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3-2023

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# Is That an Opportunity?: Global Versus Local Processing of Technological and Socioeconomic Constraints

by

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## Abstract

Opportunity beliefs lead entrepreneurs to explore or walk away from opportunities. The dominant process for explaining opportunity beliefs is structural alignment theory's analogical problem solving of information. Information can be conceptualized according to its structure with some information presented as separate pieces of information (local) and others as aggregated information (global). We conducted an experiment with 116 upper-level managers and engineers, and found that structural and procedural similarities between technologies and socioeconomic conditions of markets drive opportunity beliefs. We found that the constraining effects of technological and socioeconomic differences on opportunity beliefs are contingent on individuals' global versus local processing.

## Introduction

Recognizing opportunities is an important success factor for both firms in dynamic industries and aspiring entrepreneurs. Scholars have given significant attention to the processes and antecedents of opportunity recognition and factors determining awareness of potential supply-demand pairings (cf. Kirzner, 1997). Much of this attention in such foundational entrepreneurial action theories has focused on increasing understanding of how to identify information and signals about potential supply and demand pairings that exist and are yet to be identified. Consistently, much of the extant research has resulted in scholarly understanding of factors that drive awareness of potential supply-demand pairings and the mechanisms behind them. Some scholars contributed factors, such as prior knowledge, human capital, and alertness that drive individuals' awareness of supply and demand (cf., Chen et al. 2014; Fiet 2007; Gruber et al. 2012; Shane 2000). Other scholars have provided explanations for the increased general awareness of supply and demand and how that general awareness can lead towards equilibrium (Kirzner, 1997). However, awareness of supply and demand is not sufficient for entrepreneurial action. Specifically, within the individual-opportunity (IO) literature, opportunity refers to situations in which it is feasible from both a technological and market perspective to sell goods and services for a profit (Eckhardt and Ciuchta, 2008; Eckhardt and Shane, 2013). This suggests the possibility that some opportunities that entrepreneurs might notice might not be viewed as feasible from a technological or market standpoint or may pair an ill-fitting technology with a potential market. From the perspective of aspiring entrepreneurs, identification of an opportunity involves both noticing situations where the potential for selling goods and services might exist and the formation of subjective beliefs about whether a technology fits with and can be feasibility implemented into a market (Grégoire and Shepherd 2012). As Grégoire and Shepherd (2012, p. 756) explain, "entrepreneurial action is not only influenced by the positive or negative valence of opportunity beliefs...but also by the varying uncertainty of these beliefs (e.g., I am more certain vs. I am less certain that this is/is not an opportunity)." In short, scholars make two assumptions about the nature of entrepreneurial opportunities within this individual-opportunity (IO) domain; namely, that (i) opportunities exist, waiting to be identified and (ii) opportunities are uncertain – (Casson 1982; Knight 1921; Shane and Venkataraman 2000).

The extant literature has primarily focused on one of these assumptions about the nature of opportunities – specifically, noticing or becoming aware of the parameters of existing potential for selling goods and services. The sparsity of research within the individual-opportunity (IO) view on the individuals’ subjective certainty of whether a technology fits with and can feasibly be implemented to a market likely contributes to the scholarly debate around this issue. Alvarez and Barney (2013) and Garud and Guilian (2013) take issue with the IO view claiming that extant theories of discovery do not adequately address why individuals who identify the same informational cues and signals do not consistently perceive those signals as opportunities. Eckhardt and Shane (2013) defend the IO view but concede that the field needs theoretical models to help explain how individuals’ beliefs about potential opportunities form within the framework of technological (supply) and socio-economic (demand) constraints. They specifically encourage scholars to examine “how individual perceptions interact with technological and socio-economic constraints” (Eckhardt and Shane 2013, p. 163). This suggests a need for a theoretical understanding of how individuals having cognitive differences navigate through the uncertainty of technological and socio-economic constraints related to potential supply and demand pairings (Alvi and Carsud 2017). Indeed, the actual existence of an opportunity matters less than an individual seeing something as an opportunity and being willing to act on it (Hsieh and Kelly 2016).

Scholars also note that the limited extant research we have on uncertainty and opportunity recognition needs to, but usually does not, specify what entrepreneurs are uncertain about and what influence those unique sources of uncertainty have on individual beliefs (García et al. 2017; Ramoglou 2013; Ramoglou and Tsang 2016). The limited extant research on these constraints utilizes structural alignment theory’s process of analogical problem solving as a theoretical framework. Structural alignment theory arises from cognitive psychology and posits that individuals form beliefs based on relational matches between a target (new information/signal) and some source (prototype, abstraction, or previous exemplar) (Rosch, 1975; Gentner, 1983). Entrepreneurship applications of the theory suggest that two types of similarity in relational matches are the driving force behind cognitive alignment, namely structural similarity and superficial similarity (*cf.* Grégoire & Shepherd, 2012; Mueller and Shepherd 2016; Uygur 2019). *Structural similarity* refers to underlying systems bearing resemblance in a source and target (relations between relationships). *Superficial similarity* refers to underlying objects and their properties bearing resemblance in a source and target (relations between objects/persons/features) (Blanchette & Dunbar 2000). However, cognitive alignment is actually driven by three critical types of similarity: the two studied already within entrepreneurial action literature, and a third type - procedural similarity - that needs to be incorporated into our understanding of how analogical processing influences entrepreneurial action. (Gentner, 1983; Chen, 1996; Chen 2002). *Procedural similarity* refers to underlying processes, especially with regard to implementing solutions bearing resemblance in a source and target (relations between processes/implementation) (Chen, 1996). We believe this study to be the first to theoretically incorporate and empirically analyze all three constructs of analogical problem solving in the context of entrepreneurs identifying opportunities.

We propose a third construct of analogical problem solving (procedural similarity) to fill an important scholarly gap within entrepreneurship literature because when the procedural step fails, analogical problem solving cannot be completed (Chen 1996; Chen, 2006). When beliefs form and scholars interpret those beliefs only with consideration for the structural and superficial similarity types, the results may be confounded and belief formation delayed and incomplete (Chen, 2002). Therefore, the present understanding of how the degree of similarity between technological constraints and socio-economic constraints drive individuals’ certainty about potential supply-demand pairings is incomplete. This research is founded on the assumption that considering procedural similarity can add explanatory power to the models of opportunity beliefs.

Given that analogical problem solving is a cognitive process, this study also investigates if problem-solving is contingent upon individual-level cognition that might influence information and signal processing (Basso and Lowery 2004). Specifically, analogical problem solving as a framework involves steps related to individual pieces of information as well as a step related to the aggregation of information into a big picture. That is, the process of analogical problem solving relies on both individual, compartmentalized information and sorted or aggregated information (Gentner 1983). Therefore, it is important to examine which kind of information individuals give precedence to—the big picture or the individual pieces that comprise the big picture. To capture such cognitive preference, we examine the influence of an individual-level moderator - global versus local precedence - on the relationship between technological and socio-economic constraints and individuals’ beliefs about fit and feasibility of opportunities.

Within this study, we contribute to the scholarly understanding of the role of uncertainty and individuals' subjective perceptions about innovative opportunities within the IO view by asking how opportunity differences and individual differences influence beliefs about opportunities. Specifically, we develop a more comprehensive understanding of analogical problem solving by introducing a previously unaccounted for similarity type at the opportunity-level. Additionally, we introduce a previously unaccounted for cognitive style as an individual-level moderator. These contributions provide a richer understanding of how the use of analogy is important to entrepreneurial cognition and opportunity recognition. In examining these phenomena, we further contribute to the entrepreneurship literature by studying the intersection of two of the four entrepreneurial research domains – individual/teams and opportunities with specific consideration for how uncertainty influences opportunity recognition (Busenitz et al. 2014). According to Busenitz et al. (2014), there are four domains of entrepreneurial scholarly enquiry; 1) environments, 2) individuals/teams, 3) opportunities, and 4) mode of organizing. By studying the intersection between individual/teams and opportunities we contribute to a “clearly meaningful” (Busenitz et al. 2014, p. 13) scholarly discussion, which has had a low number of studies in the past decade (Busenitz et al. 2014).

The rest of the paper is organized as followed: first, we develop a theoretical understanding of how analogical problem solving is fundamentally about opportunity characteristics within an entrepreneurship context. Second, we outline how individual differences interact with opportunity characteristics within the analogical problem-solving lens. Next, we describe how we test the hypotheses via an experiment. Finally, we interpret the results of the experiment and offer corresponding conclusions and implications.

## **Theoretical Development**

### **Analogical Problem Solving and Opportunity Recognition**

This study builds on foundational entrepreneurial action theories (Child, 1997; Grégoire and Shepherd 2012), and specifically on the theories about the identification of entrepreneurial opportunities (Dutton & Jackson, 1987; Kirzner, 1997). The extant research on entrepreneurial action emphasizes either which individuals are more likely to identify and exploit opportunities (*cf.* Grégoire and Shepherd 2012; Gruber et al. 2012; Plambeck and Weber 2009) or the nature and source of opportunities (e.g. Alvarez and Barney 2010; Fiet 2007). As a result, scholars note the pressing need for understanding the cognitive dynamics of how individual actors make idiosyncratic connections between stimuli (Gregoire et al. 2010). The dominant process for explaining individuals' idiosyncratic connections between stimuli is structural alignment theory's analogical problem-solving. Analogical problem solving is used to understand these mental connections in many fields, such as studies on memory, child development, marketing, and creativity among others – and is theoretically and empirically appropriate for entrepreneurship (Grégoire et al. 2010). Gentner (1983) defines three critical constructs in analogical problem solving, which we introduce here:

- 1) **Superficial similarities between stimuli.** When high, this type of similarity can be noticed spontaneously as the potential new market is using similar parts, components, and types of people as the original technology application. For instance, a defense company developed a new technology used in telescope mirror development for NASA. An entrepreneur considering this in the decision to apply this technology to produce mirrors for scopes to sell to the military would be high in superficial similarity while using this telescope mirror development technology inside eye scanners to fill a demand in the Lasik surgery market for patients would have low superficial similarity.
- 2) **Structural similarities between stimuli.** This similarity is based on how similar the technology is in its new market application as compared to the purpose for which the technology was originally developed. For example, a technology that generates 3D maps of surfaces for aircraft parts would be highly structurally similar to using the technology to generate 3D maps of eye surfaces. On the other hand, using the technology to create random music structures for background noise in elevators would be low structural similarity since the purpose is no longer mapping surfaces in the new application.

- 3) Procedural similarities between stimuli. This similarity relates to how the technology is used or interacted with by the end-user. For example, if NASA creates brain monitoring technology to help extend pilot attention spans and has the pilots interact with the technology via flight simulation games, having children play flight video games while their brain is monitored to help them with ADHD would be high in procedural similarity. However, implementing that technology to children by inducing dreams in them while the child simply laid still would be low in procedural similarity because the new market user is not holding a controller to fly a virtual aircraft on a screen as was done in the original market application.

Together, superficial, structural, and procedural similarities compose the concept of analogical problem-solving. Individuals tackle problems by drawing analogies between a known solution principle and something novel (e.g., a problem that needs a new or an improved solution) (Chen 2002; Gentner 1983). Grégoire and Shepherd (2012) find that entrepreneurial opportunity differences, indicated by varying degrees of superficial and structural similarity in technology-market combinations, play a role in opportunity recognition because they influence the beliefs that individuals form about whether something is an opportunity.

### **Analogical Problem Solving in the Technology Transfer Context**

We chose technology transfer as a context to study because our focus is on understanding how beliefs form given the second assumption of the IO view, that opportunities are uncertain, and that technology is a context associated with high uncertainty. Analogical problem solving is a process of comparison that is particularly useful when trying to acquire an understanding of something new or uncertain, such as an entrepreneurial opportunity (Gentner 1983; Kahneman and Tversky 1979; Markman and Loewenstein 2010; Uygur 2019; Zhang and Fitzsimons 1999). Analogical problem solving involves three necessary components—individuals must: (1) notice a potential for analogy by identifying similarities between a supply source and a potential target, (2) mentally map the correspondences they noticed between a source and a target to form higher-order relations (sort and aggregate information) and (3) make a mental connection about how to execute or implement the source’s solution principle in the target’s domain given that domain’s specific individual nuances as shown in Table 1 (Chen 2002; Gick and Holyoak 1980; Holyoak and Koh 1987). The third component, which entrepreneurship literature has ignored to date, focuses on procedural similarity and determining to what degree an individual is certain they can implement some found match in a new target domain. Procedural similarity concerns the degree to which implementational details of how individuals use or execute a solution principle within a target domain resemble the implementational details of how individuals execute a solution principle in a source domain (Chen 2002).

Superficial similarities in the context of technology transfer occur “when the basic elements of a technology (e.g., who develops the technology, the context where it is developed, its parts or components, the inputs it uses, the materials/people it works within the lab, and the output it produces) resemble the basic elements of a market” (Grégoire and Shepherd 2012, p. 754).

Structural similarity refers to the degree of similarity between how the components are causally linked to achieving the underlying goal or the aspect of analogical problem solving known as the solution principle (Chen 2002). Grégoire and Shepherd (2012, p. 754) note that in the context of technology transfer, “when the intrinsic capabilities of a ... technology (what it can do and the logical/scientific/functional mechanisms underlying how it can do this, such as how the various parts and input of a technology ‘work’ together) resemble the ‘causes’ and ‘mechanisms’ underlying latent demand in a market (i.e., the reasons why people in the market are not completely satisfied with current means of meeting their needs).”

Procedural similarity was not included nor theorized in Grégoire and Shepherd (2012). Cognitive psychologists note that superficial and structural similarities, alone, do not adequately capture the complex, multi-componential relationships between source and target. This is especially true when the context of analogical transfer is applied to a context of high uncertainty (Chen 2002). Our study here adds to the extant literature by theorizing this third component of analogical problem solving, and then empirically testing this construct and its interaction with a new individual-level moderator.

In addition to adding procedural similarity to the scholarly understanding of entrepreneurial discovery, we contribute to Structural Alignment Theory by considering the effects of procedural similarity on a third party’s beliefs. The extant cognitive psychology literature has thus far examined only procedural similarity’s influence on the actual user of a

solution principle (in our context, this would be a customer or user of a new product) (Chen 2002). We fill a gap in that literature by considering how procedural similarity influences a third person who does not directly use the solution principle embedded in the ‘know-how’ portion of an opportunity (the third person here is an entrepreneur).

----- Insert Table 1 about here -----

### **Superficial Similarity and Opportunity Characteristics**

The extant literature’s focus on only superficial and structural similarities, implicitly suggests that the primary obstacle to opportunity recognition is finding new opportunity ideas (focusing on the first of the two major assumptions about opportunities within the IO view). The literature notes that high superficial similarity between a technology and a target market fosters a cognitive path to facilitate entrepreneurs’ thinking about opportunities in a positive light (Grégoire et al. 2010). Indeed, Shane and Venkataraman (2000) suggest that an entrepreneurial discovery is a ‘conjecture’ or a ‘belief’ about some combination of source and demand. At the point of opportunity recognition, entrepreneurs do not know if their conjecture is correct or not.

Research on cognition has identified superficial similarities as the default reasoning mode because superficial similarities drive retrieval of knowledge from memory compartments (Holland et al. 1989; Keane et al. 1994). New stimuli naturally focus a human’s mind to consider objects, things or ideas that have superficially similar elements to known objects and ideas (Grégoire and Shepherd 2012). Considering such objects, things or ideas, one primes mental models stored in memory so that the individual does not have to rely on passive recall (Namy and Gentner 2002). This process makes individuals feel as though it is easier to make sense of and understand new stimuli, thereby reducing how uncertain they perceive the new stimuli to be (Grégoire et al. 2010). Thus, we suggest the following:

*Hypothesis 1: Superficial similarity positively influences opportunity beliefs.*

### **Structural Similarity and Opportunity Characteristics**

The process of analogical problem solving involves three sequential steps: noticing, mapping, and executing (Chen 2002). Step one, noticing a potential analogy, is often a result of superficial similarities whereas step two is primarily influenced by higher-order relationships, such as the degree of structural similarity within a potential match (Chen 1996; Chen 2002; Gentner and Markman 2005; Gick and Holyoak 1983; Holyoak and Koh 1987). Structural consistency is satisfied by the compliance of two constraints, parallel connectivity and one-to-one correspondence (Gentner and Gunn 2001: 566). Structural similarity is a part of the mapping step that involves the individual’s one-to-one correspondences culminating into an overall depiction of a collective of high-order relationships. These higher-order relationships form a network that reflects the overarching capabilities of the technology—its aims and/or its uses—on the technology side of the pairing. On the market side of the pairing, step two of analogical problem solving involves the development of mental models of why people use products/services—what motivates their purchases and spurs their collective behaviors (Grégoire and Shepherd 2012). In the context of technology management, structural similarity is high when the capabilities of a source of supply (e.g. a technology) match the needs, demands or wants of a market. Structural similarity is particularly influential when individuals are interpreting, making judgments, and/or drawing inferences (Grégoire and Shepherd 2012). Research indicates that, all else equal, people tend to prefer structurally similar matches (Gentner 1983; Gentner and Gunn 2001). Consistent with this finding, we suggest the following:

*Hypothesis 2: Structural similarity positively influences opportunity beliefs.*

### **Procedural Similarity and Opportunity Characteristics**

Cognitive psychologists warn that merely noticing and mapping analogous relations is insufficient. Just because an individual notices and maps relations between a source and target, does not guarantee that the individual will be able to successfully transform the solution principle into a viable solution for a target problem (Chen 2002). This is consistent with cognition studies that conclude that procedural transfer is not necessarily an automatic consequence of successful mapping (Novick and Holyoak 1991).

Having tried-and-true procedural details about how to apply a solution principle to a target problem can increase an individual's certainty about a newly found solution principle. We propose that procedural similarity not only influences how effective individuals are at coming up with solutions, but also their degree of confidence or certainty that a particular solution will actually work. In other words, when proposed implementational details for a technology into a market are not similar to the procedures in the technology's original use, one is left to wonder if the pairing will be successful (uncertainty).

For example, consider a documented case of technology transfer used in Grégoire and Shepherd's (2012) experiment on the effects of opportunity differences on subjective opportunity beliefs. The authors present subjects with NASA's EAST (Extended Attention Span Training) technology (originally developed to serve a market of shuttle pilots through the means of flight simulators) as a potential solution principle to the market need of increasing the concentration ability of ADHD children; in this opportunity idea, the training would be implemented by having children with ADHD play video games in which the training and electroencephalogram neurofeedback is embedded. The video games are conceptualized as low in superficial similarity to the flight simulators because, unlike flight simulators, video games represent activities children involve themselves with; however, procedural similarity may also be confounded in this comparison. Although the parts, components, and people (superficial features) associated with video games and flight simulators are, indeed, low in similarity, the way the training is implemented via flight simulators and video games is procedurally similar. Specifically, both methods likely involve a trainee sitting in a chair, holding some control device in their hands, and watching the 'thing' they are controlling on a screen in front of them while receiving the electroencephalogram neurofeedback. In this example, the concentration training (solution principle) is implemented in a procedurally similar way to the ADHD children and the pilots (the users are doing nearly the same thing in each market). Therefore, it is reasonable that procedural similarity could play a role in respondents' subjective belief ratings for this case. Prior research has neither theorized nor empirically examined the influence of procedural similarity on opportunity beliefs.

Consider an alternative to video games as the method of delivering NASA's training to ADHD children, such as through musical instruments. Like video games, musical instruments are not superficially similar to flight simulators, yet the sensors could still be attached to the individuals to monitor electric conductivity and send signals. In other words, superficial similarity is low and structural similarity is high for both video games and musical instruments (as is the case in their given vignette); however, the idea of using musical instruments does not seem quite as attractive of an idea as a video game; why? The answer is that the use of musical instruments leaves some implementational details as abstract because the way musical instruments are played is considerably different than the way a flight simulator is operated (the original implementation method of the technology); additionally, executing training through a video game is similar to executing training through a flight simulator so that the implementational details are inherently provided in the information from the source because the user does effectively the same thing. That difference in abstractness is important because as individuals put forth effort to infer what it might mean to pair a technology with a particular market, they must make subjective judgments as they form beliefs (Dimov, 2010; Sarsvathy, 2008; Shepherd et al., 2007). When individuals are not provided with clear contextual details and instead must rely on abstract concepts when making sense of a situation, individuals have a difficult time processing that abstractness and will be less certain about whatever beliefs they form (Grégoire and Shepherd, 2012; Hayes and Kraemer, 2017). This uncertainty in their beliefs is important to consider because it blocks entrepreneurial action (Grégoire and Shepherd, 2012). Further, when individuals conceptualize situations with a high degree of clarity in how a source maps onto a target, because similarity is high, they are more likely to form positive subjective beliefs about the fit and feasibility that the target will map well to the source and be more confident in those beliefs.

This example is congruent with our argument that the main obstacle to coming up with breakthrough uses for technologies is one of uncertainty in beliefs about how feasible implementation is, not just whether an individual can notice the parameters of existing potential for selling goods and services. We suggest that the degree of similarity between procedures that are known to work and procedures that are proposed to be utilized to implement a technology in a market also influences the degree of certainty that individuals will have regarding the success of that technology-market pairing.

*Hypothesis 3: Procedural similarity positively influences opportunity beliefs.*

## **Analogical Problem Solving and Individual Characteristics**

Given that analogical problem solving is a cognitive process, individual differences that influence cognitive processing of information could impact the influence that similarity types have on beliefs through moderation (Basso and Lowery 2004; Grégoire and Shepherd 2012). Specifically, information can be conceptualized according to its structure with some information presented as unique, separate pieces of information and others as aggregated information (Navon 1977). Navon (1977) first articulates these two structures of information as an entire forest (aggregated information) versus individual trees with their varying shapes and types (separate pieces of information). Interestingly, although two individuals might be presented with the same information from the same environment, they can see that information differently depending on the preference for individual pieces of information versus their preference for the big picture. Cognitive psychologies refer to individuals' tendency to process information either locally (individuals who primarily focus on 'the trees' or individual pieces of information) or globally (individuals who primarily focus on 'the forest' or aggregate information) as Global versus Local Processing (Basso and Lowery 2004; Navon 1977). *Global precedence* occurs in the right hemisphere of the brain and influences perceptual and attentional processes (Basso and Lowery 2004); a global precedence refers to a tendency to more readily perceive and attend to global configural aspects of information rather than the features that comprise the configuration when presented with information containing both global and local features (Basso and Lowery 2004). *Local precedence* occurs in the left hemisphere of the brain and also influences perceptual and attentional processes (Basso and Lowery 2004); however, a local precedence refers to a tendency to more readily attend to local component parts and individuals who display a local precedence tend to manifest poor visual processing of global configural information when presented with information containing both global and local features (Basso and Lowery 2004; Navon 1977). As mentioned previously, the steps involved in analogical problem solving vary in the relevance of informational structures. Specifically, step one is driven by individual pieces of information associated with superficial similarities; step two is driven by structural similarities or structured information that is aggregated and configured as a whole; step three is driven by individual pieces of information associated with procedural similarities (Chen 2002). Given that the steps of analogical processing vary in terms of which structure of information is most relevant, the moderating effect of global processing precedence depends on the focal type of similarity as discussed below.

## **The Moderating Effect of Global Processing Precedence**

Individuals' global processing precedence is primarily theorized to influence visual-spatial tasks (Basso and Lowery 2004). However, scholars have recently taken note of this construct's potential to have influence beyond information processing of visual-spatial tasks (Förster, 2009). For example, Förster et al. (2009, p. 384) explain that 'people can think about the same action (e.g., watering plants) in abstract, global terms (e.g., designing the room) or in more concrete, local terms (e.g., getting the water in the can and pouring it over the plants).

Individuals' tendency to have either a global or local precedence indicates which type of information, and to what degree, individuals give precedence (Förster, 2009). Indeed, individuals' capacity for processing information is limited (Miller, 1956). As individuals receive an abundance of information, they must select which information to process first or focus more on (Förster, 2009). Some people tend to focus on, and more readily process, global information whereas others focus more on local information. People seek consonance between information they process and the beliefs and expectations that they subsequently derive (Festinger, 1957). One of the primary ways of achieving cognitive consonance is by lowering the importance of some factors. Individuals' tendency to process global (local) information results in them more heavily weighting the importance of the big picture (detailed) factors.

From these three analogical problem-solving dimensions, firstly, superficial similarity deals with specific details, such as: objects, characters, parts, components, materials, etc. (Gentner 1983; Grégoire and Shepherd 2012). Individuals who focus on specific details (local precedence) are more likely to process and be attentive to superficial similarities than individuals who focus more on the big picture (global precedence). In short, global processing precedence will moderate the relationship between superficial similarity and the perceived attractiveness of a technology-market combination such that the positive relationship between superficial alignment and opportunity beliefs will be higher for individuals with a local precedence.

*Hypothesis 4a: Global processing precedence positively moderates the relationship between superficial similarity and opportunity beliefs.*



Second, structural similarities are more likely to be heavily weighted by individuals that focus on the big picture. Global precedence leads to a focus on similarity whereas local precedence leads to a focus on dissimilarity (Förster 2009). If a market's people, objects and other superficial features are dissimilar to a technology's superficial features, then individuals will rely on higher-order (big picture) relationships (e.g., structural similarity) to successfully analog the two domains because the more similar information is the more likely information is to get categorized and aggregated. Therefore, global processing precedence will moderate the relationship between structural similarity and the perceived attractiveness of a technology-market combination such that the positive relationship between structural alignment and opportunity beliefs will be higher for individuals with a global precedence.

*Hypothesis 4b: Global processing precedence positively moderates the relationship between superficial similarity and opportunity beliefs.*

Finally, procedural similarity's importance is magnified when individuals tend to process details before big picture information. Consistent with cognitive psychologists' explanations of limitations in an individual's capacity to process large amounts of information, if an individual prefers to process details first, then these details will influence his/her beliefs and expectations more. Specifically, global processing precedence will moderate the relationship between procedural similarity and the perceived attractiveness of a technology-market combination such that the positive relationship between procedural alignment and opportunity beliefs will be lower for individuals with a global precedence.

*Hypothesis 4c: Global processing precedence negatively moderates the relationship between superficial similarity and opportunity beliefs.*

----- Insert Figure 1 about here -----

## Methods

When examining the roles of cognitive factors in the processes of making decisions or forming beliefs, policy-capturing-experimental designs offer an advantage over other designs (Davidsson 2007). Specifically, policy-capturing designs avoid reliance on retrospection and one's understanding of their own beliefs and, instead, allow researchers to decompose decisions into parts enabling them to make specific inferences about the relationship between decision attributes and beliefs (Louviere 1994; Shepherd and Zacharakis 1999). Consistently, studies that examine individuals' evaluations involving similarity types within Structural Alignment Theory frameworks primarily rely on experimental designs (e.g., Grégoire et al., 2010; Grégoire and Shepherd, 2012; Estes and Hasson, 2004).

## Sample

To provide some degree of external validity, our sampling frame focused on individuals that are likely to expend some cognitive energy at the theoretical relationships we are predicting, namely ascertaining and evaluating information related to new sources of supply and changes in demand. Because the individuals who licensed the technologies used in this study's experimental vignettes into the 'true' new markets were engineers, and upper-level managers at the time they noticed the potential pairings, we focused on these types of individuals for our sampling frame. Consistently, we focus our sampling efforts on targeting the population of individuals whose professions likely direct some of their cognitive energy in similar ways. Therefore, the main criterion for inclusion in the sampling frame is that an individual is either an upper-level manager or an engineer.

We used Qualtrics services coupled with screener questions to target our sampling frame. Qualtrics is a commercial panel provider that works with several industry partners in order to recruit targeted participants. Qualtrics' pool of participants is large and diverse which can result in demographically heterogeneous, flexible, and high-quality samples with low participant attrition (Brandon et al., 2013). We provided Qualtrics information regarding our desired participants by specifying upper-level managers or engineers as the Job Category demographic. The panels used by Qualtrics are designed to capture a heterogeneous mixture of the overall population (public firms, private firms, all levels, ages, races, genders, skill levels, etc. are very well represented and the individuals provide extensive demographic data before any individual study targeting them). They responded to our request for participants by using their established sampling pool to randomly target anyone in the US who filled out a Job Category that matched engineer or high-level titles in management (such as C-level titles). As a further verification that a respondent was actually an upper-level manager or an engineer, we relied on screener questions to narrow the targets to the correct

sampling frame. 257 individuals filled out the initial screener questions aimed to identify if they fell within the sampling frame. Of those, 82 were not allowed to participate because they did not select either upper-level manager or engineer as their profession. Ten more individuals were not allowed to participate because when they responded to an open-ended question later in the survey to retest whether they met the sampling criteria, they revealed that they were not actually upper-level managers or engineers. 49 additional respondents failed one of our screener questions meant to ensure respondents were paying attention (screener questions included response speed and attention questions, such as “please select the third circle below”). The final sample size ended up being 116 individuals, each making 4 opportunity evaluations, for a total of 464 evaluations. 76 (65.5 percent) of the respondents are upper-level managers and 40 (34.5 percent) are engineers. Thirty industries are represented in the sample. Statistics related to the sample are provided in Table 2.

----- Insert Table 2 about here -----

### **Experimental Design**

Following Grégoire and Shepherd (2012), we operationalized the three types of similarity at two levels each, low and high. We use a 2 (procedural)  $\times$  2 (structural)  $\times$  2 (superficial) design, with procedural similarity between subjects and structural and superficial as within subjects factors. We used four different vignettes of opportunities to commercialize technologies to capture these levels. A sample vignette is showcased in Table 3. All four scenarios were developed using real technology transfer cases and first tested with a pilot study of 10 entrepreneurs (each evaluated all 4 vignettes for a total of 40 evaluations). Similar to Grégoire and Shepherd’s (2012) pretest, the entrepreneurs were asked to read each vignette (containing both a technology description and a market description) and, then: (1) list the aspect(s) in which the market was different from the technology (differences indicate low similarity) and (2) list the aspect(s) in which the market was similar to the technology (similarities indicate high similarity). As expected, participants listed more dissimilarities when a factor was supposed to be ‘low’ and more similarities when a factor was supposed to be ‘high’. Mean difference tests for the number of dissimilarities vs. similarities listed were significant for all types of similarities in the direction consistent with our manipulations of high (more similarities and fewer dissimilarities) and low (more dissimilarities and fewer similarities), as illustrated in Table 4 ( $p < 0.001$ ) supporting the internal validity of the manipulations in the vignettes.

----- Insert Table 3 about here -----

----- Insert Table 4 about here -----

Each upper-level manager and engineer read the pre-tested opportunity vignettes market descriptions that represent actual recent attempts by entrepreneurs to exploit technologies into new markets through license agreements. The detailed sequencing of the items and manipulations in the experiment is outlined in table 5. Overall, we first validated the instruments in a pilot study as described above, we then progressed participants through the experiment with random assignment to a high or low procedural group. The vignettes are formatted the same way as Grégoire and Shepherd’s (2012) and consistently rely on variance in the technology descriptions to capture high and low levels of superficial, structural, and procedural similarities. An example of the technology description manipulations is provided in table 6. To rule out ordering effects related to which vignette a participant evaluated first, we utilized a Latin-square design for within-subject opportunity characteristics. Each order within the Latin-square design has four different versions of each within-group similarity manipulations and we used two different orders of markets to allow for testing of ordering effects for both market order and level of similarity order (there were no significant ordering effects for either).

As we showed each opportunity vignette to participants, we asked them about their degree of certainty that the technology in the opportunity (1) *fits with* and (2) can be *feasibly implemented* to the market of the opportunity. We asked participants questions to measure the moderating variable and controls last to avoid creating demand artifacts associated with the moderating variable.

----- Insert Table 5 about here -----

----- Insert Table 6 about here -----

## **Variables**

### ***Dependent Variables (Opportunity Beliefs, Level – 1)***

Which opportunity beliefs are relevant depends on which stage of the entrepreneurial process one is focusing on (Grégoire et al. 2010; Shepherd et al. 2007)? Therefore, we use a dependent variable that is consistent with the early evaluation question of entrepreneurship: is that an opportunity for me? Specifically, to capture the dependent construct, opportunity beliefs, we ask respondents about their degrees of certainty that a supply source (1) *fits with* and (2) can be *feasibly implemented* to a market on a 9-point Likert scale. We report results for these two dependent variables both separately and aggregately.

### ***Independent Variables (Similarity Types – Low and High, Level – 1)***

*Superficial Similarity:* Opportunity differences that capture the degree of similarity between things such as (i) a technology's: developer(s); context; parts; inputs; people; materials and physical output, and (ii) a market's: people; users; materials and tools are encompassed in superficial similarity (Grégoire and Shepherd 2012). For example, one of the scenarios used in this experiment was developed at a university in conjunction with retired Air Force pilots to be used by the U.S. military to train new combat pilots. The new 'true' market for this technology is educators using the technology to train students of visual and experimental science domains, such as physics. This represents a low degree of superficial similarity because the people and context for the technology development (retired pilots, new combat pilots, etc.) are not similar to the new market's people and context (educators, young students, experimental science, etc.). Because the 'true' technology-market combination represents low superficial similarity, we created multiple descriptions of the technology (keeping the market description the same) to represent high superficial similarity. To do so, we portrayed the technology as developed by Stanford University's Departments of Adolescent Psychiatry and Artificial Intelligence Engineers to be used by young children that are learning a second language. Adolescent psychiatrists, young children and people learning a second language together represent a high degree of superficial similarity to the new market of educators, young students, and experimental scientists. We provide one sample scenario with headings to show which versions represent high or low superficial similarity in table 3.

*Structural Similarity:* Opportunity differences that capture the degree of similarity between higher-order relationships such as (i) a technology's: capabilities; purpose and functional, scientific and logical mechanisms, and (ii) a market's: reasons for dissatisfaction with existing solutions; source of latent demand and causes or mechanisms underlying why the market wants what it wants are encompassed in structural similarity (Grégoire and Shepherd 2012). Each technology-market combination has an inherent level of structural similarity (high or low). For example, one of the technologies was actually developed to make military air-combat training more realistic (the 'true' purpose and capability of the technology); however, the 'true' new market wants to license the technology because it is unsatisfied with existing methods of identifying students' learning styles. Because the 'true' new market's need (identifying students' learning styles) is not similar in regards to higher-order relationships of underlying latent demand to the 'true' technology's original purpose/capability (making military air-combat training more realistic), the true level of structural similarity for this technology-market combination is low. Although we show all subjects the true new market application of this technology, we alter the technology so that some see a technology description that represents low structural similarity and others see one that represents high structural similarity. To capture high structural similarity for this particular scenario, we portray the technology as originally developed to help understand individuals' learning styles. The survey includes four different technology-market pairs to ensure that every subject will see both high and low levels of structural similarity and both high and low levels of superficial similarity in a  $2 \times 2$  format.

*Procedural Similarity:* Opportunity differences that capture the degree of similarity between (i) how a technology was originally executed or implemented to users (i.e., how users interacted with the technology to benefit from its capabilities), and (ii) how a new market will interact with a technology (how the technology will be implemented to users in the new market) to benefit from its capabilities are encompassed in procedural similarity (cf., Chen 2002). Similar to the superficial and structural similarities, each technology-market combination has an inherent level of procedural similarity. Consistent with the technology-market combination described in the superficial and structural similarity descriptions above, the 'true' procedure or implementational details of the technology involve users participating in a simulated contest of some kind against an artificial intelligent agent that uses this type of interaction to learn about users. In the new market, however, the artificial agent does not participate in the contest; rather, the agent merely observes users' actions to learn about them.

In short, this aspect of the design captures differences between a technology and the market that are not captured by superficial or structural similarities. Even when superficial features between a technology and market are highly similar (e.g., adolescent psychiatrists and students or trainees  $\approx$  educators and science students), and structural relationships between a technology and a market are highly similar (e.g., identifying learning styles of pilot trainees  $\approx$  identifying learning styles of science students), procedural details about how a technology is implemented to users can still be different (e.g., a technology's agent participates in a contest against a student  $\approx$  a technology's agent merely observes a student participate in a contest against someone/something else). This version of the technology description captures this third type of difference. Half of the subjects are randomly assigned to low procedural similarity and half will see technologies that are high in procedural similarity.

### ***Moderating Variable (Global Processing Precedence, Level – 2)***

There are two primary methods of measuring global processing precedence. One is based on Solomon and Felder's (1999) learning style index and is primarily used in cognitive education research (*cf.* Heffernan et al. 2010). The other measurement method was developed by Navon (1977) and relies on responses to timed queries to visual-spatial imaging. Indeed, global versus local precedencies is often theorized to influence visual-spatial processing of the physical world around a person. However, scholars have recently taken note of this construct's potential to influence factors beyond the perception of visual-spatial imaging tasks (Förster 2009). For example, Förster et al. (2009, p. 384 *emphasis added*) explain that "people can think about the same *action* (e.g., watering plants) in abstract, global terms (e.g., designing the room) or in more concrete, local terms (e.g., getting the water in the can and pouring it over the plants)." They further suggest a potential link between global precedence - and perceptions about novel situations, which highlights why it is reasonable to investigate if there is a link between precedence and perceptions about uncertain entrepreneurial opportunities. Given that our conceptualization of this construct more closely aligns with action-oriented information in novel situations, where the information is not visual-spatial, we chose to utilize a scale based on Solomon and Felder's (1999) items.

### ***Control Variables (Level – 2)***

There are many known drivers of individuals' beliefs and perceptions about entrepreneurial activities (e.g., Davidsson and Honig 2003; Gimeno et al. 1997; Ucbasaran et al. 2008). Consequently, we measure and control for individual differences in education, entrepreneurial experience, entrepreneurial success, entrepreneurial intention, employment status, length of employment and industry, prior knowledge of the focal technologies, prior knowledge of the focal markets, creative self-efficacy, and innovative self-efficacy, age, and gender.

## **Data Analysis and Findings**

The nature of the data produced by the experimental instrument is nested across two levels (individual beliefs about opportunities nested inside of individuals). As such, we utilized multi-level modeling. Specifically, we rely on Hierarchical Linear Modeling 7 (hereafter, HLM) (Raudenbush et al. 2001) to analyze the data. HLM is used in a wide variety of social sciences studies because it offers the following benefits over single-level statistical packages: higher accuracy regarding type I error rates; variance that is proportioned across each of the different levels instead of assuming, potentially incorrectly, that variance is attributable to one level; assessment of both within- and between-variance and direct predictors at multiple levels (McCoach 2010).

Before running HLM models, we checked for common method bias, which is a common problem in psychology research (Podsakoff et al. 2003). We utilized Podsakoff et al.'s (2003) common method variance test of forcing an exploratory factor analysis containing all variables in the model into one component loading. The cumulative percent of variance explained was only 25.81 percent which is well below the 50 percent threshold for the extraction sums of the squared loadings. Therefore, common method variance is not a concern for this data.

We followed McCoach's (2006; 2010) guidelines for sequential HLM modeling. First, we ran an unconditional model which confirmed that regressions' independence of responses assumption is violated and a multi-level modeling technique (such as HLM) is necessary (Table 7). Indeed, 29.6 percent of the variability in respondents' opportunity beliefs is explained by factors specific to the individual, and the remaining 70.4 percent of the variability is explained by characteristics of the opportunity (e.g., socio-economic and technological constraints, respectively). Next, we ran a model with only the three similarity types and all of the direct effect controls included as predictors. Following McCoach (2010), we then trimmed controls with non-significant p-values; although we used a more conservative test

and only removed those with a p-value greater than 0.10 (controls were only trimmed if the p-value was greater than 0.10 in both the standard model and the model using robust standard errors). Finally, we added the moderating controls (prior knowledge of technology and markets, etc.) and the predicted moderating variable, global versus local precedence, to test the hypotheses. Hypotheses were examined using the parameter estimates, which can be interpreted the same as unstandardized regression coefficients (Drover et al. 2017).

----- Insert Table 7 about here -----

### **Main Effects**

Means, standard deviations and correlations of the variables are shown in Table 2. Table 8 shows the results for the hypotheses when the outcome variables are the combined fit and feasibility measures. Superficial similarity was only marginally significant ( $p = .06$ ) with opportunity belief (H1). Superficial similarity may show significance in future research where larger samples are available. We did find support for H2, that structural similarity does associate with opportunity beliefs. The coefficient for structural similarity is 0.22 and is significant below the 0.01 level, indicating that the more structurally similar a supply source is to a demand source, the more positive beliefs people will generally form about that pairing being an opportunity. We also found support for H3, that procedural similarity associates with opportunity beliefs. Procedural similarity's coefficient is 0.97 and is significant below the 0.001 level. This indicates that the more procedurally similar a supply source is to a demand source; the more positive beliefs people will have about that pairing being an opportunity. These latter two hypotheses results support the central premise of this study that procedural similarity is distinct from superficial similarity and has a unique effect on the formation of beliefs about opportunities. Tables 9 and 10 show the same three hypotheses, but disaggregate the components of fit only (Table 9) and feasibility only (Table 10) as outcome variables, for comparison with Table 8 that shows a combined measure of fit and feasibility that is more realistically how an entrepreneur would be evaluating an opportunity.

### **Moderating Effects**

Hypotheses 4 theorized about the moderating relationship of global versus local processing precedence. Again, Table 8 shows the outcome measure of fit and feasibility combined, while Tables 9 and 10, disaggregate that measure into its components. Global processing precedence (4c is supported at  $p < 0.01$ ) significantly moderates the influence of the opportunity difference for procedural similarity in the direction predicted for the combined (Table 8) as well as the two disaggregated measures (Tables 9 and 10). However, the moderation of the influence that superficial (4a) and structural (4b) similarities have on opportunity beliefs was not found to be significant, thus 4a and 4b were not supported. It is largely the relationship between procedural similarity and opportunity beliefs about fit that is driving the results in this study for hypothesis 4; the p-value when feasibility is the dependent variable (Table 10) is marginally significant at  $p = 0.05$ . With fit as the dependent variable (Table 9), and with a combined fit and feasibility variable (Table 8), hypothesis 4c is significant ( $p < 0.05$ ). Hypothesis 4c predicts that individuals who tend to have a local precedence—that is, individuals that focus more on details than the big picture—will place greater emphasis on procedural similarity than those with a global precedence when forming beliefs about the fit and feasibility of potential supply-demand pairings in determining if something is an actual opportunity.

Generally, we find support for the central idea of this paper, that procedural similarity is distinct from superficial similarity and plays a role in determining the extent to which individuals will form positive beliefs about the fit and feasibility of potential supply-demand pairings. Specifically, hypotheses 1, 2, and 3 predict that superficial, structural and procedural similarities, respectively, will each have a positive direct effect on opportunity beliefs. The results shown in Tables 8, 9, and 10 show that hypotheses 2 and 3 are supported whereas the coefficient for the path that we predicted in hypothesis 1 is marginally ( $p = 0.06$ ) significant. All paths were positive as predicted, but superficial similarity was only marginally significant in its relationship to opportunity beliefs, while structural similarity and procedural similarity were found to have a significant and positive effect on opportunity beliefs.

The processing precedence of the entrepreneur (global versus local precedence) did significantly moderate the influence that procedural similarity had on opportunity beliefs, specifically, a global processing precedence (local processing precedence) correlates with lower (higher) belief in the opportunity. Entrepreneurs with a precedence of looking at details at the local level see more opportunity with procedural similarity than global precedence entrepreneurs. Global versus local processing precedence had a significant moderating effect on neither superficial

nor structural similarity influences on the opportunity belief. Whether entrepreneurs process global (big picture) or local (detail) first in their thought process does not seem to impact their view of an opportunity based on the influences of superficial or structural similarities.

----- Insert Table 8 about here -----

----- Insert Table 9 about here -----

----- Insert Table 10 about here -----

## Discussion

Our study provides four contributions to entrepreneurial action literature, specifically focused on understanding opportunity identification through a cognitive analogical problem-solving lens. First, we provide a deeper and richer analysis of the underlying similarities between technologies and markets by introducing a previously unaccounted for similarity type, thereby deepening scholarly understanding of entrepreneurial cognition. We articulate how each type of similarity corresponds with specific steps in the process of analogical problem solving and identify how those steps and similarity levels influence cognitive alignment between supply and demand sources. The theoretical arguments and empirical results in this study demonstrate the importance of including all steps of analogical problem solving and contrast previous understanding that opportunity beliefs are largely driven by structural alignment alone. This contribution highlights the importance that entrepreneurs pay close attention to how customers interact with products and services even after accounting for how well a product or service solves consumer needs.

This study's newly introduced similarity type not only adds to our breadth of understanding about antecedents to opportunity identification but also clarifies some previously understood relationships which were likely confounded. Prior research in entrepreneurship has not accounted for the role that prospective customer interaction with a product or service plays in how likely an individual is to believe that something is an opportunity (Grégoire & Shepherd, 2012). The present study clarifies that perceptions about how customers will interact with a product or service are an important driver of opportunity beliefs. Without consideration for this new contribution, previous understanding of how beliefs about opportunities form may have overstated the role of superficial similarity (relations between objects). Indeed, previous research relies on experimental vignettes that incorporate some procedural details (relations between processes) into superficial descriptions (relations between objects). The present study separates the two and demonstrates that of the two similarity types, the newly introduced one, procedural similarity, is more of a driver of opportunity beliefs than superficial similarity is.

Second, we contribute to the cognitive psychology literature by providing a unique context in which its constructs have impact. Specifically, our argument that procedural similarity between technologies and markets can drive entrepreneurs' beliefs about opportunities is novel to Structural Alignment Theory both in context and construct relationship. Cognitive psychology research has considered only the impact that procedural similarity has on the actual individuals using some solution principle. Uniquely, we are offering the first known arguments for procedural similarity impacting the beliefs of a third party (rather than the actual end-user of a solution principle).

Third, we contribute to the entrepreneurship literature by advancing knowledge of the interaction between the individuals/teams and opportunity domains (Busenitz et al. 2014). In their review of entrepreneurship literature, Busenitz et al. (2014) find that only 4% of entrepreneurship articles had focused on the interaction of these two critical domains of entrepreneurship research and encourage future studies to examine this "critical" interaction (pg. 14). Further, we answer the calls of Mueller and Shepherd (2016) for developing a deeper and richer understanding of the underlying similarities between technologies and markets, of Wood and McKelvie (2015) for studying the interaction effects of critical entrepreneurial constructs, and of Zapkau et al. (2017) for studying previously neglected areas of entrepreneurship research.

Finally, through this study, we have explained how individuals' beliefs about innovative opportunities might vary based on the degree to which they process information globally or locally. By doing so, we contribute to both technology management literature and cognitive psychology literature. We contribute to the technology management literature by providing a new theoretical lens to foster scholarly understanding of why two individuals can look at the same information about a technology and socio-economic problem and form drastically different beliefs about the viability of applying that technology to solve the focal socio-economic problem. We contribute also to the psychology

literature on global vs. local precedence by integrating the construct into work on Structural Alignment Theory to foster scholarly understanding of which types of similarity will matter more or less to certain individuals' belief formations. We demonstrate that individuals' characteristics and opportunity characteristics interact (consistent with the IO perspective) as individuals form subjective beliefs about opportunities. Specifically, we show that individuals who tend to give precedence to local information over global information will give more weight to procedural similarities in their evaluations of potential technology-market combinations. This finding directly responds to the call from Eckhardt and Shane (2013) for scholars to explain how individuals' beliefs about potential opportunities form in the face of technological (supply) and socio-economic (demand) constraints.

### **Implications**

This paper offers some practical implications for entrepreneurs. First, we suggest that in addition to emphasizing unserved and underserved market problems, aspiring entrepreneurs should pursue market innovation by focusing on how the end-user may interact with new technologies. This method is consistent with trends in entrepreneurship education encouraging students to identify customer needs and generate a "minimal viable product" (Ries 2011). The current trends in practice and pedagogy understand market innovation as aligning technologies with market problems or pain points. However, besides a focus on unserved or underserved market problems, entrepreneurs can pursue market innovation by focusing on end-users' interaction with technologies; in short, entrepreneurs cannot ignore how customers actually use proposed solutions.

Another practical implication of this study is how entrepreneurs can persuade other potential stakeholders that their idea is worth pursuing. Entrepreneurs should utilize the new similarity type added herein as a persuasive tool. Specifically, this study provides evidence that the less a new product or solution deviates from what a market is used to in terms of how a product is used, the more people will believe that it is a good solution. This can be used to persuade stakeholders, such as customers, investors or alliance partners (Dutta and Hora 2017).

Finally, policymakers should also be interested in these results given that the pace of technology advancement far surpasses technology commercialization rates (Markman et al. 2008). Scholars note that the disparity between technology advancement and commercialization is growing as knowledge distribution grows and that we need a better understanding of processes involved in applying technologies to markets through commercialization (Markman et al. 2008). Our research sheds light on a process that entrepreneurs could use to identify new opportunities. Specifically, since technologies are underutilized commercially, entrepreneurs can focus on structurally and procedurally similar new markets as places to license and commercialize unexploited or underutilized inventions/technologies. Scholars calls for more understanding of the cognitive processes at play in deciding if a technology has any real potential application for markets is consistent with filling the widening gap between technology advancement and technology commercialization (*cf.* Haynie and Shepherd 2009).

### **Future Research and Limitations**

Future research on entrepreneurial action and discovery can benefit from integrating relationships between constructs found in cognitive psychology that correlate well with constructs important to entrepreneurship. For example, as we seek to understand how entrepreneurs form their beliefs about something as uncertain as an entrepreneurial opportunity, why not look to cognitive science which already has tested theories that help explain how other classes of individuals (such as children) make sense of things they encounter that are uncertain (such as how to unlock a locked door). By doing so, management research benefits not only from the parsimony provided by cognitive psychology theories, but can contribute back to them. Indeed, entrepreneurship scholars note that cognition-focused research, in particular, needs theories that explore cognitive styles and learning together as this theory does (Marvel et al. 2016). Cognitive psychologists find "that expecting novelty induces global processing" (Förster et al. 2009, pg. 383). This will help explain why research often finds that structural similarity is very impactful to belief formation (e.g. Grégoire & Shepherd 2012). Specifically, technology transfer as a context involves novelty and is, therefore, likely to induce experimental participants to process information globally and focus on big picture information, such as structural similarity. Therefore, future research may need to include entrepreneurial contexts that are less novel than technology transfer when studying technology market similarities.

There are some limitations to keep in mind when considering the implications of these findings. Specifically, this study only examines one type of opportunity (technology commercialization) and this study operates under the assumption that opportunities exist but are uncertain and are, therefore, contingent on the subjective perceptions of

individuals. Scholars have demonstrated that some opportunities are created endogenously through the action of creative individuals or firms (Alvarez and Barney 2007). Certainly, this constrains any implications that arise from this study to opportunities that adhere to the assumptions of the IO perspective. That is, some opportunities do not fall within the assumptions set forth by the IO perspective (Alvarez and Barney 2007). Opportunities that fall within the creation perspective, for example, “are endogenously generated through process, such as creative imagination and effectuation” (Garud and Giuliani 2013, p. 158). From the creation perspective, meaning-making is not constructed subjectively through conjectures and beliefs but, rather, is part of a relational process that is ongoing (Garud and Giuliani 2013). Although a limitation, there is an opportunity for bridging understanding between the IO and creation perspectives with respect to subjectivity. The present study acknowledges subjectivity’s role within the IO perspective. Furthermore, the study of entrepreneurial cognition within a technology commercialization fits within the growing trend of blended educational programs—those that blend entrepreneurial theory with technical education (Turner and Gianiodis 2018). Turner and Gianiodis (2018) point out that entrepreneurship education is branching out of business schools and, therefore, going forward we need to study entrepreneurship within contexts where universities are integrating entrepreneurial education; these authors specifically identify science, technology, engineering, and math as such areas. Although pedagogy is not the direct focus herein, the findings do contribute to our understanding of applying entrepreneurial pedagogy to technology and engineering contexts.

A second limitation of this study relates to the external validity of the experimental design. The design of the experiment required individuals to evaluate four completely unrelated potential opportunities sequentially in a very short period of time. It is very unlikely that an individual would ever evaluate unrelated potential opportunities back-to-back. Although we utilized a Latin-square design to rule out ordering effects associated with evaluating scenarios back-to-back, the generalizability of this experimental design is still limited because individuals are not likely to evaluate opportunities in a similar sequential manner. Despite these limitations, this study offers important contributions to scholarly understanding, as outlined above.

### Conclusion

Eckhardt and Shane (2013) concede that the entrepreneurship discipline needs new theoretical models to help explain how individuals’ subjective beliefs about potential opportunities are formed in the face of technological (supply) and socio-economic (demand) constraints. We specifically incorporate subjectivity into the persuasiveness of technological and socio-economic constraints to particular types of individuals. The implication is that Structural Alignment Theory increases our understanding of the entrepreneurial process within the IO perspective because it helps us understand how individuals form conjectures—which a great deal of research appears to have overlooked (Eckhardt and Shane 2013)—in the face of technological and socio-economic constraints, particularly for opportunities characterized by high uncertainty.

The central premise of this paper is that the IO perspective of entrepreneurship will benefit from a simultaneous theoretical and empirical examination of the effects of opportunity differences on the formation of beliefs as well as the extent to which they are contingent upon individual characteristics. By examining the effects of individual-level characteristics and opportunity-level attributes simultaneously, we can gain a better understanding of the variability that is driven by characteristics of the individual vis-a-vis characteristics of the opportunity. Furthermore, studying the effects of opportunity differences allows us to study questions such as whether, and why, some opportunities might be more difficult to recognize irrespective of an individual. Extant literature that only considers differences across individuals is unable to examine questions about why some opportunities might be more difficult to recognize for individuals, in general. In this study, however, we can control for individual differences and examine the main effects of opportunity differences on opportunity recognition.

We theorize and find evidence supporting the idea that opportunities are different with respect to the degree of superficial, structural, and procedural similarity embedded in their sources of supply (e.g., a technology) and demand (e.g., a market). Opportunities that are comprised of a supply source and demand source that are more similar along these types of similarity are more likely to be recognized because individuals are more likely to form positive fit and feasibility beliefs about them. That is, the degree of similarity (as conceptualized herein) between a supply source and a demand source is directly tied to the obviousness of opportunities; not obviousness in terms of finding an idea, but with respect to the individual’s certainty that what they have found is an opportunity. Given associations between rarity and value (Barney, 1991), identifying factors that contribute to the obviousness of opportunities is an important scholarly understanding.



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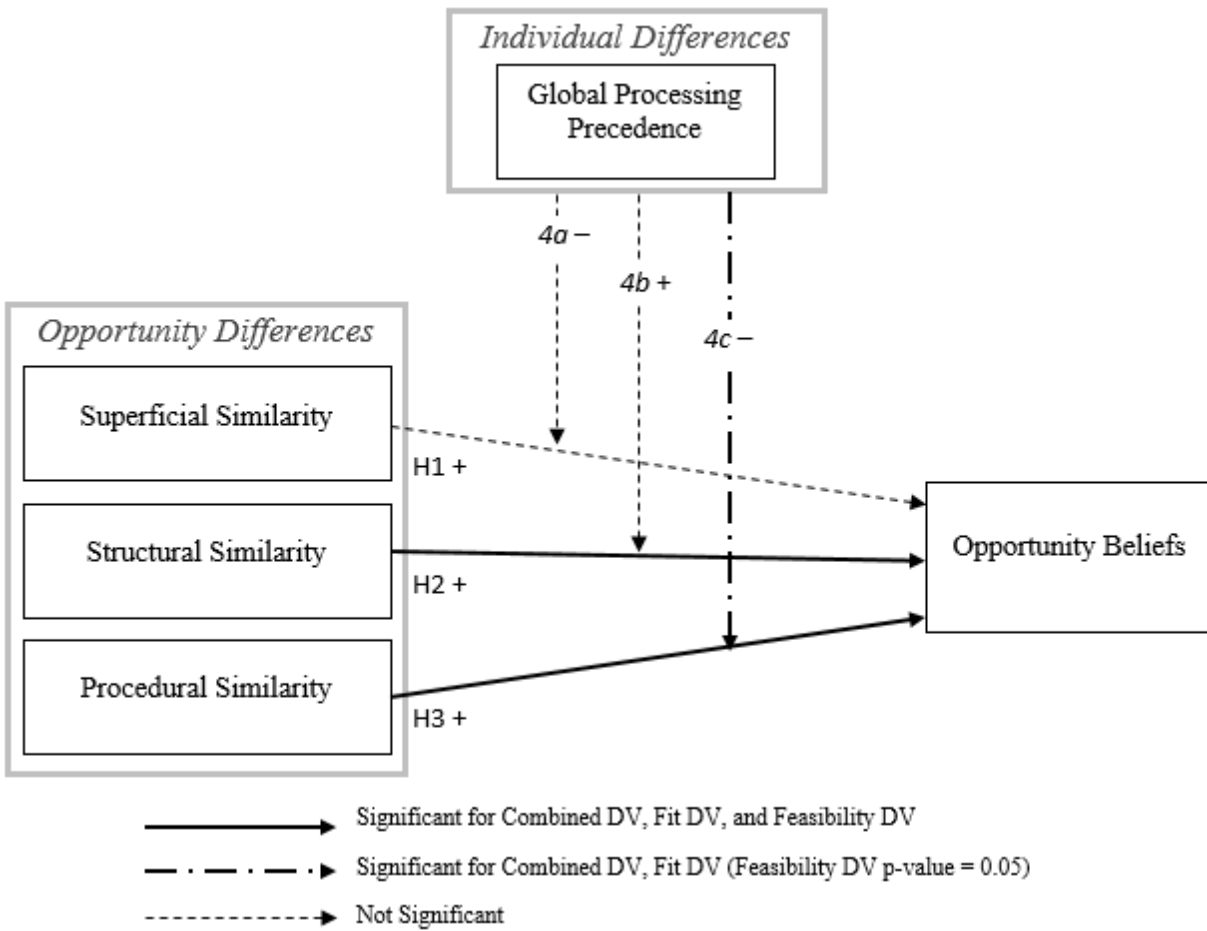
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## Appendix

**Figure 1 Analogical Problem Solving's Role in Opportunity Beliefs**



**Table 1 The Process of Analogical Problem Solving**

		Step One: Superficial Focus on <b>finding ideas from prior knowledge</b>	Step Two: Structural Focus on <b>finding ideas by mapping, sorting, or interpreting</b>	Step Three: Procedural Focus on <b>certainly of ability to implement ideas after ideas are 'found'</b>
<b>Cognitive Psychology Literature</b>		'... spontaneously notice the analogy' (p. 3)	'... mapping - finding a set of one to one correspond...' (p. 2)	'... generate an analogous solution' (p. 32)
	Gick and Holyoak 1980	'... constructing mental representations of the source and the target ... [and] ... selecting the source as a potentially relevant analogue to the target' (p. 332)	'... mapping the components of the source and target' (p. 332)	'... extending the mapping to generate a solution to the target' (p. 332)
	Holyoak and Koh 1987	'The initial step in analogical transfer is to construct a representation or schema of the source and target problems.' (p. 411)	'The second step in solving problems by analogy is to perceive the analogical relationship and to map the correspondences between the key elements of the source and target problems' (p. 411)	'The third step involves the implementation of an acquired solution to solve the target problem ... [subjects] encounter difficulty in implementing an analogous solution when the source and target problems required different procedures, even if they shared a general principle.' (p. 411)
	Chen 1996	'First, the potentially analogous relationship between the problems must be noticed' (p. 83)	'... the correspondences between the key elements of the source and target must be mapped' (p. 83)	'Yet, noticing and mapping the analogous relations between source and target problems does not ensure that a solution principle can be automatically transformed into a solution for a target problem; another important process involves executing a solution principle in solving a concrete problem' (p. 83)
	Chen 2002	'... finding a correspondence between the conceptual structures of the two domains compared' (p. 1-2)	'In the next stage, structural consistency is imposed, with the effect of sorting the matches into structurally consistent kernels.' (p. 5)	'Finally, inferences are drawn by a kind of pattern completion from base to target.' (p. 5)
	Gentner and Markman 2005	'... finding a correspondence between the conceptual structures of the two domains compared' (p. 1-2)	'In the next stage, structural consistency is imposed, with the effect of sorting the matches into structurally consistent kernels.' (p. 5)	'Finally, inferences are drawn by a kind of pattern completion from base to target.' (p. 5)
<b>Entrepreneurship Literature</b>	Grégoire, Barr, and Shepherd 2010	'...lead one to recall corresponding features of a relevant source from memory' (p. 416)	'...executives thought of opportunities where the markets and technologies shared high levels of structural relationships...' (p. 425)	The cited study did not include this type of similarity.
	Grégoire and Shepherd 2012	'...superficial similarities [are] the default mode of reasoning...[and] play an important role in guiding the retrieval of knowledge from memory' (p. 759)	'...structural similarity is particularly influential in tasks that involve interpreting...focus[ing] on logical relationships	The cited study did not include this type of similarity.

**Table 2 Means, Standard Deviations and Correlations**

Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age	44.50	11.45	1														
Manager (vs. Engineer = 0)	.66	.48	.12**	1													
Founder of Business	.10	.31	.20**	-.17**	1												
Owner of Business	.13	.34	.21**	-.10*	.63**	1											
Entrepreneurial Experience	.46	.89	.19**	.01	.56**	.61**	1										
Entrepreneurial Intent	3.67	2.26	-.19**	-.14**	.21**	.10*	.32**	1									
Gender (Female)	.40	.49	.11*	.14**	.07	.06	.06	-.05	1								
Size of Business (# employees scaled)	8.72	4.01	-.15**	-.01	-.20**	-.22**	-.19**	-.04	.03	1							
Standardized Race (Minority)	.09	.29	-.21**	.05	-.11*	-.04	.10*	-.01	.10*	.14**	1						
Education Scaled	3.37	1.34	-.24**	-.16**	-.03	-.05	-.17**	.01	-.18**	.15**	-.05	1					
Creative Innovative Self Efficacy	5.05	1.97	-.10*	-.04	.16**	.12*	.29**	.37**	-.29**	-.01	-.02	.07	1				
Entrepreneurial Self Efficacy	3.59	.73	-.08	-.13**	.26**	.23*	.36**	.55**	-.04	-.07	.01	.02	.60**	1			
Global vs. Local Precedence	5.19	2.33	-.04	.09	-.02	.05	.07	.18**	-.22**	-.02	-.06	-.07	.22**	.08	1		
Standardized Prior Knowledge of Technology	-0.06	0.91	-.10*	-.12**	.05	.08	.16**	.25**	-.18**	.14**	.06	.02	.46**	.20**	.25**	1	
Standardized Prior Knowledge of - Market	-0.09	0.93	-.04	-.07	.07	.09*	.19**	.23**	-.09	.07	.07	-.06	.39**	.15**	.19**	.80**	1

\*p<0.05, \*\*p<0.01, \*\*\*p<0.001

### Table 3 Sample Experimental Vignette SOAR Technology Scenario Descriptions

#### Market Stimulus 1: everyone sees this market stimulus

##### Heading to show participants: *Is there a way to tailor education for each student?*

There are many approaches to teaching visual and experimental science domains, such as physics. Educators now believe that children have unique learning styles (individuals' natural patterns of acquiring and processing information in learning situations). Furthermore, educators believe that learning tasks that are highly visual or experimental in nature, such as physics, should be tailored to fit each student's particular learning style.

At present, most educators do not have a systematic method for identifying what students' learning styles are. A growing number of educators are looking for viable tools to help them identify students' learning styles and, subsequently, tailor learning tasks to match.

"If I license SOAR technology," says Dr. Mike van Lent, "I plan to embed it as a tutor in a computer game in which students play electric field hockey to tailor physics education. Instead of playing against an opponent, students will strategically place electric charges on a screen to cause a unit-charge particle, or puck, to move around obstacles. SOAR simply watches and observes differences between what the student does and what the SOAR tutor would have done if it had participated. By observing a student, SOAR begins to learn a student's learning style and can then customize the next task."

#### Technology Stimulus 1.1: 25 percent see this technology stimulus (High Superficial / High Structural)

##### Heading to show participants: *Stanford to customize foreign language education.*

Stanford University is proud to announce that it has developed a new technology called SOAR that could revolutionize the way that young children learn a second language. The technology was developed as a joint project between Stanford's Departments of Adolescent Psychiatry and Artificial Intelligence Engineering to help educators understand the learning styles of children so that their second language education can be tailored to each individual.

SOAR is a software application that uses a sophisticated set of algorithms to understand the learning styles of individuals through the interaction between humans and computers. SOAR catalogs each user's unique set of characteristics and customizes user experiences accordingly.

##### *Low Procedural Similarity (50 percent of group see this)*

The software has been integrated into computer-based games for young children. Children play against a simulated SOAR agent who talks with the child throughout the game in the foreign language. The SOAR player actually talks with a child as it participates in the game against the child; it can react to changes in a child's behavior or voice pattern to tailor language education to each child's learning style.

##### *High Procedural Similarity (50 percent of group see this)*

The software has been integrated into computer-based games for young children. There is no opponent in the games; rather, children use voice commands spoken in the foreign language to navigate a car around obstacles while a SOAR agent observes. The SOAR agent watches the child and can react to changes in the trainee's behavior or voice pattern to detect learning styles.

#### Technology Stimulus 1.2: 25 percent see this technology stimulus (Low Superficial / High Structural)

##### Heading to show participants: *University of Michigan teams up with retired pilots to help train combat pilots.*

The University of Michigan is proud to announce that it has developed new training technology called SOAR that could revolutionize the way military combat pilots are trained. The artificial intelligence technology was developed as a joint project with the Special Operations Aviation Regiment of the U.S. military to help understand individual trainees learning styles, preferences, and tendencies.

SOAR is a software application that uses a sophisticated set of algorithms to understand the learning styles of individuals through the interaction between humans and computers. SOAR catalogs each user's unique set of characteristics and customizes user experiences accordingly.

*Low Procedural Similarity (50 percent of group see this)*

The software has been integrated into the U.S. Military's fixed-wing aircraft training simulators. Trainees practice combat against simulated SOAR agents; the SOAR agents actually participate in the combat against the trainee and can react to changes in the environment and changes in the trainees behavior by re-prioritizing their objectives as a human enemy would.

*High Procedural Similarity (50 percent of group see this)*

The software has been integrated into the U.S. Military's fixed-wing aircraft training simulators. There is no opponent in the simulations; rather, trainees navigate around obstacles while a SOAR agent observes. The SOAR tutor watches the trainee and can react to changes in the trainee's behavior or voice pattern to detect preferences, learning styles, etc.

Technology Stimulus 1.3: 25 percent see this technology stimulus (High Superficial / Low Structural)

Heading to show participants: **Stanford to customize foreign language education.**

Stanford University is proud to announce that it has developed a new technology called SOAR that could revolutionize the way that young children learn a second language. The technology was developed as a joint project between Stanford's Departments of Adolescent Psychiatry and Artificial Intelligence Engineering to help make second language training more realistic.

SOAR is a software application that acts like a human because it is capable of adapting to changes in the environment, such as nationality, or others behavior to make foreign language training more realistic.

*Low Procedural Similarity (50 percent of group see this)*

The software has been integrated into computer-based games for young children. Children play against a simulated SOAR agent who talks with the child throughout the game in the foreign language. The SOAR player actually talks with a child and behaves like a native of the country's language the child is learning, making the training more realistic.

*High Procedural Similarity (50 percent of group see this)*

The software has been integrated into computer-based games for young children. There is no opponent in the games; rather, children use voice commands in the foreign language to navigate a car around obstacles while a SOAR agent observes. The SOAR agent watches the child and can react to changes in the trainee's behavior or voice pattern to adjust the environment and obstacles to be more realistic.

Technology Stimulus 1.4: 25 percent see this technology stimulus (Low Superficial / Low Structural)

Heading to show participants: **University of Michigan teams up with retired pilots to help train combat pilots.**

The University of Michigan is proud to announce that it has developed new training technology called SOAR that could revolutionize the way military combat pilots are trained. The artificial intelligence technology was developed as a joint project with the Special Operations Aviation Regiment of the U.S. military to make combat training more realistic.

SOAR is a software application that acts like a human because it is capable of adapting to changes in the environment or others behavior--by altering the priority of its objectives, for example--to make military training more realistic.

*Low Procedural Similarity (50 percent of group see this)*

The software has been integrated into the U.S. Military's fixed-wing aircraft training simulators. Trainees practice combat against simulated SOAR agents; the SOAR agents actually participate in the combat against the trainee and can react to changes in the environment and changes in the trainees behavior by re-prioritizing their objectives as a human enemy would.

*High Procedural Similarity (50 percent of group see this)*

The software has been integrated into the U.S. Military's fixed-wing aircraft training simulators. There is no opponent in the simulations; rather, trainees navigate around obstacles while a SOAR agent observes. The SOAR tutor watches the trainee and can react to changes in the trainee's behavior or voice pattern to adjust the environment and obstacles to be more realistic.



**Table 4 Manipulation Internal Validity Pre-test**

Similarity Type	High vs. Low Mean Similarities	High vs. Low Mean Differences
Superficial	1.35 vs. 0.35 ***	0.35 vs. 1.55 ***
Structural	1.25 vs. 0.25 ***	0.00 vs. 1.25 ***
Procedural	0.96 vs. 0.13 ***	0.00 vs. 0.75 ***

\*p<0.05, \*\*p<0.01, \*\*\*p<0.001

**Table 5 Full Factorial Experimental Design Process**

Steps							
Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8
Pre-test scenarios internal validity	Instructions and Consent Form	Random Assign to High or Low Procedural Similarity	Dependent Variable measured for the 4 scenarios	Moderator measured using Solomon and Felder's (1999) scale	Control Variables measured	Rule out ordering effects	Analyze using HLM

**Table 6 Technology Manipulation Example**

Similarity Type	True Technology	True Market	True Level of Similarity	Manipulated Technology Description	Manipulated Level of Similarity
Superficial Similarity	Developed by Northrup Aerospace for NASA telescope mirrors	Lasik surgery (eyes, patients, etc.)	Low	Eye Institute developed to use with patients' eyes	High
Structural Similarity	Examines surface to generate 3D map of shape / smoothness (find surface imperfections quickly)	Quickly and accurately generate a 3D map of surface distortions to identify imperfections	High	Identify discolorations in the Macular foe early detection of diabetes	Low
Procedural	Technician repeatedly scans small samples of surface and extrapolates	Technician uses the device to scan the entire surface one time	Low	Technician uses a hand scanner to repeatedly scan small sections of Macular	High

**Table 7 Random Effects, Standard Deviations and Inter-correlation Coefficient**

Unconditional Model	
	Variance ( <i>SD</i> )
Within Person, $\sigma^2$	0.56 (0.75)
Opportunity Beliefs Intercept, $\tau_{00}$	0.24 (0.49)***
Inter-correlation Coefficient	0.296

\*p<0.05, \*\*p<0.01, \*\*\*p<0.001

**Table 8 Results – Opportunity Beliefs (fit and feasibility combined)**

		<b>Opportunity Beliefs</b>	<b>Superficial Similarity</b>	<b>Structural Similarity</b>	<b>Procedural Similarity</b>
<b>IVs</b>	Superficial Similarity	0.13 (0.07) <sup>l</sup>			
	Structural Similarity	0.22 (0.07)**			
	Procedural Similarity	0.97 (0.27)***	-0.19 (0.14)	0.03 (0.15)	
<b>Trimmed Controls</b>	Founder		0.51 (0.28) <sup>l</sup>		
	Owner		-0.58 (0.25)*	0.20 (0.21)	
	Creative/Innovative Self Efficacy			-0.10 (0.05) <sup>l</sup>	
	Entrepreneurial Self Efficacy		0.21 (0.09)*	0.24 (0.13) <sup>l</sup>	
	Prior Knowledge of Market	0.06 (0.09)	-0.09 (0.10)	-0.02 (0.12)	-0.32 (0.17) <sup>l</sup>
	Prior Knowledge of Technology	0.09 (0.10)	0.05 (0.11)	-0.14 (0.14)	0.22 (0.19)
	Global Precedence		-0.04 (0.03)	0.03 (0.03)	-0.13 (0.05)**

<sup>l</sup>*p* < .10, \**p*<0.05, \*\**p*<0.01, \*\*\**p*<0.001

**Table 9 Results – Opportunity Beliefs (fit only)**

		<b>Opportunity Beliefs</b>	<b>Superficial Similarity</b>	<b>Structural Similarity</b>	<b>Procedural Similarity</b>
<b>IVs</b>	Superficial Similarity	0.14 (0.07) <sup>l</sup>			
	Structural Similarity	0.24 (0.07)**			
	Procedural Similarity	1.12 (0.27)***	-0.14 (0.14)	0.01 (0.14)	
<b>Trimmed Controls</b>	Founder		0.37 (0.29)		
	Owner		-0.60 (0.26)	0.21 (0.21)	
	Creative/Innovative Self Efficacy			-0.07 (0.05)	
	Entrepreneurial Self Efficacy		0.23 (0.09)*	0.22 (0.13) <sup>l</sup>	
	Prior Knowledge of Market	0.08 (0.09)	-0.05 (0.11)	0.04 (0.12)	-0.27 (0.18)
	Prior Knowledge of Technology	0.17 (0.20)	0.01 (0.91)	-0.22 (0.13)	0.17 (0.20)
	Global Precedence		-0.04 (0.03)	0.02 (0.03)	-0.16 (0.05)**

<sup>l</sup>*p* < .10, \**p*<0.05, \*\**p*<0.01, \*\*\**p*<0.001

**Table 10 Results – Opportunity Beliefs (feasibility only)**

		<b>Opportunity Beliefs</b>	<b>Superficial Similarity</b>	<b>Structural Similarity</b>	<b>Procedural Similarity</b>
<b>IVs:</b>	Superficial Similarity	0.12 (0.07) <sup>l</sup>			
	Structural Similarity	0.19 (0.02)**			
	Procedural Similarity	0.77 (0.27)***	-0.26 (0.14) <sup>l</sup>	0.07 (0.16)	
<b>Trimmed Controls</b>	Founder		0.72 (0.29)*		
	Owner		-0.55 (0.26)*	0.19 (0.23)	
	Creative/Innovative Self Efficacy			-0.14 (0.05)*	
	Entrepreneurial Self Efficacy		0.19 (0.10) <sup>l</sup>	0.25 (0.14) <sup>l</sup>	
	Prior Knowledge of Market	0.02 (0.09)	-0.14 (0.11)	-0.09 (0.13)	-0.39 (0.18)*
	Prior Knowledge of Technology	0.14 (0.10)	0.11 (0.11)	-0.03 (0.15)	0.30 (0.20)
	Global Precedence		-0.04 (0.03)	0.05 (0.13)	-0.09 (0.05) <sup>l</sup>

<sup>l</sup>*p* < .10, \**p*<0.05, \*\**p*<0.01, \*\*\**p*<0.001