td>
<td>20.62</td>
<td>85.17</td>
</tr>
</tbody>
</table>

Note. Extraction Method: Maximum Likelihood.

Pattern matrix table (Table 3-3) shows factor 1 to include the variables correct coherence with a significant positive loading of .94 and variable correct name with a significant negative loading of -.70<sup>5</sup>. From the perspective of dual-process theories, this factor corresponds to dual-control function of a domain-specific gestalt or object schema. In this view, correct coherence variable represents the implicit aspect of a domain-specific object which explains the positive loading of the variable as a measure of intuitive judgment. On the other hand, the correct name variable represents the explicit aspect of gestalt closure in the form of object name which is why it has negative loading around factor 1.

<sup>5</sup> Cutoff value for significant loading: [.60]
Factor 2 included a negative loading from incorrect name (-.81) and a positive loading from correct name (.64). The loading of both correct and incorrect name variables around the same factor can be indicating that factor 2 is highlighting the portion of solutions which although counted as wrong based on the intended criterion, were indeed excellent alternatives revealed to the subjects when looking at gestalts. The reason for the loading of correct name around this construct is that, depending on individual differences and context, sometimes these explicit gestalt closures or instantaneous revelations happen to be identical. Therefore, factor 2 can be associated with the construct of \textit{revelation}. Finally, factor 3 consisted of the high positive loading of .95 from incorrect coherence variable. The high loading of incorrect coherence on a separate construct can be indicative of its different nature and source. This can be explained by the idea that, due to contextual elements and individual differences, some subjects resorted the effortful executive function processes instead of relying on their intuitive resources to identify the gestalts or detect coherences. Although very suitable cognitive tools, executive function processes can generate erroneous solutions (incorrect coherence) for fast-paced intuitive tasks such as WGCT. Given this, factor 3 can be labeled \textit{conscious executive function} as the third construct underlying the WGCT data structure.

Table 3-3. \textit{EFA 1. Pattern Matrix for WGCT Original Variables.}

\begin{tabular}{lccc}
\hline
Variable & Factor 1 & Factor 2 & Factor 3 \\
\hline
Correct name & -.70 & .64 & -.15 \\
Incorrect name & .17 & -.81 & -.38 \\
Correct coherence & .94 & -.01 & -.10 \\
Incorrect coherence & -.05 & .02 & .95 \\
\hline
\end{tabular}

\textit{Note.} Rotation Method: Oblimin with Kaiser Normalization.
EFA Results with Original WGCT plus REI Variables

All the assumptions for EFA 2 were confirmed. KMO test obtained a good sample adequacy (KMO = .70) and the null hypothesis of identical matrix was rejected by Bartlett's sphericity test $\chi^2 (28) = 697.006, p < .001$. The matrix determinant value was .23. EFA 2 was conducted including both WGCT original variables plus REI scores of rationality and experientiality. Three factors with eigenvalues higher than 1 were extracted which were sufficient to explain the underlying structure of the WGCT (72.77% of total variation). Factor 1 had an eigenvalue of 1.77 and accounted for 29.54% of variance in the data. Factor 2 had an eigenvalue of 1.35 and explained 22.49% further variance in the data. Factor 3 had an eigenvalue of 1.24 which explained another 20.73% variance (Table 3-4).

Table 3-4.
EFA 2. Total Variance Explained for WGCT Plus REI Variables.

<table>
<thead>
<tr>
<th>Component</th>
<th>Initial eigenvalues</th>
<th>Total % of variance</th>
<th>Cumulative %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.77</td>
<td>29.54</td>
<td>29.54</td>
</tr>
<tr>
<td>2</td>
<td>1.35</td>
<td>22.49</td>
<td>52.04</td>
</tr>
<tr>
<td>3</td>
<td>1.24</td>
<td>20.73</td>
<td>72.77</td>
</tr>
</tbody>
</table>

Note. Extraction Method: Maximum Likelihood.

The table of EFA 2 pattern matrix (Table 3-5) shows that WGCT variables of correct name had a negative loading of -.92 and correct coherence a positive loading of .73 around factor 1. This result confirmed the EFA 1 loading pattern and directionality for the first factor as explicit-implicit function of a gestalt schema. Factor 2 also included the same loading pattern obtained from EFA 1, namely, a high negative loading from incorrect name (-.96) and a positive loading from correct name (.31), although loading value of correct name was nonsignificant. As a result, the construct of revelation as the underlying source of subjects’ alternative solutions to gestalt items was also confirmed. Factor 3 included the positive loadings of experientiality (.80)
and rationality (.78) modes of thinking. This loading pattern is consistent with EFA 1 factor 3 labeling as conscious executive functioning. Both subscales of rationality and experientiality are self-report questionnaires which prompt subjects to reflect on items and provide a self-rating of their degree of rationality and intuitiveness. Therefore, due to the introspective nature of items, executive functioning processes are utilized to rate the items rather than subconscious intuitive processes or the momentary-conceived revelations employed in split-second coherence discriminations of gestalts. Table 3-5 below display EFA 2 factor loading results.

The results of both EFA1 and EFA 2 generated consistent factor solutions of implicit/explicit coherence discrimination (factor 1), revelation (factor 2) and conscious executive functioning (factor 3) even when REI data were added to the pool of WGCT data. It seems that these three extracted constructs from the data structure are characteristically and conceptually very close to the biofunctional processes described in the literature section. Given these results, two more EFAs were conducted on the data, this time with variables defined based on the understanding spiral (Figure 3-3), to evaluate the validity of the proposed model and the obtained factor structure.

Table 3-5. EFA 2. Pattern Matrix for WGCT and REI Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct name</td>
<td>-.92</td>
<td>.31</td>
<td>.02</td>
</tr>
<tr>
<td>Incorrect name</td>
<td>.06</td>
<td>-.96</td>
<td>.01</td>
</tr>
<tr>
<td>Correct coherence</td>
<td>.73</td>
<td>.14</td>
<td>-.10</td>
</tr>
<tr>
<td>Incorrect coherence</td>
<td>.57</td>
<td>.51</td>
<td>.06</td>
</tr>
<tr>
<td>Rationality</td>
<td>-.11</td>
<td>.09</td>
<td>.78</td>
</tr>
<tr>
<td>Experientiality</td>
<td>.03</td>
<td>-.07</td>
<td>.80</td>
</tr>
</tbody>
</table>

Note. Rotation Method: Oblimin with Kaiser Normalization.
EFA Results with the Understanding Spiral Variables

The assumptions for the third round of EFA were tested. The KMO test confirmed the adequacy of the sample (KMO = .65) and Bartlett's test rejected the null hypothesis of identical matrix $\chi^2 (15) = 341.564, p < .001$. Moreover, no multicollinearity was detected as the determinant of the correlation matrix was .04. EFA performed with the understanding spiral variables also extracted three robust factors with eigenvalues higher than 1. These factors were adequate to explain the underlying data structure. Factor 1 had an eigenvalue of 2.62 and accounted for 43.80% of variance in the data. Factor 2 had an eigenvalue of 1.88 and explained 31.66% of variance. Factor 3 had an eigenvalue of 1.23 which explained another 20.64% variance (Table 3-6).

Table 3-6. *EFA 3. Total Variance Explained Based on Understanding Spiral Variables for WGCT Variables.*

<table>
<thead>
<tr>
<th>Factor</th>
<th>Initial eigenvalues</th>
<th>Percentage of variance</th>
<th>Cumulative Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.62</td>
<td>43.80</td>
<td>43.80</td>
</tr>
<tr>
<td>2</td>
<td>1.88</td>
<td>31.36</td>
<td>75.17</td>
</tr>
<tr>
<td>3</td>
<td>1.23</td>
<td>20.64</td>
<td>95.81</td>
</tr>
</tbody>
</table>

*Note.* Extraction Method: Maximum Likelihood.

EFA 3 pattern matrix table (Table 3-7) shows that factor 1 consists of revelation variable with a positive loading of .93 and coherence understanding with a negative loading of -.67. This loading pattern is in line with the understanding spiral model according to which conceptual understanding (CU top of Figure 3-3) and intuitive biofunctional understanding (BU center of Figure 3-3) are distinct yet complementary processes (contributing to each other). Therefore, although revelation is a distinct conceptual understanding process with high loading value, it
receives momentum and contribution from intuitive understanding which explains the positive and negative loading directionality of both variables on factor 1.

The same complementary model applies to factor 2 as it receives loading from both correct coherence understanding (.61) and incorrect coherence understanding (-.70). As mentioned in the previous EFA results, incorrect coherence choices are associated with conscious executive functioning processes as manifestations of conceptual understanding and, therefore, these active processes are in complementary relationship with intuitive processes based on the tenets of the biofunctional theory. Factor 3 includes a high negative loading of the understanding-by-reflection (UBR) variable (-.97). Under the new model, since revelations consist of a separate construct covering both correct names and alternative names generated by momentary revelation, UBR only corresponds to the correct object names stored in memory and retrieved through reflective and deliberative processes which also explains its high positive loading on the third factor.

Table 3-7.
EFA 4. Pattern Matrix for WGCT Based on Biofunctional Understanding Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revelation</td>
<td>.93</td>
<td>-.10</td>
<td>.29</td>
</tr>
<tr>
<td>Coherence understanding</td>
<td>-.67</td>
<td>.61</td>
<td>.32</td>
</tr>
<tr>
<td>Understanding-by-reflection</td>
<td>-.01</td>
<td>.18</td>
<td>-.97</td>
</tr>
<tr>
<td>Incorrect coherence</td>
<td>-.58</td>
<td>-.70</td>
<td>.35</td>
</tr>
</tbody>
</table>

*Note.* Rotation Method: Oblimin with Kaiser Normalization.

Having obtained the above-mentioned factor structure under the understanding spiral model, a final EFA was performed with the same understanding variables plus REI variables to test whether the same factor solutions would be extracted with a larger dataset. The assumptions
for the last round of EFA were tested. The KMO test confirmed the adequacy of the sample (KMO = .78) and Bartlett's test rejected the null hypothesis of identical matrix $\chi^2 (21) = 431.626$, $p < .001$. Moreover, no multicollinearity was detected as the determinant of the correlation matrix was .06. EFA performed with the understanding spiral plus REI variables also extracted three robust factors with eigenvalues higher than 1. Factor 1 had an eigenvalue of 2.01 and accounted for 33.49% of variance. Factor 2 had an eigenvalue of 1.28 which explained 21.47% variance, and factor 3 had an eigenvalue of 1.08 explaining another 18.13% variability (Table 3-8).

Table 3-8. 
**EFA 4. Variance Explained Based on Understanding Spiral Variables for WGCT/REI Data.**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Initial Eigenvalues</th>
<th>Total</th>
<th>% of Variance</th>
<th>Cumulative %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.01</td>
<td>33.49</td>
<td>33.49</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1.28</td>
<td>21.47</td>
<td>54.96</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1.08</td>
<td>18.13</td>
<td>73.10</td>
<td></td>
</tr>
</tbody>
</table>

*Note. Extraction Method: Maximum Likelihood.*

EFA 4 pattern matrix table (Table 3-9) shows that factor 1 consists of coherence understanding (a BU process) and rationality (a CU process) variables with positive loadings of .81 and .66 and incorrect coherence variable with a negative loading of -.57 (also a CU process). This pattern of loadings is indicating that factor 1 is receiving contributions from multiple BU and CU sources. According to the biofunctional theory, multiple sources contribute perpetually to OBA and coherence understanding is but one of those sources. Pattern matrix table also shows that another contributing source is the active “I” which is represented as rationality variable (the rational aspect, positive loading) and incorrect coherence variable (the frustrated and error-prone aspect, negative loading). Therefore, it can be concluded that this factor corresponds to the
ongoing biofunctional activity (OBA) represented by dark arrows moving clockwise in the understanding spiral figure as one of the three main processes (arrows).

Factor 2 receives a positive loading of .95 from knowing-by-revelation (CU process) variable and a negative loading of -.65 from incorrect coherence (active “I” CU process). This loading pattern from two CU processes corresponds to the second type of arrows in the spiral figure, the dark clockwise arrows rising suddenly upward to the right represent momentary constellation firing (MCF) in already alert neurons. MCF collectively announces to the active “I” revelatory knowledge and excitement. Finally, factor 3 received a high positive loading of .93 from understanding-by-reflection (UBR) variable. UBR is the third and the last process (arrow) represented by the arrows moving in the left direction until they sink in the spiral figure and takes place following the MCF, when the alert nervous system reflects on the revelatory knowledge to understand and take the appropriate action.

Table 3-9.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowing-by-revelation</td>
<td>.18</td>
<td>.95</td>
<td>-.11</td>
</tr>
<tr>
<td>Understanding-by-reflection</td>
<td>.10</td>
<td>-.20</td>
<td>.93</td>
</tr>
<tr>
<td>Coherence understanding</td>
<td>.81</td>
<td>-.14</td>
<td>.11</td>
</tr>
<tr>
<td>Incorrect coherence</td>
<td>-.57</td>
<td>-.65</td>
<td>-.26</td>
</tr>
<tr>
<td>Rationality</td>
<td>.66</td>
<td>.23</td>
<td>-.30</td>
</tr>
<tr>
<td>Experientiality</td>
<td>.46</td>
<td>.20</td>
<td>.14</td>
</tr>
</tbody>
</table>

Note. Rotation Method: Oblimin with Kaiser Normalization

Table 3-10 on the next page presents a summary of the identified factors of OBA, MCF and UBR and variables with major loadings around them.
Table 3-10.  
Major Factors with Significant Loadings Emerging from WGCT/REI Factor Analysis.

<table>
<thead>
<tr>
<th>Major Factors</th>
<th>OBA Variable (loading)</th>
<th>MCF Variable (loading)</th>
<th>UBR Variable (loading)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coherence understanding</td>
<td>(.81)</td>
<td>Knowing-by-revelation</td>
<td>(.95)</td>
</tr>
<tr>
<td>Rationality</td>
<td>(.66)</td>
<td>Incorrect coherence</td>
<td>(-.65)</td>
</tr>
<tr>
<td>Knowing-by-revelation</td>
<td></td>
<td>Understanding-by-reflection</td>
<td>(.93)</td>
</tr>
</tbody>
</table>

**Discussion**

The main goal of the present research was to test whether the whole theme biofunctional spiral of understanding (Iran-Nejad & Irannejad, 2017b) can explain the source of alternative gestalt identifications not predicted by Bowers et al. (1990) criterion. To this end, it was necessary to analyze the factor structure of subjects’ responses to WGCT items both under the original and the new biofunctional measures. Therefore, in the first phase, an exploratory factor analysis was conducted with the variables of Bowers et al. (1990) study to explore the underlying factors around which the data are structured. The results of the first EFA revealed the loading of both correct and incorrect name variables around the same factor (factor 2). This can indicate that some of the subjects’ solutions counted as incorrect based on the intended criterion are inherently of the same nature as the correct answers. In other words, factor 2 is highlighting the portion of solutions which, although counted as wrong based on the intended criterion, were indeed excellent alternatives revealed to the subjects when looking at gestalts (revelations). Therefore, EFA 1 revealed the construct of *revelation* to be the source of alternative gestalt names not predicted or intended by Bowers et al. (1990).

The exclusive high loading of incorrect coherence on factor 3, on the other hand, can be indicative of its different nature as this factor included those responses which were neither the intended solutions nor revelations. This factor loading can be explained by the idea that, due to contextual elements and individual differences, some subjects resort the effortful executive
function processes instead of relying on their intuitive resources to identify the gestalts or detect coherences. Although very suitable cognitive tools, executive function processes can generate erroneous solutions (incorrect coherence) for fast-paced intuitive tasks such as WGCT. Given this, factor 3 was labeled *conscious executive function* as the third construct underlying the WGCT data structure.

The next step in the factor analysis of the replication experiments was to explore the WGCT data structure combined with subjects’ performance on another instrument of intuition such as REI. This enabled us to test the accuracy of factor analysis results by examining whether data collected from the same participants on two different measures would display similar loading behavior around the same extracted factors. The results could also be helpful in identifying measurement issues which may introduce errors in representing the intuitive ability for each instrument or reveal latent variables or factors behind subjects’ performance on each instrument (Coolican, 2014). The second EFA results also extracted the same factors as well as similar factor loading patterns and directionality of variables obtained from EFA 1. Therefore, the construct of *revelation* as the underlying source of subjects’ alternative solutions to gestalt items was confirmed. Moreover, the positive loadings of experientiality and rationality modes of thinking on factor 3 was consistent with EFA 1 factor 3. This result confirmed the construct of *executive function* to be the source of subjects’ performance on REI. Both subscales of rationality and experientiality are self-report questionnaires which prompt subjects to reflect on items and provide a self-rating of their degree of rationality and intuitiveness. Therefore, due to the introspective nature of items, executive functioning processes are utilized to rate the items rather than subconscious intuitive processes or the momentary-conceived revelations employed in split-second coherence discriminations of gestalts. Moreover, the nonsignificant loading of
WGCT variables around the factor 3 may indicate no relationship between participants’ mode of processing as measured by REI and their intuitive coherence discrimination as measured by WGCT.

The overall results of EFA 1 and 2 indicated that the extracted constructs from the data structure are characteristically and conceptually very close to the biofunctional processes described in the wholetheme spiral of biofunctional understanding (Iran-Nejad & Irannejad, 2017b). For instance, factor 1 resembled the ongoing biofunctional activity (OBA) which consists of two distinct yet complementary processes; The first process is the intuitive biofunctional understanding (BU) which accounts for manifestations such as intuitive discrimination of correct coherence in gestalts (positive loading). BU is not consciously noticed and only sensed in the form of a gut feeling or an intuitive hunch about the coherence in gestalts. The second OBA process, on the other hand, is the more explicit conceptual understanding (CU) with consciously noticed manifestations such as understanding-by-reflection (UBR) (e.g. remembering the correct names and reflecting on them) and Knowing-by-revelation (KBR) (e.g. coming up with alternative names). In this case, correct names correspond to UBR manifestation of CU, and therefore, is announced in conscious awareness, enabling subjects to verbalize the correct names of the gestalt objects. Factor 2, on the other hand, corresponds to the KBR, which is another conceptual manifestation of OBA and covers both correct revelations and alternative revelations given to gestalt items. Finally, the conscious executive function factor corresponds to the same component of the spiral known as active or executive “I” (Figure 3-3). The third EFA confirmed the factor structure described based on the understanding spiral model.

To test whether the biofunctional model of intuition would be confirmed by a final extraction of the same constructs from the aggregate data structure, a final EFA was performed
with the same understanding variables plus REI variables. The pattern matrix table for the final EFA showed that factor 1 is receiving contributions from multiple BU and CU sources (loadings from multiple variables) and, therefore, does correspond to the ongoing biofunctional activity (OBA). According to the biofunctional model, the OBA collectively organizes contributions from multiple sources and is represented by dark arrows moving clockwise in the understanding spiral figure (Iran-Nejad, McKeachie, & Berliner, 1990). Factor 2 also received loading from two CU processes of knowing-by-revelation and active “I” executive function. This loading pattern corresponds to momentary constellation firing (MCF) as the second main process (arrow), represented by the dark clockwise arrows rising suddenly upward to the right in already alert neurons. MCF collectively announces to the active “I” revelatory knowledge and excitement. Finally, factor 3 received a high loading from understanding-by-reflection (UBR) variable as the third and the last process (arrow) represented by the arrows moving in the left direction until they sink in the spiral figure. UBR takes place in the aftermath of MCF, when the alert nervous system reflects on the revelatory knowledge to understand and take the appropriate action. Overall, the results of the present investigation revealed that the three main processes of OBA, MCF and UBR of the wholetheme spiral of biofunctional understanding underlie the WGCT-REI data structure (Iran-Nejad & Irannejad, 2017a, 2017b). Another finding was that beside the dual-control or dual-process variables (Evans & Stanovich, 2013), the latent variable of knowing-by-revelation (KBR) generated subjects’ responses to both WGCT items. These findings suggest that the biofunctional model of intuition can offer an appropriate ground to define intuition conceptually and operationally (Hruby, 2000; Iran-Nejad & Ortony, 1984; Rosch, 2000).
Conclusion

The goal of this paper was to address two problems associated with literature of research on intuition. The first problem is the absence of consensus on the definition of intuition due to the numerous definitions proposed by various theoretical camps. The second problem, closely related to the first, is that most theories have defined intuition from a specific point of view and, therefore, a conclusive framework that includes essential aspects and manifestations of intuition is needed. To address these issues in the present study, two well-known intuition instruments in the literature (gestalt closure task and rational-experiential inventory) were selected and administered to subjects. Analysis of the data obtained from both instruments revealed unique patterns of responses not reported by the original studies. This raised the possibility of involvement of some third processes not accounted for by traditional dual-control or dual-process approaches. To investigate this third element, a series of exploratory factor analyses were performed on both WGCT and REI data to find the source of these unique responses and the potential underlying factors. The factor analysis results revealed the involvement of three main factors, rather than two as proposed by dual-process accounts (Evans, 2007, 2009), to explain subjects’ performance on intuitive tasks. Moreover, these three factors had a good fit to the main components of wholetheme spiral of biofunctional understanding (Iran-Nejad & Irannejad, 2017b).

These findings offer two important implications for the development of an appropriate measure or instrument of intuition. The first implication is that revelations explained a significant portion of the subjects’ data and, therefore, should be taken into account in evaluating subjects’ intuitive performance (Iran-Nejad et al., 1990; Iran-Nejad & Stewart, 2011). The second important implication, revealed through factor analysis of the two intuition instruments used in this article, is that subjects’ dominant mode of processing is the outcome of the integrative
involvement and contribution of conceptual and biofunctional understanding processes (CU & BU) manifested by knowing-by-revelation, understanding-by-reflection and intuitive biofunctional understanding in the wholetheme spiral of biofunctional understanding (Damasio, 1999; Gazzaniga, 1992; Iran-Nejad & Chissom, 1992; Iran-Nejad, Clore, & Vondruska, 1984). Overall, the findings of the present study indicate that the biofunctional model of understanding has the potential to offer an appropriate conceptual/operational definition of intuition and can serve as a suitable theoretical framework to further explore intuition.

References


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CONCLUSION

This dissertation was an experimental attempt to offer a critical appraisal dual-process accounts of intuition by replicating two well-cited intuition instruments based on these accounts. Moreover, due to a lack of a theoretical framework in presenting a clear conceptual definition of intuition, the goal was to reanalyze and interpret the findings towards a unified model of intuition. The overall finding revealed from the integration of the results of these three studies was that the wholetheme spiral of biofunctional understanding can serve as a comprehensive model for intuition. In what follows, an overview of findings of the studies conducted in this dissertation as well as the theoretical findings obtained from the integrative analysis of the results from the biofunctional theory of understanding model are presented. This model was developed based on the following three evidence-based predictions: (a) data structures of each experiment compared to those of the original studies, (b) subjects’ unique responses and, (c) correspondence of the main factors behind the data to the components of wholetheme spiral of biofunctional understanding (Iran-Nejad & Irannejad, 2017b). More specifically, these three exploratory experiments showed that the underlying reason for initial failure to replicate waterloo gestalt closure task was the construction of correct solutions for the task based on the researchers’ intended correctness criterion as well as theoretical reliance on the respective dual-component framework (Evans & Frankish, 2009) instead of the more inclusive three-component model.
Waterloo Gestalt Closure Task: Intuition in the Context of Revelation

The initial results of first experiment conducted with Waterloo Gestalt Closure Task (WGCT) showed that subjects could not detect the gestalts which they cannot solve above the chance level. However, the results of the original gestalt closure task was replicated (people could detect the gestalts which they cannot solve above chance level (Bowers, Regehr, Balthazard, & Parker, 1990) when both the intended solutions and subjects’ alternative solutions (revelations) were combined to serve as the new correct criterion. It was also found that beside the generational difference, the failure to replicate the original results in the first round of analysis was due to the use of intended criterion for classifying subjects’ responses as correct. The intended criterion was limiting because target solutions were based on the subjective perception of the artists which could be different from the subjective perceptions of people who belong to a different time and context. Furthermore, due to the nature of the gestalts, there were times when the meaningful or meaningless gestalts in each pair seemed to be representing multiple meaningful objects.

In the WGCT study, it was also found that for almost half of the WGCT items, subjects’ alternative revelations comprised a fair portion of the responses across both samples. Moreover, the analysis of the confidence ratings associated with coherence choices revealed that subjects placed significantly more confidence in the coherence choices which were based on the revelations than coherence choices associated with the intended solutions. Therefore, revelation coherence selections were tied more to feelings of warmth and confidence. In sum, although Bowers et al. (1990) presented a reasonable cognitive account of the intended gestalt solutions as the incremental accumulation of implicit activation in memory networks, they did not predict or explain subjects’ unintended revelations in the present study.
Independent Systems versus Independent-Interactive Systems

Epstein’s cognitive-experiential self-theory (Epstein, 1998) proposes that the mind processes information by means of two independent yet interactive rational and experiential systems. Rational-experiential inventory (REI) was constructed based on this theory to target self-report attitudes of individuals’ reliance on intuitive or rational thinking style (Epstein, Pacini, Denes-Raj, & Heier, 1996). In a follow-up study, (Pacini & Epstein, 1999) presented evidence for the independence of the two systems by developing and construct-validating a 40-item version of REI. However, evidence for how the two systems interact remained to be explored as the interaction of the two systems is more dependent on specific contexts and individual differences. Therefore, in the second study of the present dissertation assessed the construct validity of the latest version of REI in terms of analytic and intuitive modes of processing. Similar to the finding of Pacini and Epstein (1999), the results showed that REI was able to determine individuals’ dominant mode of processing by classifying subjects into two groups of rational and experiential based on their self-report ratings. Moreover, factor analysis results of the second study confirmed both features of independence and interactivity. In other words, most of the REI items loaded around a single construct (independence) while some showed loadings with both constructs of rationality and experientiality. This can indicate that the two separate constructs (dual processes) do in fact interact with each other, a new finding which was also supported by the significant correlation between the two scales.

Dual-Process Model versus Three-Process Biofunctional Model of Intuition

To account for the alternative identifications not predicted by the intended list of solutions in the first gestalt closure experiment, it was necessary to understand and compare the factor structure of the WGCT data through both the original and new biofunctional model dependent measures. In addition, both of WGCT and REI original studies were conducted under
analogous assumptions of the dual-control or dual-process functioning of the mind. However, the initial factor analysis of the responses of subjects in the present investigations on WGCT data revealed a latent variable, beside the dual-process variables (Evans & Stanovich, 2013) to be influencing or moderating the responses. Therefore, a series of exploratory factor analyses were conducted including both WGCT original variables plus REI scores of rationality and experientiality.

The results indicated that the three extracted constructs from the data structure are characteristically and conceptually very close to the biofunctional processes described in the wholetheme spiral of biofunctional understanding. The pattern matrix table for the final EFA showed that factor 1 is receiving contributions from multiple BU and CU sources and, therefore, does correspond to the ongoing biofunctional activity (OBA). Factor 2 also received loading from two CU processes of knowing-by-revelation and active “I” executive function. This loading pattern corresponded to momentary constellation firing (MCF) as the second main process. Finally, factor 3 received a high loading from understanding-by-reflection (UBR) variable as the third and the last process of the wholetheme spiral of biofunctional understanding (Iran-Nejad & Irannejad, 2017a, 2017b). These findings suggested that the biofunctional model of intuition and cognition could offer an appropriate ground to define intuition conceptually and operationally (Hruby, 2000; Iran-Nejad & Ortony, 1982, 1984; Rosch, 2000). Factor analysis of the two intuition instruments used in these studies also revealed that subjects’ dominant mode of processing is the outcome of the integrative involvement and contribution of conceptual and biofunctional understanding processes (CU & BU) manifested by knowing-by-revelation, understanding-by-reflection and intuitive biofunctional understanding in the wholetheme spiral of biofunctional understanding (Iran-Nejad, 2000).
REFERENCES


APPENDIX

Rational-Experiential Inventory (REI-40)

Rate the following statements about your feelings, beliefs, and behaviors using the scale below. Work rapidly; first impressions are as good as any.

1 = definitely false, 2 = mostly false, 3 = undecided or equally true and false, 4 = mostly true, 5 = definitely true

1. I’m not that good at figuring out complicated problems.

2. If I were to rely on my gut feelings, I would often make mistakes.

3. I prefer complex to simple problems.

4. I generally don’t depend on my feelings to help me make decisions.

5. I have no problem in thinking things through clearly.

6. When it comes to trusting people, I can usually rely on my gut feelings.

7. Thinking is not my idea of an enjoyable activity.

8. I like to rely on my intuitive impressions.

9. I am not a very analytical thinker.

10. I believe in trusting my hunches.

11. I enjoy solving problems that require hard thinking.

12. I think it is foolish to make important decisions based on feelings.

13. I suspect my hunches are inaccurate as often as they are accurate.

14. I usually have clear, explainable reasons for my decisions.
15. Knowing the answer without having to understand the reasoning behind it is good enough for me.

16. I would not want to depend on anyone who described himself or herself as intuitive.

17. Using logic usually works well for me in figuring out problems in my life.

18. I enjoy intellectual challenges.

19. I can usually feel when a person is right or wrong, even if I can’t explain how I know.

20. I often go by my instincts when deciding on a course of action.

21. My snap judgments are probably not as good as most people’s.

22. Reasoning things out carefully is not one of my strong points.

23. I don’t like situations in which I have to rely on intuition.

24. I try to avoid situations that require thinking in depth about something.

25. I trust my initial feelings about people.

26. I have a logical mind.

27. I don’t think it is a good idea to rely on one’s intuition for important decisions.

28. I don’t like to have to do a lot of thinking.

29. I don’t have a very good sense of intuition.

30. I am not very good in solving problems that require careful logical analysis.

31. I think there are times when one should rely on one’s intuition.

32. I enjoy thinking in abstract terms.

33. Using my gut feelings usually works well for me in figuring out problems in my life.

34. I don’t reason well under pressure.

35. I tend to use my heart as a guide for my actions.

36. Thinking hard and for a long time about something gives me little satisfaction.
37. I hardly ever go wrong when I listen to my deepest gut feelings to find an answer.

38. I am much better at figuring things out logically than most people.

39. Intuition can be a very useful way to solve problems.

40. Learning new ways to think would be very appealing to me.

Scoring of 40-item REI: Sum of ratings (1-5) of items in a scale. Item numbers followed by an “r” are reverse scored as follows: 1 = 5, 2 = 4, 3 = 3, 4 = 2, and 5 = 1.

Rationality: Rational Ability + Rational Favorability

Rational Ability: 1r, 5, 9r, 14, 17, 22r, 26, 30r, 34r, 38

Rational Favorability: 3, 7r, 11, 15r, 18, 24r, 28r, 32, 36r, 40

Experientiality: Experiential Ability + Experiential Favorability

Experiential Ability: 2r, 6, 10, 13r, 19, 21r, 25, 29r, 33, 37

Experiential Favorability: 4r, 8, 12r, 16r, 20, 23r, 27r, 31, 35, 39
October 6, 2016

Faried Bordbar  
Dept. of ESPRMC  
College of Education  
Box 870231

Re: IRB#: 16-OR-342 “The Study of Intuitive “Knowing That” in the Absence of “Knowing How”: A Biofunctional Perspective of Human Intuition”

Dear Mr. Bordbar:

The University of Alabama Institutional Review Board has granted approval for your proposed research.

Your application has been given expedited approval according to 45 CFR part 46. You have also been granted the requested waiver of written documentation of informed consent. Approval has been given under expedited review category 7 as outlined below:

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies

Your application will expire on October 4, 2017. If your research will continue beyond this date, complete the relevant portions of the IRB Renewal Application. If you wish to modify the application, complete the Modification of an Approved Protocol Form. Changes in this study cannot be initiated without IRB approval, except when necessary to eliminate apparent immediate hazards to participants. When the study closes, complete the appropriate portions of the IRB Request for Study Closure Form.

Please use reproductions of the IRB approved stamped consent form to obtain consent from your participants.

Should you need to submit any further correspondence regarding this proposal, please include the above application number.

Good luck with your research.

Sincerely,

[signature]

Carpanato T. Myles, MSM, CIH, CIP  
Director & Research Compliance Officer

358 Rose Administration Building | Box 870127 | Tuscaloosa, AL 35487-0127  
205-348-8461 | Fax 205-348-7189 | Toll Free 1-877-820-3066
Research Invitation

Hello! You are invited to participate in a research study.

Fareed Jordbar, a doctoral candidate of Educational Psychology is conducting a study on measuring people's intuition. You will be asked to participate in two intuition tasks. The first Task consists of pairs of pictures for which you will be asked to figure out which one represents a real object. The second Task is a survey that asks you to rate some items using a scale. Complete instructions for each task will follow accordingly. It will take about 45 to 60 minutes to complete both tasks.

We will protect your confidentiality by not including your name in any part of the survey or in connection to the research. Your name only appears on this consent form to ensure that you receive extra credit for participation in this study. This information will also be removed from the data once you receive your extra credit. Only Fareed Bordbar (the researcher) will have access to the raw data. The survey data for both tasks are password-protected. Only summarized and de-identified data will be presented at conference meetings or in publications.

There will be no direct benefits to you, aside from extra credit from your instructor. The findings will be useful to the science and practice of human understanding and their implications in education.

There will be no risk in taking the survey. You may skip any questions you do not want to answer.

If you have questions about this study, please contact Fareed Bordbar at (205) 292-6751 or by email at fbordbar@crimson.ua.edu. Also, the researcher will be happy to provide you with any additional information upon your request after your participation. If you have questions about your rights as a research participant contact Ms. Tanta Myles (the University Compliance Officer) at (205) 348-8461 or toll-free at 1-877-820-3066. If you have complaints or concerns about this study, file them through the UA IRB outreach website at http://osp.ua.edu/site/PRCO_Welcome.html. Also, if you participate, you are encouraged to complete the short Survey for Research Participants online at this website. This helps UA improve its protection of human research participants.

YOUR PARTICIPATION IS COMPLETELY VOLUNTARY. You are free not to participate or stop participating any time. An alternative assignment related to the objectives of the course has been developed in Blackboard (with the same credit points) for those who are not able to participate. If you wish to choose the alternative assignment, identify 5 Big Ideas that you think you will take away from the course and submit a single-page reflective narrative explaining the significance of the ideas. Submit this narrative to your instructor to receive the extra credit.

If you understand the statements above, are at least 18 years old, and freely consent to be in this study, click on the "Agree to Participate" below to begin.
QUALTRICS COPY OF SURVEY

Please provide the following information for us to be able to inform your instructor to assign you extra credit.

First Name: __________________________

Last Name: __________________________

Date: ________________________________

- Agree to Participate
- Disagree to Participate

UNIVERSITY OF ALABAMA IRB
CONSENT FORM APPROVED: 10/5/14
EXPIRATION DATE: 01/14/2017