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EFFECT OF SUPERSTITION AND ANXIETY ON CONSUMER DECISION-MAKING IN TRIATHLETES

Riccardo Sartori*, Andrea Ceschi, Evie Michailidis, Hilda Du Plooy, Tommaso Camplone

1, 2, 3, 4, 5 Department of Human Sciences, University of Verona, Verona, Italy

ABSTRACT

Aim/Purpose : *The aim of the present study is to investigate how pre-game superstition and anxiety can drive the consumption and purchase of sports products and objects by triathletes.*

Methodology : *We tested our hypotheses via a cross-sectional study on a sample of N=124 triathletes.*

Findings : *The results of the Structural Equation Modelling provided evidence of our hypothesized relationship between pre-game anxiety and superstition, and cognitive biases. Pre-game anxiety increases the level of incidence of specific cognitive biases characterized by intuitive and implicit thinking, while superstition leads to more rational and personal cognitive biases, which affect their purchasing of sports products before games and competitions.*

Impact on Society : *The originality of our work stands in the provision of empirical evidence on the role of superstition and anxiety in characterized consumer decision-making of triathletes. Theoretically and practically, our results can extend our knowledge of the role of cognitive factors in consumer behaviors among athletes.*

Keywords : superstition, anxiety, sports performance, consumer behavior, dual-system theory

INTRODUCTION

Triathlon is a multi-sport endurance event that combines three different sports. It begins with swimming, followed by cycling, and concludes with running. Triathlons vary in distance and are known for testing an athlete's stamina, versatility, and transition skills between the different sports. Sport science researchers have approached triathlons focusing on different aspects, e.g., physical and physiological factors, muscular and physical stress (Dengel et al., 1989; O'Toole & Douglas, 1995; Sleivert & Rowlands, 1996), health risks (Gosling et al., 2010), anxiety and self-regulation (Neubauer et al., 2008), and the role of mood and cognition in pre/post-performance (Heazlewood & Burke, 2011). This is due to both the spread of triathlon and the growing economic impact of triathlon, with an increasing number of researchers within the area of consumer behavior addressing it. Wicker et al. (2012) have attempted to explore the economic industry related to the will of practicing triathlon and the practice itself. Within these aspects, researchers have mainly focused on the sports marketing of triathlon, such as sports expenditure and sports activities consumption, identifying the core characteristics of spenders (Epstein et al., 1996; Wicker et al., 2012). For example, previous studies advanced descriptions concerning individual differences as antecedents of sports expenditure of amateur and elite athletes, identifying the triathletes as an economically interesting target group and providing suggestions for managers and marketers (Wicker et al., 2012).

Numerous studies have stressed the importance of studying how internal psychological factors, such as emotions, beliefs, and attitudes, influence the consumption of sports products before competitions. Velasco and Jorda (2020) examined boredom among athletes and its implications on sports management and consumer behavior. They found that boredom significantly influences athletes' preferences for brands and consumption patterns, including the propensity to overconsume and the search for variety in sports-related products (Velasco & Jorda, 2020). Raggiotto's (2020) two-branch model further elaborates on the psychological constructs that drive consumer behavior in extreme sports, such as triathlon. Raggiotto points out that both self-validation and loyalty are critical in motivating extreme sports consumers to deepen their relationships with the brand, which can manifest in increased spending on products and equipment. Increasing knowledge of the predictive factors of consumer choices can provide advantages to sports managers in terms of targeting products. Likewise, addressing these perspectives from the mental and physical training perspective would yield valuable insights for athletes and trainers to reduce the influence of psychological constraints during pre-game and game conditions. Consumer decision-making can be impaired by the incidence of cognitive biases, which have implications even for their general life situations. Cognitive biases refer to the application of irrational or inadequate models that distort how people understand information and make decisions. Their detrimental effects on individual decisions represent an important challenge for triathletes who have to deal with the stressful conditions of competitions.

In the present paper, we consider two common psychological experiences in extreme sports, namely anxiety and superstition (Wakefield et al., 2017), as internal factors that can drive consumer decisionmaking and the application of irrational and inadequate models (Rudski, 2001; Sierra et al., 2018). On the one hand, these psychological factors have been largely addressed in sports psychology with a specific focus on their functions and outcomes during pre-game and game conditions (Bleak & Frederick, 1998; Domotor et al., 2016; Flanagan, 2013). On the other hand, in the consumer decisionmaking field, internal factors such as consumption and spending have been studied in terms of their potential to lead to bad or uninformed decisions (Chou & Chang, 2012; Kramer & Block, 2011), due to the occurrence of cognitive errors (i.e., cognitive biases). This study provides a common framework to explore the role of individual differences in athletes as antecedents of consumer decisionmaking. This can support marketing knowledge as well as applied interventions to improve the performance of athletes.

REVIEW OF THE LITERATURE

SUPERSTITION AND ANXIETY IN TRIATHLETES' CONSUMER DECISION-MAKING

Drawing on a sports psychology perspective, antecedents of consumer decision-making that might include the application of irrational cognitive models are pre-game anxiety and superstition. These individual components are commonly studied in the research areas of reasoning and decision-making processes (Epstein, 1994; Johansen & Haugen, 2013; Sadler-Smith, 2011). The main interest of academic literature has been to identify the associations between thinking and paranormal beliefs, superstitious behavior, and unscientific reasoning. This suggests that sports athletes who engage in superstition can be prone to cognitive biases that reflect irrational and inadequate models of reasoning. For example, the consumption of sports products can be made based on the personal beliefs and cultural background of the athlete. At the same time, many authors have tried to understand how anxiety could drive information processes and decision-making (Hsee & Kunreuther, 2000; Loewenstein & Lerner, 2002). Indeed, authors have defined the behavioral tendency of making errors based on preference and judgments by the current emotional state engaging in cognitive biases.

First, superstition is largely diffused in both individual and team sports (Bleak & Frederick, 1998; Buhrmann et al., 1982; Flanagan, 2013). Senseless and irrational beliefs emphasized by magical aura affect the thoughts of the athletes, emerge mostly in situations characterized by uncertainty (Vyse, 1997), and lead individuals to take actions based on those personal assumptions (Keinan, 2002; Schippers & Van Lange, 2006; Womack, 1992). People give their actions and objects (i.e., pre-game rituals, clothes, food) useful, special, and magical significance without regard to technical performance and pre-performance routines (Cohn, 1990; Kramer & Block, 2011; Vyse, 1997). These repetitive, formal, and sequential actions serve to give the athletes the illusion of self and situational control. Being occupied in superstition tunes psychological strain, reduces tension, and gives a sense of control and predictability (Bleak & Frederick, 1998; Calin-Jageman & Caldwell, 2014; Damisch et al., 2010; Keinan, 2002; Schippers & Van Lange, 2006; Womack, 1992).

Second, according to the multidimensional model of sports anxiety (Martens et al., 1990), stress competition and general level of anxiety are linked with the demand perceptions of athletes. If there is a failure in responding to these demands and is perceived to be related to a lack of personal capabilities, then athletes will respond with high levels of cognitive and somatic anxiety, which further increases if linked with goals and performance in competitions (Martens et al., 1990). Several factors may contribute to the development of negative thoughts, feelings of apprehension, and tension associated with a high level of activation of the organisms (Martens et al., 1990): goal, task, and performance' severity, their persistence related to sport participation and the context in which athletes are engaged (Patel et al., 2010). Martens et al. (1990) identified three dimensions of anxiety: cognitive, somatic, and self-confidence. While the cognitive dimensions are more related to a decrease in performance, somatic anxiety improves performance when it is at an optimum level but can lead to poor performance when it falls beyond the optimum level for the athlete. Self-confidence refers to the belief that the athlete can face the tasks and performance required by the sport (Rushall, 1992; Weinberg, 1978).

COGNITIVE BIASES IN TRIATHLETES" CONSUMER DECISION-MAKING

Superstition and anxiety are not related and reflect distinct processes (Bleak & Frederick, 1998; Schippers & Van Lange, 2006). This implies that they can reveal the application of different cognitive processes in terms of the occurrence of cognitive biases linked to intuitive or rational thought (Epstein, 1991; Hsee & Kunreuther, 2000; Kramer & Block, 2011; Loewenstein & Lerner, 2002; Stanovich et al., 2008, 2014). According to Stanovich et al. (2014), cognitive biases can be categorized as the effects of two separate thinking systems (i.e., System 1 and System 2). These systems have multiple names and different properties. Usually, the two components of the dual system theory are defined as the automatic-intuitive system (S1) and the rational-experiential system (S2) (Evans, 2003; Kahneman, 2003). In the category of System 1, the processing of information is autonomous, dependent on emotion, and under less control by individuals. It is characterized by the encapsulated modules of adaptive learning, impulsive associations, self-regulation, and automatic firing of implicit thought and learning (Stanovich et al., 2014). Examples of cognitive biases of System 1 processes are the Halo Effect (or attribute substitution for an easier question (Kahneman & Frederick, 2002), the Vividness Effect (defaulting to vivid information), the Affection Effect (or the impulsively associative thinking, also known as intellectual laziness (Stanovich et al., 2008)), and the Framing Effect which is largely discussed in heuristic and biases' literature as a choice mediated by the information presentation (Tversky & Kahneman, 1974). Many authors have proposed different definitions of the System 1 features (Bargh, 1994); however, the common characteristics are autonomy and non-optimal responses in decisions with the incidence of the cited processes.

In comparison, the effects involving the autonomous system's inhibitory mechanisms are referred to as System 2 processes. S2 features are the algorithmic and reflective mind (Stanovich et al., 2014), rational thinking and fluid intelligence, individual differences in thinking disposition and goal management concerning open-minded beliefs, and superstition thinking (Evans, 2003; Stanovich et al., 2008, 2014). Examples of S2 are the Confirmation Bias and the Status Quo Biases (Stanovich et al., 2008), which refer to the cognitive effects of internal beliefs marking the information. As one, the Anchoring Bias, a common cognitive bias discussed in the literature, is reported to be the reflection of the internal models of the rationality of one individual.

Ultimately, the automatic system can be driven by the presence of anxiety, while biases related to the rational system can be caused by the presence of superstitious beliefs and rituality (Kramer & Block, 2011). Considering superstition and anxiety as not related (Bleak & Frederick, 1998; Schippers & Van Lange, 2006) and cognitive biases as reflecting one of the two systems (intuitive and automatic system), we can argue that superstition refers to credence and dogmatic beliefs located in the reflective mind, i.e., S2 (Hypothesis 1) while anxiety refers to automatic and associative thinking in the intuitive mind, i.e., S1 (Stanovich et al., 2014) (Hypothesis 2). Based on this analysis, we formulate the following hypotheses:

H1a: Superstition (SRQ) will relate to two of the biases considered as cognitive biases of S2.
H1b: Superstition will increase the presence of cognitive biases referred to as S2 and S1.
H2a: Anxiety (OCSAI) (cognitive and self-confidence) will relate to two of the biases considered as cognitive biases of S1.
H2b: Anxiety will increase the presence of cognitive biases referred to as S2 and S1.
H3: Cognitive biases will mediate the direct relationship between athletes' perceived performance, superstition, and anxiety.

COGNITIVE BIASES TESTED IN THE PRESENT STUDY

Considering the literature, we selected the following cognitive bias measures: anchoring bias, status quo bias, halo effect, and affection effect. We adapted the cognitive biases tasks to the athletes to assess their information and decision-making processes with regard to their sports product consumption and purchasing.

As described earlier, athletes can have different perceptions about their competition and trial and base their judgment on previous performances and experience, i.e., anchoring bias. We supposed that the different perceptions of the games are influenced by heuristics and, precisely, by those cognitive shortcuts based on previous information, experience, and internal beliefs (Bunn, 1975; Tversky & Kahneman, 1974).

Status quo bias can be seen in the evaluation process of information, which involves personal beliefs that are not directly linked with the object of choice. Among athletes, specific nutrition and foods are largely diffused. For instance, some athletes prefer specific vitamin supplements over other energetic foods depending on the type of competition. This implies that an athlete's tendency to choose one nutrition instead of another could be driven by the Status Quo bias or the anomaly of repeatedly making the same choice based on internal beliefs (Kahneman et al., 1991).

The halo effect refers to the individual tendency to evaluate objects and experiences based on one's personal emotions. In athletes, how the competition or performance will be is a general impression that is

influenced by their feelings and internal or external thoughts. This tendency to judge performance and competition is given by a specific cognitive effect where people tend to evaluate information and experience based on previous feelings and thoughts (Leuthesser et al., 1995; Nisbett & Wilson, 1977).
The affection effect has been added to the questionnaire to assess the individual tendency to be influenced by risk and thoughts of future events. Indeed, the opinions of the athletes about rituals, sports products, prayers, and food are influenced by judging risks and benefits, which are influenced by positive or negative feelings and impressions about specific details. This choice module is similar to the previous biases mentioned, but in this case, individuals are guided by feelings and beliefs that affect perception and cognition. This heuristic is known in academic literature as an effect of the individuals' affection (Hsee & Kunreuther, 2000).

METHODOLOGY

Following our arguments, we designed a cross-sectional study using superstition behavior scales, anxiety sports scales, and cognitive tasks for the assessment of cognitive biases. We invited triathletes to voluntarily participate in our research by submitting the linked questionnaire on LimeSurvey (Schmitz, 2012). One hundred and twenty-four Italian triathletes (11.3% females) completed and returned the anonymous forms (age average = 40 years, SD=8.51, range between 16 and 65). The education level reported was "high school degree" for 42.7% (N=53) of the participants and a bachelor's degree for the remaining sample. Moreover, we asked the participants to indicate the type of competitions and their performance. One question regarded their usual standings in races with the item – "Splitting a hypothetical ranking of a triathlon race into three parts, tell in which part you usually are" – with the options of 1/3, 2/3, or 3/3. The second question is how much time take to complete the races: "Choose the time bend where you place more or less in the Olympic triathlon race (thinking the hardest you have done or if you have ever done an Olympic race but only sprint choose a hypothetical time)." Of the total sample, 19% reported to be "high performers," 47% "medium," and 34% "low." Among the males, 18% reported a timed race of <2hrs 15mins compared to a timed race of <2hr 30mins for females. The majority of participants (79%) were in the medium performance range with time ranging from 2hrs 15mins to 3h for males and 2hrs 30mins to 3hrs for females. The remaining 3%, male and female participants, reported a time range of more than 3hrs.

MEASURES

Superstition. The Superstitious Ritual Questionnaire (SRQ) (Bleak & Frederick, 1998) was developed to evaluate the prevalence of superstitious behavior in sports. The questionnaire consists of 42 items divided into seven sections (clothing and appearance, fetishism, preparation, game/competition, team game, team rituals, and prayer). For the present study, the SRQ was modified to accommodate the nature of the sport investigated and the hypotheses. The sections were reduced from seven to four (clothing and appearance, fetishism, rituals, and rituality) for a total of 33 items. Responses were given on a 5 point Likert scale (from 1 = never to 5 = always). An example of an item is "I am used to wearing a lucky garment" (from 1 = never to 5 = always) (Cronbach's α=.847).

Anxiety. To measure cognitive anxiety and self-confidence, the Competitive State Anxiety Inventory-2 (OCSAI) by Cox et al. (2003) was used. These authors developed the questionnaire to measure competition anxiety and evaluate three levels of anxiety based on their theory, namely, cognitive, somatic, and self-confidence. This questionnaire, which consists of 17 items, measures the same dimensions in two different situations. In one, participants have to imagine being in a quiet situation (OCSAI-1) and the other during a stressful situation (e.g., in a pre-game condition, OCSAI-2). Due to

our interest in anxiety during competitions and games, we only utilized the second time submission form. Responses were based on a 5-point Likert scale (from 1 = never to 5 = always). Examples of items are "I feel happy" or "I'm worried about reaching my goal" (from 1 = never to 5 = always).

For the Cognitive Anxiety and Self-confidence dimensions, the Cronbach values were respectively Cronbach's α=.831 and Cronbach's α=.925.

Cognitive Biases. Anchoring bias was measured by adjusting the item to a common question concerning different triathlon races. An example of an item is: "You are about to start the Olympic Triathlon: How difficult could it be to deal with 10 km on foot? 2- with 40 km? and with 5?" (1 = not at all, 5 = very much) (Cronbach's α=.870). Given a reference point, the anchoring task measures are reported a second time to evaluate their judgment over time and how it could be influenced by the anchor given.
The status quo bias was tested by asking athletes to imagine themselves in a pre-game condition and to judge their thoughts about the race based on the food supplements given. An example of an item is: "You are preparing for a race, and you have the bars/gels/supplements you usually use. How much do you feel ready to face it?" (1 = not at all, 5 = very much (Cronbach's α=.854).
The halo effect was assessed with items like: "You are preparing your pole in the exchange area. You cross an athlete with technical equipment that you think of normal quality. In your opinion, how much do you think could be strong?" (1 = strongly disagree, 5 = strongly agree) (Cronbach's α=.804).

The affection effect was measured by presenting a scenario where a well-known company of sports products has launched new products, and triathletes have to judge if the products were expensive or make reference to their emotional state. An example of an item used is: "Jacked has just launched a new costume prototype on the market made of highly technical, resistant, and hydrodynamic materials of the latest generation. The cost is around 200 euros. Do you think this product is objectively expensive?" (1 = strongly disagree, 5 = strongly agree) (α=.883).

DATA ANALYTIC PLAN OR STATISTICAL ANALYSIS

The data was analyzed by conducting a correlation analysis between SRQ, OCSAI dimensions, and cognitive biases to determine relationships between the variables. As suggested in the literature, we computed the cognitive biases by summing the task scores where the higher scores reflected the application of irrational models. The results could be positive or negative, which allowed us to assess the direction of the measure and its prevalence (Parker & Fischhoff, 2005). Then, in order to test the dependencies among the set of variables, we conducted a Structural Equation Model (SEM). We hypothesized a positive covariance between Superstition and Anxiety with the cognitive measures of decision-making in purchasing (H1). We predicted Superstition (SRQ) as related to two of the biases considered as cognitive biases of S2 (H1a, SRQ, and S2). Then, we posited a positive covariance between Anxiety (OCSAI), by its cognitive and self-confidence dimensions, with two of the biases considered as cognitive biases of S1 (H2a, OCSAI, and S1). The level of somatic anxiety was excluded from this study due to its relationship with positive effects on performance. Then, by the variance observed (S), we estimated the parameter by which SRQ and OCSAI modulate cognitive biases referred to S2 and S1 (H1b, SRQ to S2 biases; H2b, OCSAI to S1 biases). Lower levels of superstition and higher levels of anxiety (cognitive and self-confidence) lead to biases of S1 and vice versa; higher levels of superstition lead to biases of S2 dimensions considered. Finally, we tested the hypothesis that performance will be predicted by superstition and anxiety with cognitive biases as mediators (H3).
All analyses were conducted with IBM SPSS statistics version 21.1 and its added module AMOS

(Arbuckle, 2010).

RESULTS

DESCRIPTIVE STATISTICS

In Appendix A, the means, standard deviations, and correlations of the variables are reported. No significant correlations were found between the individual variables and scales. Age showed a negative correlation with cognitive anxiety and a positive correlation with the level of self-confidence. Moreover, no relevant correlations were observed with performance. Consequently, performance as a dependent variable was excluded from our model, and Hypothesis 3 relating to performance was rejected.

HYPOTHESES TESTING

Given the correlations of SQR, OCSAI, and cognitive biases, we computed the standardized scores to the hypotheses and model testing, represented in Appendix B. According to Schreiber et al. (2006), we patterned SRQ and OCSAI as latent factors with three observed variables for superstition (Appearance, Ritual, and Rituality) and the two of OCSAI (Cognitive Anxiety and Self-Confidence) with a single indicator to the cognitive biases latent variables tested with two observed variables per group: S2 (Anchoring and Status Quo) and S1 (Halo Effect and Affection Effect). We tested the variance between SRQ and OCSAI, which was null. The variables considered were standardized to estimate the reliability of the interaction. For cognitive biases, the path from latent variables to their corresponding observed variable was equal to the square root of the reliability of the observed score.

Appendix B reports the three models tested. In the hypothetical model 1, we considered all the possible interactions between variables with a fit index that suggested an acceptable model [X2(34.64, df=24, p=.64); GFI=.94; RMSEA=.060; CFI=.90.2]. Based on our Hypotheses 1a, 1b, 2a, 2b, and 3, not all the moderation effects have been found significant. Hypotheses 1a and 2a were partially confirmed. The relationship between SRQ and S2 showed a significant correlation but not with S1. Viceversa, the relationship between OCSAI and S1 and S2 was significant in both groups of observed variables (H1a and H2a). The second hypothesis has been confirmed by the null variance between SRQ and OCSAI. Therefore, we tested a second model (Model 2), keeping only the moderating effect of the OCSAI with S1 and S2 while the SRQ with S2. This interaction path elimination resulted as an increment of acceptable index: [X2(35.37, df=25, p=.82); GFI=.941; RMSEA=.058; CFI=.91]. While the chi-squared increased, we found a small reduction in GFI and RMSEA. According to the guidelines of Schreiber et al. (2006), we tested a third model (Model 3), eliminating the moderating effect of SRQ to S1 and OCSAI to S2. This attempt resulted in more linearity with literature and produced an increment of index and coefficients [X2(35.44, df=26, p=.10); GFI=.941; RMSEA=.054; CFI=.92]. The GFI, RMSEA, and CFI parameters were acceptable, according to Leung and Tan (2018). In the final model, the latent variables, SRQ and OCSAI, resulted in positive correlations with S2 (β=.36, p=.03) and with S1 (β=.40, p=.28) and the covariance between SRQ and OCSAI was null, (β=.03, p=.63).

CONCLUSION

The study aimed to understand how consumer decision-making can be influenced by the relationship between superstitions and anxiety (Bleak & Frederick, 1998; Block & Kramer, 2009; Kramer & Block, 2011; Schippers & Van Lange, 2006), considered as important cognitive factors elicited during the pre-game experiences of athletes. We found that superstition elicits rational cognitive biases while Effect of Superstition and Anxiety on Consumer Decision-Making in Triathletes anxiety leads to more intuitive cognitive biases, which is reflected in the purchasing of sports products.

Triathletes are prone to physical and muscular stress, risk-taking, and difficult competition, but there are also many other variables that underscore their psychophysical conditions. Feelings, emotions, anticipatory thoughts, and stressful situations force the cognitive processes of athletes, leading them to make systematic errors and automatic decisions. The cognitive pressure of high demands of games and sports is not necessarily related to consumption, but in the case of anxiety and superstition, we see the likelihood of athletes being engaged in fallacious cognition of purchasing as guided by their personal beliefs or emotion appraisals (Epstein, 1991). Consumers' choices are important in the area of offers, marketing fields (Mullin et al., 2014; Wicker et al., 2012), and demands. Understanding athletes' choices between one or more objects offers several implications for the same athletes, trainers, and marketers. As argued, competitions and high-pressure activities are related to the high impact of emotional demands and chronic attention on unrealistic beliefs and emotional appraisals, which influence purchasing and pre-competition behavior.

In the present study, we addressed the gap concerning how triathlon competition can affect the consumer behavior of athletes by increasing superstition and anxiety, which in turn leads to specific cognitive biases. Then, we contribute to the literature by providing evidence about the relationship between anxiety superstition and branding for athletes. However, the non-significant results with performance resulted in an important limitation to our study. Future research might focused more on the nature of the construct and design studies incorporating specific measures regarding the performance expectations considering the evidence in all the scientific fields mentioned in this study (Bleak & Frederick, 1998; Block & Kramer, 2009; Cox et al., 2003; Epstein, 1991; Johnson, 2006; Kramer & Block, 2011; Renfree et al., 2014; Schippers & Van Lange, 2006; Stanovich et al., 2014; Wicker et al., 2012). Through more studies, significant insights will be gained to sustain the demands of athletes, specifically elites (Flanagan, 2013), who are generally more at risk of stressful experiences, given their constant training and competition. Even though our study revealed interesting results and one important limitation with regard to performance, there are a few limitations that call for attention and can direct future studies. First, the sample composition limits the possibility of generalizing our results. The total sample consisted of triathletes of Italian origin, with a predominantly larger percentage of males. Increasing the number of subjects will lead to better statistical power to reach the relations and test the model, considering performance as the antecedent of superstition and anxiety. Also, only focusing on triathletes does not guarantee to have the same results in other types of sports. To solve these limitations, future studies are recommended to include athletes from different nations to ensure that specific social norms do not influence the results of the research. It is also desirable to involve a larger number of athletes from different types of sporting specialties and with more equal representation between men and women. Another limitation that stems from self-reported data is social desirability bias, especially for the answers provided by the athletes to items relating to participants' cognitive biases. It is possible that athletes might have under/or over-reported cognitive biases in an attempt to understate/or overstate these behaviors. Future studies could deal with this limitation by incorporating some indirect measures or even behavioral observations that are less susceptible to social desirability bias, such as reaction time tasks.

To conclude, several studies in sports psychology have been conducted concerning physical and physiological factors, muscular and physical stress, anxiety and self-regulation, mood, cognition, pre/post-performance, health risks during competition, and decision-making as it relates to performance. However, viewing sports through the lens of economic demands and offers can advance our understanding, which is valuable both for general and applied knowledge. As we have emphasized,

the field of superstition and anxiety in consumption behavior is timely and relevant. This is especially true in the case of athletes who have to be considered as specific individuals where several factors interact. Even if more steps need to be done in order to gain more in-depth knowledge, this study provided a suggestive initial insight into the consumer psychology of athletes.

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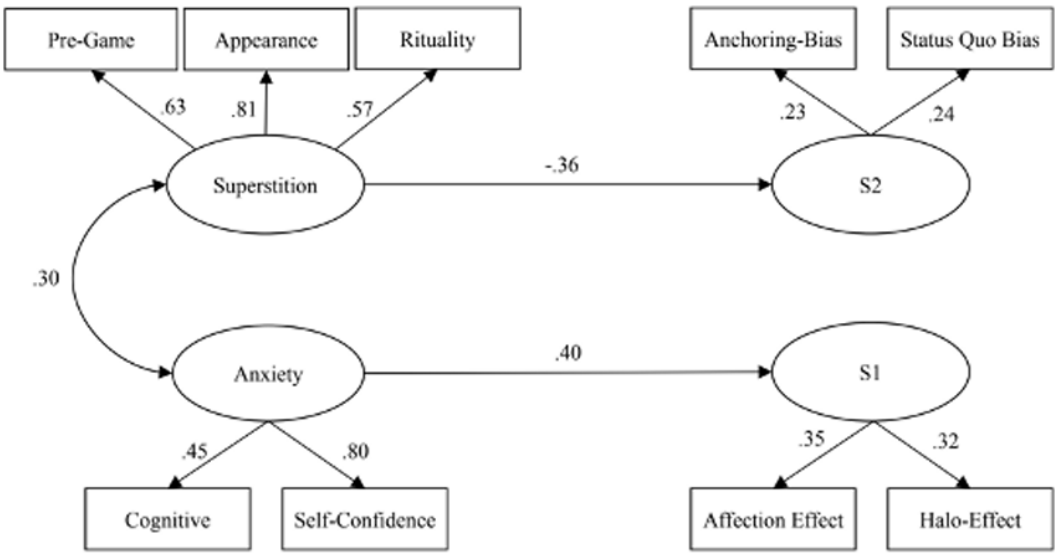
APPENDIX A. CORRELATION MATRIX OF THE VARIABLES WITH MEANS AND STANDARD DEVIATION IN THE SECOND COLUMN

		M(SD)	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1.	Gender	1.11(.32)														
2.	Age	39.60(8.51)	-.12													
3.	Education	3.68(1.86)	.08	-.02												
4.	Job	3.79(1.93)	-.07	-.07	.11											
5.	Performance 1	1.86(.71)	-.08	.19*	-.03	-.02										
6.	Performance 2	1.87(.44)	-.13	.16	-.03	-.07	.41**									
7.	Cognitive Anxiety	2.45(.66)	.13	-.20*	.02	.14	.21*	.08								
8.	Self-confidence	3.24(.81)	-.13	.34**	-.04	-.14	-.09	-.10	-.39**							
9.	Superstition Appearance	1.55(.39)	.06	-.09	06	-.13	-.095	-.24**	.14	-.01						
10.	Superstition Pre-game	1.92(.50)	-.20	-.10	-.06	.02	.09	-.16	.21*	.04	.42**					
11.	Superstition Prayer	1.38(.53	.01	-.04	.13	-.07	-.02	-.14	.09	.01	.54**	.34**				
12.	Anchoring Bias	.40(.35)	.04	.03	-.07	.01	.18*	-.12	-.04	-.07	.03	.12	.16			
13.	Status Quo	.96(.70)	-.05	.07	-.04	-.03	-.14	-.11	-.28**	.21*	.11	.11	-.01	.03		
14.	Affection Effect	1.17(.91)	.07	-.04	.05	.07	-.11	-.16	.11	-.23*	.14	-.04	-.03	.04	.08	
15.	Halo Effect	.59(.57)	-.10	-.09	.03	.09	.01	-.06	.04	-.28**	-.11	.06	-.05	.19*	.05	.29**

Note. Gender: 0 = woman. 1 = men; Education: 1 = Elementary school; 2 = Lower general secondary education; 3 = Higher general secondary education; 4 = Preparatory vocational education; 5 = Higher professional education; 6 = Bachelors' degree; 7 = Masters' degree; 8 = Ph.D.; 9 = Other. Job: 1 = Labourer; 2 = Employee; 3 = Manager; 4 = Business Owner; 5 = Entrepreneur; 6 = Student; 7 = Homemaker; 8 = Freelance; 9 = Retired; 10 = Unemployed; 11 = Other. * p < .05. ** p < .01.



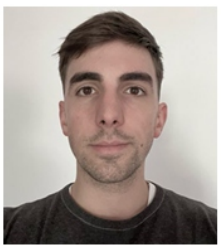
AUTHORS

Riccardo Sartori is an Associate Professor of Work and Organizational Psychology in the Human Sciences Department of Verona University. He is a psychologist and psychotherapist, graduated in Work and Organiza tional Psychology, and has a Ph.D. in Perception and Psychophysics. His interests focus on (1) assessment of candidates and personnel (individual, group, and organizational assessment, (2) training and development of human resources, and (3) business consulting dealing with organizational dynamics (organizational co-habitation, cooperation, conflict, etc.). He is the Director of the research center APRESO (Applied Research in Soci ety and Organizations).

Andrea Ceschi is an Associate Professor in Work and Organizational Psychology (WOP) at the Human Sciences Department of Verona Uni versity. As co-founder and scientific director of the research center APRESO (Applied Research in Society and Organizations), my expertise lies in organizational behavior, individual differences and decision-making at work, and social dynamics in the applied psychology field.

Evie Michailidis is a Postdoctoral researcher in Work and Organisa tional Psychology in the Department of Human Sciences, Verona Univer sity, Italy. Her research mainly concerns the role of job characteristics (e.g., organisational justice, job stressors, appreciation from managers and colleagues) in the experience of emotions in the workplace and employ ees' wellbeing. Also, with her research, she investigates how and under which circumstances employees recover from job demands during off-job hours.

Hilda Du Plooy is a clinical psychologist with a PhD in child and adoles cent psychology from South Africa and an MSc in cognitive neuroscience and clinical neuropsychology from the University of Padua, Italy. She is a PhD student in Human Sciences at the University of Verona in Italy. Her area of interest includes student mental health in Higher Education, be havioural economics, and emotional intelligence, combining fields such as industrial/organizational psychology and clinical psychology.



Tommaso Camplone is a student in the master's degree program in Work and Organizational Psychology at the Human Sciences Department of Verona University. He collaborates with the research center Applied Research in Society and Organizations (APRESO).

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OBSERVATIONS ON ARROGANCE AND MEANING: FINDING TRUTH IN AN ERA OF MISINFORMATION

Eli Cohen
Informing Science Institute, Santa Rosa, CA, USA

ABSTRACT

The paper discusses various factors contributing to disagreements, such as differing experiences, perspectives, and historical narratives, leading to disagreements within families and societies. It explores how beliefs, values, and biases feed into disagreements, with confirmation bias affecting decisionmaking and the media. Cultural values also play a role, showcasing conflicts between meritocracy and inclusivity in ethical decision-making. Haidt's Moral Foundations Theory highlights differences in value priorities between Western and Eastern societies. The impact of Western values like rationalism, freedom, and tolerance, under threat from Marxist illiberalism on campuses, is discussed. The text also delves into disinformation, emotions in warfare, and the use of fake information and images for propaganda purposes. The need for diligent reporting to avoid spreading disinformation is emphasized, given its potential to create misconceptions and harm diplomatic relations.

Keywords. informing, values, disinformation, soft power, fake images

INTRODUCTION

Misinformation and disinformation play a significant role in hindering the ability to reach consensus. By distorting facts and spreading false narratives, they create confusion and foster ignorance among individuals, leading to a breakdown in shared understanding. This lack of accurate information and shared knowledge further fuels disagreements and prevents productive dialogue and collaboration. Using descriptive research methods, this paper examines factors that contribute to disagreements. Previously, Cohen (2021) provided a model to describe how misinformation (and disinformation)

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Finding Truth

contribute to the inability to reach shared understanding. Salient elements were shown to be each person's selective attention and how the message was packaged. This paper extends that contribution. This paper notes that high-value words, like freedom, have lost a meaning shared by all by gaining an alternative meaning, resulting in a lack of shared understanding. As a result, the loss of shared understanding leads to ignorance. The arrogance of the ignorant occurs when those holding one view refuse to consider the countervailing views of others. Apart from individual viewpoints, there may also be a lack of shared values. Civilizations can and do clash in their values. The paper concludes by relating this to how governments use soft power to advance their cause.

These points are discussed one by one, beginning with disagreements that do not necessarily involve

arrogance.

DISAGREEMENTS ARE PART OF LIFE

Disagreements are a part of life. Even within families, people disagree at times. Cohen (2021) showed the role played by self-selection of differing information sources as one cause of disagreements. This paper expands on the question of how disagreements come about. People's experiences, perspectives, and realities can be fundamentally different. While they may breathe the same air and occupy the same physical environment, their inner worlds and life circumstances vary greatly. People carry their own history, that is, unique thoughts, beliefs, emotions, and experiences that shape their perception of the world.

PEOPLE MAY UNDERSTAND THE PAST DIFFERENTLY

But just as people often remember the past differently, historians, as scholars tasked with unraveling the complexities of historical events, often disagree over various aspects of the past, e.g., Kaufman (2024.) Their conflicting viewpoints extend beyond mere factual disparities to encompass debates about what should be emphasized, remembered, and other essential aspects of historical understanding.

One's narrative influences one's understanding of events

Just as historians approach history through differing theoretical frameworks or prioritize certain aspects of the past over others, resulting in contrasting narratives, we all do. Merriam-Webster Dictionary (Merriam-Webster, n.d.) defines narrative, as used here, as "a way of presenting or understanding a situation or series of events that reflects and promotes a particular point of view or set of values." This is important because people, even historians, form their understanding through their narratives.

For example, while most historians view history via empirical historiography, Marx viewed history through the lens of class struggle.

Conflicting narratives lead to disputes over the significance of specific events, the motivations of historical figures, or the societal, cultural, and economic forces that shaped the course of history. Professors make deliberate choices about what should be remembered and taught. Gibbon (2017) notes that these choices are influenced by factors such as cultural perspectives, political ideologies, and societal values, leading to divergent narratives and conflicting accounts of the past. Alternative narratives can and perhaps should be used constructively to understand the sides of reality, as we see in the next section.

Conflicting narratives can be based on disinformation

But narratives can also be used destructively. For example, history can be fabricated to meet political needs. The hundred-year-old forgery The Protocols of the Elders of Zion is an antisemitic example of disinformation, likely written at the behest of Russia's Czar to focus discontent away from him. (Britannica, 2024; United States Holocaust Memorial Museum, 2019)
Let us explore how different narratives can lead to constructive and destructive disagreements.

TYPES OF DISAGREEMENTS

A recent publication by Bernstein (2024) provides a simplistic view of how to respectfully (constructively) resolve disagreements. However the history of arguments and how to resolve them spans centuries. Below shows how this is handled in the Talmud (Dolgopolski, 2009).

Constructive disagreements

Adherents of Constructive Disagreement follow these rules in their search for truth:

1. They debate the issues without ad hominin attacking people or aiming to harm relationships.
2. They are motivated to learn from the other, not to win the argument.
3. They respectfully listen to the other side and are open to understanding their viewpoint.
4. They recognize that, despite holding conflicting narratives, both positions can have elements of truth.

Arrogance: Destructive disagreements

Unlike Constructive Disagreements, which are civil and are formed after hearing and acknowledging the other point of view, Destructive Disagreements have one or more of these elements:

1. Viewing arguments as a zero-sum game and so attempting to win the disagreement without regard to the other side,
2. Attacking the opponent with ad hominem statements.
3. Having no interest in learning from different viewpoints, typically by failing to listen.
4. Acting to impede or prevent others from hearing other viewpoints.

We currently see destructive disagreements played out on college campuses.

VALUES: CONFLICTING VALUES CAN LEAD TO ARROGANCE

BELIEFS, VALUES, AND TRUTH

Both constructive and destructive arguments draw from beliefs. Figà Talamanca and Arfini (2022) explored the echo chamber and the epistemic filter bubble effects. Filter bubbles occur when relevant sources of information are omitted. In these cases, those in the bubble are unaware of significant information and reasoning. The echo chamber effect involves choosing to be exposed only to information sources reinforcing one's beliefs.

Plus, confirmatory bias

Confirmation bias is people's tendency to process information by looking for or interpreting information consistent with their beliefs. People are especially likely to process information that supports their own beliefs when an issue is highly important or self-relevant (Casad & Luebering, 2024). This biased approach to decision-making may be unintentional, resulting in a person ignoring or forgetting information inconsistent with their beliefs.

What may be worse than an individual's confirmatory bias is confirmatory bias in mainstream media.

It can create an epistemic filter bubble by involving one or more of the following biases:

- Reporter bias (Weidmann, 2016),
- Editor bias (the one who decides what to print and what to emphasize, that is, how to slant a story) (Friedman, 2014, 2015, 2017),
- Headline editor bias (University of Washington Libraries, 2017) and
- Placement, such as by the layout editor who decides where to place the report, which photos to show and their size, and what parts of the story to cut to meet limitations (University of Washington Libraries, 2017).

Finding Truth

Social media lacks even the mainstream media's attempt at journalistic honesty. Its principal goal is to dominate the users' attention for profit using the users' emotions.

"There is very little training on how to use emotions more subtly, in a way that opens minds to possi bilities constructively but is not designed to persuade" (Freeman, 2018).

EFFECT OF CULTURE AND VALUES

One reason why there are disagreements is conflicting cultural values. The impact of culture and values within that culture complicates the search for truth in ethical decision-making. Such cases are not right versus wrong but one person's sense of right versus the other person's sense of right. For example, political conflicts are common worldwide. Figure 1 illustrates major ethno-territorial conflicts around Asia, Africa, and Europe. And there are conflicts of rights vs rights within countries.

Figure 1. Political conflicts, from Major Ethno-territorial conflicts around Asia, Africa, and Europe. Personal Communications. Used with permission.

For example, consider the disagreements around whom to hire or which students to admit to a college. Those who value meritocracy over inclusivity might advocate for hiring or admitting the best and the brightest. Others who value inclusivity over meritocracy would prefer hiring or welcoming some from the disadvantaged group. Such right vs right creates tension among ethical decision-makers seeking truth.

Constructive decision-making stresses the importance of leaving room for others' perspectives and values, even when one is confident about one's decision-making process. Values clarification, a popular notion in the 1970s, was summarized in Kirschenbaum et al. (1977). It involves having individuals understand what they value and understand what others value. The examples in the previous paragraphs focused on clashes within a culture. The situation is even more complex when it involves clashes across cultures.

Values vary even more between cultures: Weird Worlds

Morris (1956) examines how the East and West differ, including the impact of value Haidt (2012) builds on Morris's pioneering work by exploring East/West impacts on values in greater depth and across

various cultures. Haidt argues that people share concepts of moral values universally but prioritize these moral values differently, leading to disagreements. What is new is his showing how values vary from individual to individual and across cultures. For example, Haidt shares his experience living in India, where he discovered a hierarchical society prioritizing authority over liberty and fairness.

People's values underpin their beliefs and conduct.

Haidt suggests that morality across cultures shares common themes: care vs. harm, fairness vs. cheating, loyalty vs. betrayal, authority vs. subversion, sanctity vs. degradation, and liberty vs. oppression. For example, what do you value more if you see your sister cheating: loyalty to her or fairness?

Haidt posits that these six themes are shared by all or most civilizations. However, their relative valence differs across cultures, particularly between the West and the East. That is, Western relative value patterns differ from Eastern ones.

Haidt uses the term WEIRD to denote Western, Educated, Industrialized, Rich, and Democratic (hence the acronym WEIRD) societies.

WEIRD arrogance explains some disagreements

In general, thinking patterns in the West descended from the Greek tradition. However, this is not the case in Africa, India, Asia, and even Eastern Europe (Henrich et al., 2010; Stewart, n.d.; Upp, 2021). Some moral value patterns in play today by some cultures are derived from those of 15th-century Arabia (Termińska, 2009).

Henrich et al. (2010) write cultures "build virtues, narratives, and institutions upon these foundational [ethical] systems, resulting in the diverse moral beliefs we observe globally and even conflicts within nations."

"Broadly speaking, Western society strives to find and prove 'the truth,' while Eastern society accepts the truth as given and is more interested in finding the balance. Westerners put more stock in individual rights; Easterners put more stock in social responsibility," writes Bukhbat (2016).

Researchers, beware. These different value weightings have a significant impact on research generalizability. Henrich et al. (2010, p.6) point out that most Western researchers take their sample data from WEIRD cultures and then inappropriately generalize their findings to represent the world's population. His study suggests "that members of WEIRD societies, including young children, are among the least representative populations one could find for generalizing about humans." Assault on Western Civilization: Critical reasoning vs Marxist illiberal assertions Western countries benefit from the legacy of European culture and have championed liberty, charity, scholarship, and human rights much more than other countries.

Liberal values include Rationalism, that is, the exercise of human reason and critical inquiry; Freedom, that is, the ability to think or act as one wishes under self-determination; and, most notably for this paper, Tolerance, that is, a willingness to accept views or actions that one disagrees or of which one disapproves. In this sense, critical thinking is a liberal value in line with constructive disagreements. In his prescient book Developing Critical Thinkers, Brookfield (2010) writes that critical thinking is a productive and positive activity.

However, these positive values are under attack on campuses that enable and even promote Marxist

illiberalism, that is, restricting freedom of thought, debate, acquisition of information, or behavior. Here are two examples.

Tafarella (2024) writes that the college president of his campus asked for an endorsement of a 12page glossary of terms published by the California Community College system. He notes that this glossary will be used in faculty evaluation, hiring, policy formation, and even course outlines. The glossary defines merit as "a concept that … is embedded in the ideology of Whiteness and upholds race-based structural inequality." The glossary states that Colorblindness "perpetuates existing racial inequality and denies systemic racism." He writes that faculty are expected to go along with this dogma or possibly be culled from their job.

Shay (2021) writes of similar experiences at his university where those using bullhorns prevented the presentation of alternative views. Students are fed the Marxist approach that they are either the oppressed or the oppressor. Brown (2019) writes, "In contrast to the Rational and Context-based approaches, the Critical Approach rejects the idea that citizens owe any obligation to the State. Instead, regarding the State as a tool used by one dominant group—be it economic class or gender—to suppress the majority…" By Critical Approach, Brown does not mean critical thinking, but rather the Marxist ideology of Critical Theory that seeks to liberate people from all forms of oppression. All people are either oppressors or the oppressed with no shades in between.

University students used to be taught how to think, not what to think.

Disinformation as a source of disagreement

Disagreement can arise from disinformation. Marx established the ideas of false consciousness and ideology, which he defined as the interests of one group of people disguising themselves as those of the entire community (Márkus, 1983). Combining false consciousness and ideology can lead to psychological warfare in Post-Truth Times. The term "post-truth" is employed by some to denote "a situation in society and politics, in which the boundary between truth and untruth is erased, facts and related narratives are purposefully produced, emotions are more important than knowledge, and the actors of social or political life do not care for truth, proof and evidence" (Vacura, 2020). A central element of such relies on the fact that emotions significantly impact people's perception more than facts (Hyvärinen & Beck, 2018; Yang et al., 2023).

Disinformation and emotion. Earlier, we saw how Russia produced a fabricated document, The Protocols, to advance its political purposes. Russia pioneered a model of disinformation to gain political influence that is now being replicated by other actors (Africa Center for Strategic Studies, 2022). Fake information is commonly used in warfare to encourage one's forces, discourage the opponent's forces, and gain support from the uninformed masses worldwide. In addition to fake information, emotions are employed as tools of war. In this way, war occurs not only on the physical battlefield but also on the psychological battlefield of public perception. This is called soft power (Murray, 2022; Nye, 1990; "Unpacking the connection", 2023; "What is soft power?", 2023)

For example, recently Hamas, through its health ministry, issued fake casualty figures. See, for example, Bennett (2024), Bermudez (2023, 2024), "Hamas casualty numbers" (2024), Herman (2024), Pletka (2024), Simpson et al. (2024), and Wyner (n.d.).

The importance of this is that the first news story picked up by the news outlets is the one people remember, and news outlets are reluctant to contradict their own stories later (R. Stern, personal communication, May 19, 2024).

Fake Images create disinformation. Today, AI and social media technology enable the rapid dissemination of falsehoods through various channels and the effortless creation of untrue documents and fake images. In the past it took substantial resources to create fake images (Landes, 2023). Now all it takes is a child with a social media account (Mims, 2023)

For example, see the fake pictures shown in Figure 2.

Figure 2. Fake images created via artificial intelligence are promulgated in the media.

REDEFINING WORDS

Disagreements can occur when words take on new, even contrary meanings. Mark Twain is attributed with saying "the difference between the almost right word and the right word is really a large matter – it's the difference between the lightning bug and the lightning." Over centuries, words can naturally evolve and change meaning. This is known as semantic shift, semantic progression, semantic development, or semantic drift. For example, the original meaning of "awful" was "inspiring wonder (or fear)," but now it means "extremely bad".

In modern times we find that word-meanings have been deliberately changed for political purposes. This misdirection of meaning was predicted by George Orwell (1949) who wrote in his book 1984, that the leaders changed the meaning of words, made everyone question what was true, continuously rewrote history, and punished people who disagreed. In the book 1984, Syme says to Winston, "Don't you see that the whole aim of Newspeak is to narrow the range of thought?" (Orwell, 1949, p. 48) In recent times, some words have been redefined to advance political purposes. Genocide, ethnic cleansing, occupation, refugee, proportionality, colonialism, apartheid, Nakba, and racism are examples of today's Newspeak. See, for example, Herf (2023), Mor (2024), Rivkin and Casey (2024), and Sawwan (2024).

MAJOR PLAYERS IN SOWING DISINFORMATION

Various actors have been named as sowing disinformation for the purpose of de-unifying those advancing Western values. They are Russia, China, and Islamists. The term Islamist was created to differentiate followers of Islam from the parties within Islam who reject Western values and aim to create a global caliphate.

CHINA

China has been accused by various countries and organizations of engaging in disinformation campaigns to shape public opinion and advance its interests. These campaigns often involve spreading false or misleading information through social media platforms and other online channels. For example, according to reports published in the Wall Street Journal, "The Chinese government is pouring billions of

dollars annually into a global campaign of disinformation, using investments abroad and an array of tactics to promote Beijing's geopolitical aims and squelch criticism of its policies, according to a new State Department assessment" (Volz & Gordon, 2023).

China uses fake authors, bot armies and lawsuits as some of its tactics Microsoft discovered that China was among the first to use generative AI for its state-sponsored online influence operation against foreign voters. (Volz, 2024; Volz & Gordon, 2023). It has been alleged that "the CCP [Chinese Communist Party] is remotely infiltrating U.S. society through pro-communist organizations in the West to achieve its insidious intent of disrupting American society" (Su, 2024; See also Network Contagion Research Institute, n.d.).

RUSSIA

As mentioned above, Russia has used disinformation for more than a century for its political advantage. Bugayova et al. (2024) provides details on its methods and strategy. In addition to use its disinformation channels to interfere in elections, it uses it against the West to promote a crisis in Israel and Gaza (Cohen & Boyd, 2019; Shamrai, 2023).

HAMAS

Kaplan (2024) explores the techniques used by Hamas for their successful media campaign that "has turned mainstream media, policymakers … into spokespeople and campaigners for an Islamist terror agenda." In a post-truth world that they create, for example on campuses, they use simple and simplistic slogans. They master control of the media and its 24-hour news cycle to get its message out first. For example, even before any facts were known, news outlets quoted their assertions as facts that an Israeli missile hit a hospital and killed 500. Since the hospital has only 300 beds, this should have been immediately suspect. It turns out that a terror group's missile misfired, killing 50 on the hospitals parking lot.

Finding Truth

Common truths are a lie can travel halfway around the world while the truth is still putting on its shoes, and once fake news rings its bell, it cannot be unrung (Vosoughi et al., 2018). In this context, the first incident report of an event is the one remembered, and Hamas's strategy of providing reporters with fake news reports has proven to be highly effective. See, for example, an Honest Reporting article by Lax (2024). R. Stern (personal communication, May 19, 2024) also made this observation.

SUMMARY

We saw above how values and biases affect one's understanding of situations and the lack of general agreement. Disagreements can arise due to differences in people's experiences, perspectives, and realities. But values cannot explain disagreements based on false beliefs. Disagreements are a part of life. Even historians often have conflicting viewpoints about historical events, leading to debates about what should be remembered and taught. These differences can lead to constructive or destructive disagreements.

Constructive disagreements are characterized by respectful debate, a desire to learn from the other side, and openness to understanding different viewpoints. In contrast, destructive disagreements involve ad hominem attacks, a lack of interest in learning from others, and a failure to listen to different perspectives.

Beliefs, values, and biases contribute to disagreements. Confirmatory Bias, the tendency to process information in a way that supports existing beliefs, can lead to the exclusion of relevant sources of information and the reinforcement of one's beliefs. This bias can be exacerbated when it affects mainstream media, creating an epistemic filter bubble by involving various biases, such as reporter bias, editor bias, headline editor bias, and image size and placement.

Cultural values can also lead to disagreements, particularly in ethical decision-making. For example, the value of meritocracy may conflict with the value of inclusivity, leading to tension among ethical decision-makers seeking truth. Constructive decision-making involves leaving room for others' perspectives and values, even when one is confident about one's decision-making process. Haidt's Moral Foundations Theory suggests that people share common themes of morality across cultures, but their relative value differs. Western societies tend to prioritize individual rights, while

Eastern societies prioritize social responsibility.

Researchers must be aware of the impact of different value weightings on research generalizability. Most Western researchers take their sample data from WEIRD cultures and inappropriately generalize their findings as representative of the world's population. Western countries have championed liberty, charity, scholarship, and human rights more than other countries. Liberal values like rationalism, freedom, and tolerance align with constructive disagreements. However, these positive values are under attack on campuses that enable and promote Marxist illiberalism, which restricts freedom of thought, debate, acquisition of information, or behavior.

Values cannot explain disagreements based on false beliefs. Marx established the ideas of false consciousness and ideology, which can be used to impose false beliefs on others. Disinformation and emotions are commonly used in warfare to gain political influence and demoralize opponents. Fake images, documents, and news can be easily created and disseminated through various channels, leading to misconceptions and stereotypes about foreign countries.

The media possess soft power and should be diligent in their reporting to avoid spreading disinformation and contributing to negative stereotypes about foreign countries. Falsehoods in the news diffuse farther, faster, deeper, and more broadly than the truth, leading to misconceptions and potential economic or diplomatic consequences.

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AUTHOR

Eli Cohen founded and serves as the Executive Director of the Informing Science Institute, Senior Editor-in-Chief of Informing Science: The International Journal of an Emerging Transdiscipline, and Editor-in-Chief of the journal Issues in Informing Science and Information Technology. He has a background in psychology, statistics, business, and cat tending. He retired from Kozminski University.

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INFORMATION TECHNOLOGY AND THE COMPLEXITY CYCLE

Thomas R. Gill, T. Grandon Gill *
University of South Florida, Tampa, Florida, USA
University of South Florida, Tampa, Florida, USA

ABSTRACT

Aim/Purpose : *In this paper we propose a framework identifying many of the unintended consequences of information technology and posit that the increased complexity brought about by IT is a proximate cause for these negative effects.*

Background : *Builds upon the three-world model that has been evolving within the informing science transdiscipline.*

Methodology : *We separate complexity into three categories: experienced complexity, intrinsic complexity, and extrinsic complexity. all three forms can lead to unintended consequences at the individual, task and system levels. Examples of these consequences are discussed at the individual level (e.g., deskilling, barriers to advancement), the task level (e.g., perpetuation of past practices), as well as broader consequences that may result from the need to function in an environment that is more extrinsically complex (e.g., erosion of predictable causality, shortened time horizons, inequality, tribalism).*

We conclude by reflecting on the implications of attempting to manage or limit increases of complexity. Contribution : Shows how many unintended consequences of IT could be attributed to growing complexity

Findings : *We find that these three forms of complexity feed into one another resulting in a positive feedback loop that we term the Complexity Cycle. As examples, we analyze ChatGPT, blockchain and quantum computing, through the lens of the complexity cycle, speculating how experienced complexity can lead to greater intrinsic complexity in task performance through the incorporation of IT which, in turn, increases the extrinsic complexity of the economic/technological environment.*

Recommendations *for Practitioners Recommendations for Researchers Consider treating increasing task complexity as an externality that should be considered as new systems are developed and deployed. Provides opportunities for empirical investigation of the proposed model.*

Impact on Society Systemic risks of complexity are proposed along with some proposals regarding how they might be addressed.

Future Research : *Empirical investigation of the proposed model and the degree to which cognitive changes created by the proposed complexity cycle are necessarily problematic.*

Keywords complexity, task complexity, information technology, homophily, punctuated equilibrium, systemic risks, information overload, fitness, rugged landscape, unintended consequences

INTRODUCTION

Where would we be without information technology? IT has become exponentially more powerful and elaborate over the last fifty years, yielding countless benefits, and allowing us to attain a level of efficiency vis-à-vis space, time, and effort hitherto inconceivable. IT has also provided us with more options and forms of recreation and socializing. It has given society the ability to better respond to

events—the ability to work and learn from home during the COVID-19 pandemic being a recent example.

Despite its myriad benefits, there has also been increasing recognition of many possible unintended consequences of the ubiquitous presence and use of IT. For example, using machine learning algorithms, AI can detect the characteristics associated with successful hires far more efficiently than a human ever could. Unfortunately, these algorithms can be equally efficient in replicating the prejudices and unconscious biases of past human performers (O'Neil, 2016).

Numerous other examples of unanticipated negative consequences of IT exist, across a wide spectrum of effects. The list includes job deskilling (Braverman, 1998; Faik et al., 2020), loss of privacy (Clarke, 2016; Meingast et al., 2006), anxiety/unhappiness (Bawden & Robinson, 2009; Salo et al., 2022), vulnerability (Nawir et al., 2016), dependency (Shu et al., 2011), inactivity/obesity (Fotheringham et al., 2000), loss of competency (Braverman, 1998), and both inequality (e.g., the digital divide;

Aanestad et al., 2021; Autor et al., 1998), and perceived inequality (Turel, 2021). The sheer diversity of these examples raises this question: are the negative effects of IT largely independent or are they related? In this paper, we propose a conceptual scheme called the "complexity cycle," arguing that many of these effects have a common thread. The scheme, based on three distinct forms of task complexity, argues that the introduction of IT frequently leads to changes at the local (individual task) level that contribute to changing broader system levels (e.g., the economic environment) that eventually feed back to the local level and motivate further changes.

We begin by presenting a broad definition of what constitutes a task. We then describe three forms of task complexity – experienced complexity, intrinsic complexity, and extrinsic complexity – drawing from both complexity theory and IS research pertaining to complexity. We next consider how the three forms of complexity interact with each other. The result is a hypothetical positive feedback loop that we refer to as the complexity cycle.

Using the complexity cycle as our conceptual framework, we then consider some examples of how different information technologies might act upon the cycle. The specific technologies we consider are ChatGPT (standing in for generative AI as a whole), blockchain, and quantum computing. We argue that the first two can impact the cycle incrementally, whereas the last of these could lead to a discontinuous change in the economic/technology environment though its potential impact on privacy and security.

Based on the predicted behavior of the cycle, we then consider a variety of unintended consequences that could result from the ongoing changes produced by the proposed complexity cycle. Potential consequences are proposed at the individual level (e.g., deskilling, barriers to advancement), the task level (e.g., perpetuation of past practices), the broad system level (e.g., erosion of predictable causality, shortened time horizons, inequality, tribalism). We then discuss how this proposed conceptual scheme might allow us to better anticipate and manage the challenges of task changes accompanying the introduction of IT and the potential implications for informing science.

REVIEW OF RESEARCH

In this section, we review relevant elements of task complexity theory that are the foundation of the ideas presented in this paper.

We conclude the section by considering research that specifically deals with task complexity's relationship to information systems.

TASK COMPLEXITY THEORY

Before beginning this review, we acknowledge that many meanings have been proposed for the "task complexity" construct (Hærem et al., 2015), and the more general concept of "complexity" has been applied to individual thinking in many ways, including "complex thinking", "complexity thinking" and "complex systems thinking" (Teixeira de Melo et al., 2020, p. 167). For our purposes, however, we will employ a lens that considers task complexity in three ways: as it is experienced by an individual task performer (experienced complexity), as it describes the requirements and activities of the task in symbolic terms (intrinsic complexity), and as it characterizes the structure and behavior of the environment in which the task is performed (extrinsic complexity).

What is a task?

To understand task complexity, we must have a working definition of what constitutes a task. For the purposes of this paper, we define a task as having three elements: 1) a set of allowable starting points, 2) a set of acceptable ending points, and 3) a set of rules that specify or limit how the performer can transition from start to finish. This definition, adapted from research related to the informing task (Gill & Mullarkey, 2017), allows most intentional activities to be characterized as tasks. It is also agnostic with respect to how the task is performed—provided such performance is consistent with the specified rules, which may either be very specific (e.g., tasks offering little or no discretion) or which offer little or no guidance on how to achieve an end state. For example, individuals might meet the requirements of the task of "playing a game of chess" regardless of whether they win or lose the game. On the other hand, were those same individuals to cheat (i.e., violate the rules) during the game, then they would not have performed the task.

Having flexibility in defining a task is critical to unwinding the ambiguity of what is meant by task complexity—an ambiguity that has been widely observed (e.g., Campbell, 1988; Hærem et al., 2015). One way to resolve this ambiguity is to recognize that the task complexity construct has been used to describe tasks at three different levels: in terms of its effects on the individual (experienced complex ity), in terms of the objective properties of the task itself (intrinsic complexity), and in terms of how the task interacts with the environment (extrinsic complexity; Gill & Mullarkey, 2017). Each of these levels is related; nevertheless each requires us to think about a task in a different way.

Experienced complexity

The first type of complexity, experienced complexity, takes place within the mind of the task performer. Originally described by Campbell (1988), it is largely subjective in nature. Its presence is signified by feelings experienced by the task performer, most commonly difficulty (O'Donnell et al., 2005), uncertainty (Te'eni, 1989), and/or ambiguity (Oedzes et al., 2019). Of the three forms of task complexity, experienced complexity alone exists solely in the mind of the task performer. It can be viewed primarily as a function natural mental limitations vis-à-vis memory and processing capability, such as the long-known limits on short term memory capacity (e.g., Miller, 1956) and the mechanisms we have for overcoming these limits, such as chunking and the gradual process through which complex sequences of cognitive activities become automatic (Shiffrin & Dumais, 1981). Because a task's experienced complexity can range from negligible to impossibly hard—depending on the individual's familiarity and practice (e.g., the task of playing a piano sonata)—the experienced complexity of a task is best applied to a single task instance, fixed with respect to a particular performer and a particular point in time.

The level of experienced complexity can also exert a profound effect on the effectiveness of task performance. To achieve optimal performance, the cognitive demands of a task are best kept within a range above the levels that lead to boredom and below the levels resulting in information overload. The relationship between performance and cognitive demands has been described as the inverted U curve (Streufert & Streufert, 1978), signifying the sharp drop off when cognitive demands either fall below the desirable range or overload the performer's cognitive capacity. More recently, occupying this peak performance range has been referred to as achieving flow (Csikszentmihalyi et al., 2014), or being "in the zone" (Payne et al., 2011).

Because experienced complexity is influenced by naturally occurring human cognitive limits, the optimal range is unlikely to change dramatically over time. Nevertheless, as previously noted, repetitive practice of a task can reduce its demands. Alternatively, the individual may be able avoid uncomfortably high cognitive demands by transferring some or all parts of a task to other performers. These may be individuals or, potentially, constructed systems—most commonly IT-based.

Intrinsic complexity

The second type of complexity, intrinsic complexity, can be determined from the symbolic representation of the task, sometimes referred to as the problem space (Card et al., 1983). This form of task complexity bears some similarity to Wood's (1986) view of complexity and Campbell's objective complexity (1988) but differs in two important respects:

1. Being determined by the problem space used to perform the task rather than the task itself, intrinsic complexity may differ across task performers if they apply different problem spaces. For example, the intrinsic complexity of selecting elements of a stock portfolio may differ substantially if one performer uses a spreadsheet and another uses a Ouija board. (Naturally, one may choose to define the task such that the latter does not meet the criteria of the task rules).

2. By specifying that intrinsic complexity is based upon the symbolic representation of the problem space, it becomes possible to view it as extending across multiple performers, including non-human (e.g., IT-based) symbol manipulation systems. For example, Hærem et al. (2015) used North Sea counterterrorism to illustrate how the complexity of a task involving many human and non-human components might be modeled.

Because intrinsic complexity is determined by the underlying nature of the problem space, it can be treated as objective. There is, however, no clear consensus regarding whether task complexity should be viewed as a single value or as a collection of values. Campbell (1988) proposes four dimensions, Wood (1986) proposes three dimensions (but proposes that they can be added to form a "total complexity"). Hærem et al. (2015) reject the notion of different types of task complexity, arguing that they are really antecedents of a single underlying construct of task complexity, which they view as a function of the nodes and linkages within a task network. Whether or not a single underlying task complexity construct exists, we believe the consequences of intrinsic complexity (however it is operationalized) are likely to correlate with:

- The size of a computer program capable of fully simulating the problem space.
- The amount of time it would take to learn to perform the task according to the specified problem space.
- The size of a complete description of the problem space.

Another good indicator of intrinsic complexity is the amount of memory and computational power it takes to complete a task. In this regard, the game of chess would involve a problem space that is more intrinsically complex than the game of checkers. The evidence for this could include the fact that computers mastered checkers in the 60s but didn't master chess until the 90s. However, an unsophisticated problem space for playing chess might well prove to be smaller than the problem space needed to play master-level checkers. With respect to a task's scope, it is best defined with respect to the set of task instances that can be completed using the problem space for which it has been evaluated.

Under intrinsic complexity, the symbolic representation of the problem space can extend across performers. For example, a skilled U.S. tax accountant might complete a tax return using a set of rules (i.e., problem space) very similar to that incorporated in a tax preparation software application such as TurboTax (in theory, at least). If that were the case, the intrinsic complexity of the tax preparer working independently might be very similar to that of a novice using the software, since the novice's problem space includes access to all the rules embedded in the program.

Extrinsic complexity

Extrinsic complexity captures how the external environment responds to the task. It is the form of task complexity that is least addressed in the task complexity literature. We believe it to be important, however, since it incorporates an aspect of task complexity that goes largely unaddressed by that literature: the quality of task performance. Unlike experienced and intrinsic complexity, it best applied to a very broad set of task instances, as should become clear shortly.

The roots of extrinsic complexity are in complex systems theory, drawing heavily on concepts from evolutionary biology (e.g., Kauffman, 1993). The principal model used is that of a fitness landscape, which provides a functional mapping from the attributes of an entity (which might be a gene, an organism, an individual, an organization) to a fitness value. That value captures the likelihood that the entity will (a) survive, and (b) reproduce. In a low complexity landscape, the attributes of the entity contribute to the fitness value independently. For example, in a multiple-choice test, the attributes might correspond to the individual answers and the fitness might be the resulting test score. Assuming each attribute has a "right" value and is scored independently of the others, the landscape would have a single peak—where the correct answer is specified for every question.

In a high-complexity landscape, the attributes interact with each other to determine fitness; combinations rather than individual values are what matter. Whereas a low complexity landscape will have one optimum fitness point (i.e., a peak), a high complexity landscape will be rugged—i.e., will have many local peaks and sharp drop offs. A cookbook provides a good practical analogy for a rugged fitness landscape. Each recipe in the book could be assigned a fitness value. In this example, fitness would be a predictor of the likelihood that you would be willing to make the recipe again after trying it (i.e., survival) or even copy it to give to a friend (i.e., reproduction). What makes this landscape rugged is that each recipe represents a local fitness peak in the authors' minds. Otherwise, they would write in those incremental changes (e.g., adding a bit more sugar than the original recipe calls for) needed to make it a peak. Thus, the landscape for the cooking task within that one book could consist of (literally) thousands of local peaks (recipes), with countless more peaks across the entire cooking landscape.

The cooking example also illustrates a variety of general complex landscape properties:
• Individual attributes mainly contribute to fitness in combination with other attributes, e.g., the presence of garlic adds to the fitness of some recipes and detracts from others.
• Seemingly insignificant changes to attributes can have a big impact on fitness, e.g., consider what happens when baking powder (the rising agent) is inadvertently left out of a cake recipe.
• Local peaks can exhibit very high levels of variation, e.g., some recipes are very popular while others will barely ever be used.
• Even with an understanding of the mechanisms driving fitness, the fitness of a new, untried combination is nearly impossible to predict without testing it. For example, when IBM used

Watson to develop new recipes the results were far from uniformly successful (Pinel, 2015). Although the fitness landscape concept has been applied to some business tasks, such as strategy formulation (e.g., Levinthal, 1997), it has not been incorporated into prevailing task complexity models. In adapting the fitness landscape concept to task complexity, we can conceive of each task end state (which includes information on how the task was performed) as having a fitness value. If the value is low, we would avoid using that approach in the future. We would also try to avoid contexts where we were forced to use that same approach. Where fitness is high, we would likely use the same approach should a similar task instance ever come up (i.e., the approach would survive). Moreover, other performers watching us may seek to imitate the approach (i.e., reproduction). Because we would expect performance quality to elicit similar reactions, the values of outcome quality and fitness might logically serve as proxies for each other.

Complex landscapes are generally associated with complex systems (such as ecologies). While the underlying factors that lead to complex systems behavior remain the subject of study, three general characteristics are commonly associated with increasing complexity (Gill & Mullarkey, 2017):
• Increase in the number of elements in the system.
• Increase in the number and density of interactions between elements in the systems.
• Increase in the rate at which interactions between elements affect each other.

As landscape complexity grows, we would expect to see the following changes in the landscape's characteristics (Gill & Mullarkey, 2017):
• Increased number of local fitness peaks: Although there can be many positions on the simplest fitness landscape, there are very few peaks and those peaks are relatively easy to find through incremental search. More peaks mean sharper rises and drop-offs and more potential alternatives to choose between.

A landscape with many peaks also increases the risk of ending up on a low fitness peak if incremental search is used.
• Reduced ability to determine meaningful causality: In an environment with low extrinsic complexity, main effects dominate interactions, so it is meaningful to impute causality to specific attributes. As extrinsic complexity increases, it becomes nearly impossible to decompose attributes that contribute to fitness; experimentation or observation of experiments becomes the only way to assess fitness.
• Distributions of fitness become increasingly non-normal: Where fitness is determined by the sum of fitness contributions of individual attributes, fitness values across the landscape are likely to follow a normal distribution. In landscapes of increasing complexity, non-normal distributions (particularly those governed by the power law) abound. In the book The Black Swan, Nassim Nicholas Taleb (2007) gives a hypothetical example of height following a power law, wherein it would be possible to see

individuals whose heights exceed the heights of another thousand individuals combined. Wealth, a plausible proxy for economic fitness, is an example of a value that follows a power law in the real world. For example, the top 1% of U.S. earners are wealthier than the entire middle class combined (Kaplan & Kiersz, 2021).
This would be impossible if wealth followed a normal distribution.
• Punctuated Equilibrium: Extrinsically complex landscapes lend themselves to punctuated equilibrium. This concept was devised by Stephen Jay Gould (Gould & Eldredge, 1972) and entails extended periods of homeostasis followed from time to time by large events that change the entire landscape.

These characteristics make it much more difficult, confusing, and frustrating to navigate an extrinsically complex landscape. While the multitude of peaks can provide huge opportunities, these opportunities are not uniformly distributed. Fitness power laws raise the stakes (compared with normal distributions), as the most successful will occupy a position of fitness that may be one hundred, one thousand, or ten thousand times better than a mediocre position. Extrinsic complexity also adds an element of ambiguity to the results of one's decisions or efforts. Being more difficult to assess causality, it is hard to predict the effect that a decision is going to have on one's fitness overall. The larger number of fitness peaks also has the potential of overwhelming people by presenting them with too many options to choose from.

Summary
The three forms of complexity are summarized in Table 1.

Table 1: The Three Forms of Task Complexity

	Experienced Complexity	Intrinsic Complexity	Extrinsic Complexity
Definition	Complexity experienced based on the cognitive load brought about by a task	Complexity in the symbolic representation of a task (rules and alternatives, processing power, etc.)	Complexity of the landscape of task outcomes vis-à-vis interrelatedness of elements, number of fitness peaks, turbulence of the landscape.
Result of increase	Perceived difficulty, uncertainty, ambiguity	Larger problem space, number of branches, time to learn	Fitness landscape ruggedness, punctuated equilibrium, power laws
Scope of initial and target state sets	Very narrow	Sharing the same problem space	Very broad
Effect of repeated task performance	Decreases	Increases	Indeterminant

COMPLEXITY IN INFORMATION SYSTEMS

The topic of complexity has been researched frequently in the management and IS fields. In this research, complexity is generally categorized as either the complexity of tasks (Campbell, 1988; Wood, 1986), or the complexity of systems (Beese et al., 2016; Liang et al., 2015). Previous research has also

studied the interaction between task complexity and system complexity wherein a co-dependency arises between a task and a system. The user is dependent on the system to complete the task and the system is dependent on the user's knowledge of the system's semantic relationship with the task.

From this co-dependency, representational complexity emerges, presenting an obstacle to effective use of a system (Lauterbach et al., 2020). As it relates to our framework, representational complexity is the intrinsic complexity leftover after users have offloaded some of the intrinsic complexity of a task to a system. The experienced complexity of an individual using the system will decrease as the user becomes accustomed to it.

There has been a recent call for more IS research on digital solutions to the problems brought about by the complexity of digital systems (Benbya et al., 2020). Sociotechnical systems and the complexity thereof result in "wicked" problems that can be tamed but not solved completely (Tanriverdi et al., 2010). Complexity oriented methods have been applied to such wicked problems as Recommender systems (Malgonde et al., 2020).

Incremental changes in digitized processes can bring about bursts of complexity and large changes in structure (Pentland et al., 2020). Research has been conducted as to how to use digital technologies to steer organizations through phase changes from old states to desired new states (Sandberg et al., 2020). Also studied in the IS literature is organizational complexity, or a non-linear interaction between elements in an organization resulting in emergent effects (Park & Mithas, 2020). When causality is difficult to define and causal elements are intertwined, Qualitative Comparative Analysis can be used to glean insights and make predictions without assuming that causal factors are decomposable (Iannacci et al., 2022).

THE PROPOSED THEORY

The use of IT in task performance can potentially impact all three forms of task complexity. We further propose that these three forms of complexity, when enabled by IT, can interact to establish what we call a complexity cycle. This cycle, illustrated in Figure 1, begins when—for whatever reason—the experienced complexity associated with performing task instances (along with anything else happening in parallel) moves performers towards the excessive demand side of the previously mentioned inverted U curve. The performers then have a variety of options to move to a more comfortable level of experienced complexity. These include:

- Practicing the task until it becomes routine.
- Taking shortcuts (e.g., imitating other task performers) to reduce the cognitive demands of the task.
- Finding other performers to share the task with.
- Using IT to offload all or part of the task with performers.

If the last of these options is selected, the intrinsic complexity of the task will likely increase. For example, when individuals employ tax preparation software to complete their income taxes, the software not only performs necessary computations—which would not have much impact on intrinsic complexity—it also provides them with access to a vastly expanded problem space relating to the tax code. While an individual task performer's decision to switch to tax software is not likely to have much impact on the tax preparation fitness landscape, if many performers make this switch, we are likely to see such software evolve quickly, and many new variations emerge. Moreover, if the use of the software becomes widespread, it could impact the agency responsible for collecting taxes and updating the tax

code. The increased flexibility provided by the new systems could then embolden legislators to pass more complicated tax laws, leading to increased intrinsic complexity of the tax preparation task. Furthermore, individual task performers may be impacted by extrinsic complexity increases driven by forces outside of the tax preparation task. For example, the introduction of new asset classes (e.g., bitcoin) may demand changes to the system of tax laws. Because the fitness landscape for one entity co-evolves with fitness landscapes for other entities (Kauffman, 1993), IT-enabled extrinsic complexity from one task landscape can transform other task landscapes. As a result, the behaviors that are associated with complex landscapes (e.g., ruggedness, indeterminant causality, power law outcomes, punctuated equilibrium) can bleed across landscapes. The increasingly turbulent behaviors of the task environment will cause performers to seek out additional help in reducing experienced complexity. If done through use of IT, the cycle continues.

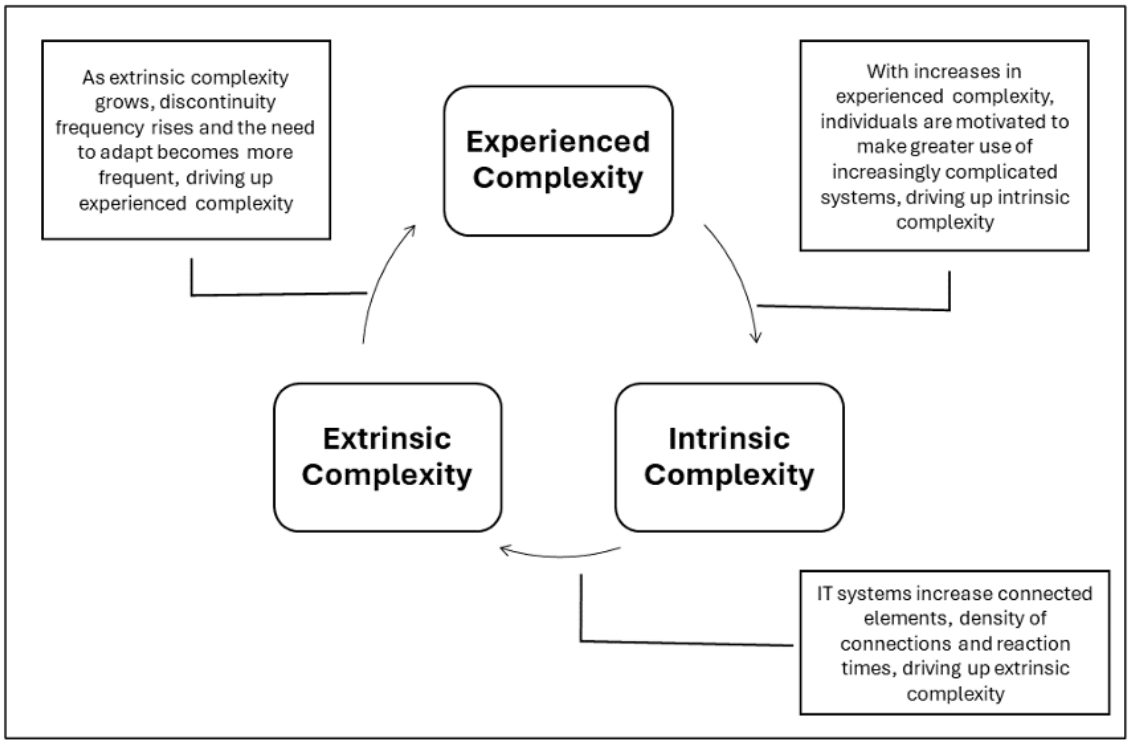

Figure 1: The IT-driven complexity cycle

APPLICATION OF THE THEORY: CHATGPT AND OTHER EXAMPLES

In this section, we briefly explore how the Complexity Cycle might be used to identify potential unintended consequences of widespread adoption of emerging technologies. We begin by looking at ChatGPT, then briefly consider blockchain and quantum computing.

CHATGPT

A recent example that illustrates the how the complexity cycle may be applied can be found in the recent (December 2022) public release of OpenAI's advanced chatbot: ChatGPT. The application employs advanced language modeling based on user prompts and a large language model and exemplifies many of the capabilities of generative AI. The tool uses reinforcement learning from human feedback, wherein the actions taken by ChatGPT in the form of language output are rated by users, allowing the platform to learn from every attempt to respond to a prompt (Ramponi, 2022).

ChatGPT has been applied to accomplish a variety of tasks such as college essay writing (Mitchell, 2022), medical writing (Biswas, 2023), and journalistic writing (Longoni et al., 2022). It can explain complex concepts and has even managed to pass a Wharton MBA exam (Rosenblatt, 2023).

Looking at the tool from a task perspective, consider the example of ChatGPT's success at essay writing through the lens of the complexity cycle. At a university in South Carolina, a student submitted a 500-word essay on David Hume's paradox of horror (Mitchell, 2022). The essay was of such a quality that the professor was unable to prove that it was not the student's own writing, except by goading the student into confessing. It is worth noting that the decision to use ChatGPT to write this essay on Hume represents a decrease in experienced complexity, but an increase in intrinsic complexity—both drastic. Experienced complexity is decreased because the student no longer had to craft a 500-word essay on Hume, but rather a one to two sentence prompt to feed ChatGPT. Intrinsic complexity increased since the problem space of the task grew given that it was drawing upon the entire base of knowledge contained in ChatGPT.

Just as the problem space of the essay writing task was increased, the problem space of many other tasks has been increased by way of the offloading of these tasks to ChatGPT. By early February of 2023, ChatGPT was well on its way to surpassing 100 million users (Garfinkle, 2023). Stated another way, that corresponds to 100 million users all employing essentially the same problem space for a wide variety of tasks. We might then speculate that if millions of individuals addressing a similar problem all come up with similar solutions (by virtue of using the same problem space) much more rapidly than in the past, the fitness of these solutions is bound to be impacted—leading to a rapidly changing fitness landscape. This would translate to an increase in extrinsic complexity facing the performers. Closing the loop, we might further speculate that the increasingly dynamic fitness landscape driven by generative AI would, in turn, lead to increases in experienced complexity. These increases would, in turn, motivate further offloading of task activities to AI tools. And so, the cycle would continue.

BLOCKCHAIN

While exploring the mechanics of blockchain technology is beyond the scope of our paper, the key feature of blockchain is to provide a means of recording transactions that:

- Cannot be altered once a transaction is recorded
- Can be audited
- Can be conditioned on the completion of other transactions.

Collectively, these three capabilities represent activities that would often require an intermediary, such as a lawyer or agent. In consequence, a key systemic change expected to occur with blockchain's increasing adoption is widespread disintermediation (e.g., Srikanth, 2017). Viewed in terms of the extrinsic complexity of the environment, widespread disintermediation might
be expected to exert a significant impact. In the current environment, intermediaries play an important role in controlling the speed and frequency of transactions. For example, intermediaries can determine the speed at which funds are transferred between accounts or the timing of a real estate closing. Once disintermediated, these transactions could occur much faster and at lower cost—encouraging a greater frequency of smaller transactions. Both of these systemic changes would typically increase the extrinsic complexity of the environment according to our model. With increasing extrinsic complexity, individuals participating in the system—particularly those operating as intermediaries or depending on intermediaries--would experience increasing cognitive demands. In response, they would be motivated

to implement additional blockchain and other technologies, driving further increases in extrinsic complexity, and so forth.

QUANTUM COMPUTING

Quantum computing refers to a class of computing technologies that employ principles of quantum mechanics, such as superposition and entanglement. Reliance on these principles cause it to differ radically in architecture and capabilities from today's ubiquitous digital technologies. For this reason, quantum technologies are expected to offer huge advantages for certain types of computing problems, while providing little or no benefit for others (Inglesant et al., 2021). Because quantum phenomena include the ability to occupy many states simultaneously, the technology is expected to revolutionize tasks that can benefit from pursuing multiple threads simultaneously.

Examples of such tasks include encryption, optimization, and simulation. Quantum computers may also support certain problems that are "beyond the capability of any classical computer" (Inglesant et al., 2021, p. 1368).

The practical applications of quantum computing remain uncertain at the present time. Its radical architecture and anticipated capabilities suggest, however, that its impact on the global economic environment could be transformative. For example, quantum computing has the potential to render existing encryption algorithms ineffective (Inglesant et al., 2021). Should this happen, virtually every information system where privacy or security is important would need to be redesigned. We speculate that such a development could lead to a discontinuity in our technology environment unparalleled in digital history.

In our two earlier examples, ChatGPT and blockchain, we described a process whereby increasing use of technologies gradually causes the extrinsic complexity of the economic and technology environment to grow. Such growth would be expected to increase characteristic complex system behaviors, such as punctuated equilibrium. Quantum computing, in contrast, illustrates a potential scenario whereby the technologies themselves precipitate a massive discontinuity in the economic environment. In all three examples, however, human participants in the system would be expected to react by relying more heavily on technologies to reduce their experienced complexity. And the cycle continues.

UNINTENDED CONSEQUENCES OF COMPLEXITY CYCLE

Information technology has yielded many benefits to society at large. These include increased productivity, greater ease of access to information, a wider variety of opportunities for recreation, and enhanced capabilities for social interaction. Nevertheless, the complexity cycle model posits that these may come with long-term hidden costs. For our purposes, it is useful to distinguish between the costs that are:

- directly related to the individual performers
- likely to impact the performance of the task, and
- more systemic in nature and are expected to occur only with the widespread deployment of the technologies in question.

INDIVIDUAL PERFORMER RISKS

Deskilling: When IT is used to reduce the experienced complexity associated with a task, the skills that are transferred are likely to atrophy. In the era of intelligent systems, more and more decision-making

elements of the task are likely to be transferred, often using data analytics and artificial intelligence as a replacement for domain expertise (Sambasivan & Veeraraghavan, 2022). That will leave performers with a reduced skill set and, most likely, reduced adaptability to future task changes.

Barriers to advancement: Increasing reliance on IT in performing tasks can potentially create barriers to further advancement in an organization in two ways. The first is a direct consequence of deskilling, which can increase the gap between what the individual learns on the job and what needs to be known to move to the next organizational level. The second is that jobs will be redesigned to demand technical skills, such as the ability to use AI effectively, that existing intermediate-level workers may not possess (Shiohira, 2021, p. 14).

TASK-SPECIFIC RISKS

Perpetuation of Past Practices: As IT is applied to more intrinsically complex tasks, the ability of develop ers and task performers to articulate the rules governing system behavior is impaired. Machine learning and other AI techniques address this problem by inferring relationships from past data. Historical bias and population bias, for example, can both lead to discriminatory results when data is used to train machine learning systems (Mehrabi et al., 2021). These relationships are often not in the form of understandable rules but are instead embedded in opaque statistical relationships and coefficient weights. If such data incorporated biases from past decision-makers, such biases will likely be perpetuated undetected.

SYSTEMIC RISKS

The co-evolution of landscapes means that even if a task doesn't experience the risks just described, it may still be impacted by the growing extrinsic complexity of its environment. Examples include the following.

Erosion of Explainable Causality: What constitutes causality remains a topic of debate, even within the IS field (Markus & Rowe, 2018). It is commonly framed as a one-way relationship between a set of factors (the cause) and a set of outcomes (the effect). While causality seems likely to exist regardless of the extrinsic complexity of the system in which a phenomenon is observed, our ability to articulate that causality is likely to decline as its complexity grows. For example, what causes one recipe to "taste better" than another?

The interconnectedness and interactions between elements that characterize extrinsic complexity make it very difficult to predict the ceteris paribus effect of an incremental change to a task on its overall fitness. Owing to the high level of interaction between attributes as complexity grows, simple statistical tools such as linear regression fail when observed data is drawn from a rugged landscape (Gill, 2012). Individuals operating on such landscapes will also find that the fitness associated with untested combinations is nearly impossible to predict.

Shortened Time Horizons: The interconnectedness enabled by IT can cause changes in one part of the task environment to ripple through all parts of the task environment and bleed into other task environments. Responses to changes from systems and agents tend to become much faster as information is exchanged in nanoseconds. This can shorten the periods of homeostasis between system changing events characterized by punctuated equilibrium. In addition, since its very inception, IT has been able to process quantitative data faster and more accurately than humans. Unfortunately, we could find no research that specifically addressed the impact IT use on individual time horizons. This absence

may not be surprising, as even futurists have trouble clarifying the concept (e.g., Brier, 2005). That research does point out, however, that complexity has a significant impact on how far ahead we can visualize (p. 844). It follows that as IT increases the rate at which changes can proliferate though an environment, the time frame over which we can comfortably envision the consequences of our actions will shorten.

Owing to the punctuated equilibrium behavior observed in many extrinsically complex systems, including business environments (Gersick, 1991), we can also predict that increasing extrinsic complexity could lead towards short-term bias. The rationale is as follows. Discontinuities are perceived as being unpredictable, both in timing and effect (Taleb, 2007). We would expect analysis of the shortterm future (i.e., before the environment experiences a major transition) to be more effective at reducing uncertainty than analysis of the long term (given the unpredictability of discontinuities). We would therefore expect that increasingly relying on IT to analyze decisions (as a means of controlling experienced complexity) would make us more confident of our analysis of short-term solutions compared to long term solutions. Since decision theory assumes that the level of uncertainty is negatively factored into our choices, applying an approach that reduces the uncertainty of the short-term options while having minimal impact on longer term options would be expected to drive our preference towards the more certain (short term) choices, all other things being equal.

Inequality: The direct implications of IT on inequality—through differentials in access and differentials in skills—have long been discussed (Hargittai et al., 2019). The increasing use of IT in tasks and the resultant incorporation of tech elements into these systems certainly would tend to exacerbate this form of inequality. Furthermore, although deskilling directly impacts task performers, reducing their potential economic value in the long run, it also supports the creation of a parallel (and likely much smaller) set of task performers—the creators of the technologies used to support the task. That set of individuals must necessarily become more and more skilled as they take on tasks demanding problem spaces of ever-increasing intrinsic complexity.

The potential consequences for inequality of IT's impact on the extrinsic complexity of the environment is less recognized. There is considerable empirical evidence that extrinsically complex systems produce non-normal distributions of outcomes, frequently in the form of power laws (e.g., Taleb, 2007). The result: highly visible inequality. While this effect has not been directly addressed, a selfreinforcing cycle leading to inequality driven by IT (Ragnedda et al., 2022) and inequality driven by structural changes that were enabled by IT (Bauer, 2016), such as complex supply chains, have been proposed. Both these proposed effects would be consistent with growing extrinsic complexity.

Tribalism: The use of IT is not the only way to reduce experienced complexity. In an extrinsically complex environment, we have already noted that causality is very hard to determine, so analysis may well fail in the search for fitness. An alternative is to seek out individuals or practices that appear to be high-fitness and imitate them as closely as possible. In fact, simulations suggest that such imitation may be an excellent approach to achieving high fitness as extrinsic complexity grows (Gill, 2012). In highly rugged landscapes, however, even small differences in attributes can have a large impact on fitness (Gill & Mullarkey, 2017). It can therefore benefit the individual to seek out other individuals who are as similar as possible across relevant attributes. By observing how the landscape rewards and punishes the behaviors of these self-similar individuals, it becomes possible for the decision-maker to avoid the risk of engaging in behaviors that could result in serious fitness declines. Moreover, as landscapes become

become more extrinsically complex, the risk of large fitness declines accompanying small changes grows. The logical consequence of dealing with such landscapes is for self-similar individuals to form into groups, an outcome referred to as homophily (Gill, 2012). For such a group to be effective in overcoming ruggedness, all members would need to share a common set of core attributes (e.g., personal characteristics, opinions, values) that define the group while allowing variation in noncore attributes as a means of testing other combinations for fitness. Individuals could be members of several of these groups, but the core attributes would necessarily be different across groups. For example, the core attributes for a group of individuals based around performing the same task might be quite different from the attributes associated with membership of a weekly book club.

In addition to increasing the ruggedness of the landscape—thereby motivating the formation of these groups—IT also helps to enable their formation and ongoing activities. The second stage of the internet era, sometimes referred to as Internet 2.0, included the formation of social networks, making it easier to:

- Form homophilic groups untethered by geography.
- Share experiences with other group members.
- Reinforce activities that support group identity and castigate those that are inconsistent with the group's defining core attributes.

A potential consequence of these networks—perhaps unintended, perhaps not—is the formation of echo chambers (Kitchens et al., 2020). In these environments, expressions of support for core attributes are naturally encouraged. Variations across non-core attributes will similarly be encouraged, since they provide evidence for the fitness or non-fitness of untested combinations that will likely be relevant to the rest of the group. The underlying structure of rugged fitness landscapes also suggests that with growing extrinsic complexity, members of dissimilar groups will become increasingly resistant to compromise. On a rugged landscape, the area between two adjacent peaks is necessarily a low fitness valley. This can lead to an underlying hostility between groups that can best be described as tribalism, a term that has been used to describe the subreddit communities on the reddit platform (Robards, 2018). Unfortunately, the very erosion of causality that accompanies increased extrinsic complexity makes it unlikely that logical arguments or appeals to causality will have much effect in swaying opinions.

IMPLICATIONS FOR INFORMING SCIENCE

The proposed complexity cycle (and the associated specific/systemic) risks could have significant implications for how we can inform effectively—the core of informing science: The fields that comprise the discipline of Informing Science provide their clientele with information in a form, format, and schedule that maximizes its effectiveness. (Cohen, 1999, p. 215).

In this section we first consider the informing challenge presented by the proposed complexity cycle and then consider the paradoxical problem of trying to address that challenge using IT.

THE INFORMING CHALLENGE OF COMPLEXITY

The study of complexity and its impact on informing has been a recurring theme in the informing science transdiscipline. For example, a single client resonance model, shown in Figure 2, has been proposed to illustrate the challenges of ensuring that a client accurately receives and internalizes a sender's message. Rather than being thought of as a theory, it is best viewed as a conceptual scheme (Gill, 2011) for thinking about how messages are internalized by a client. Of particular importance, rather than assuming that a sender's messages are faithfully received, it highlights the potential for communications to fail owing to lack of attention, distortion/interference, and outright rejection.

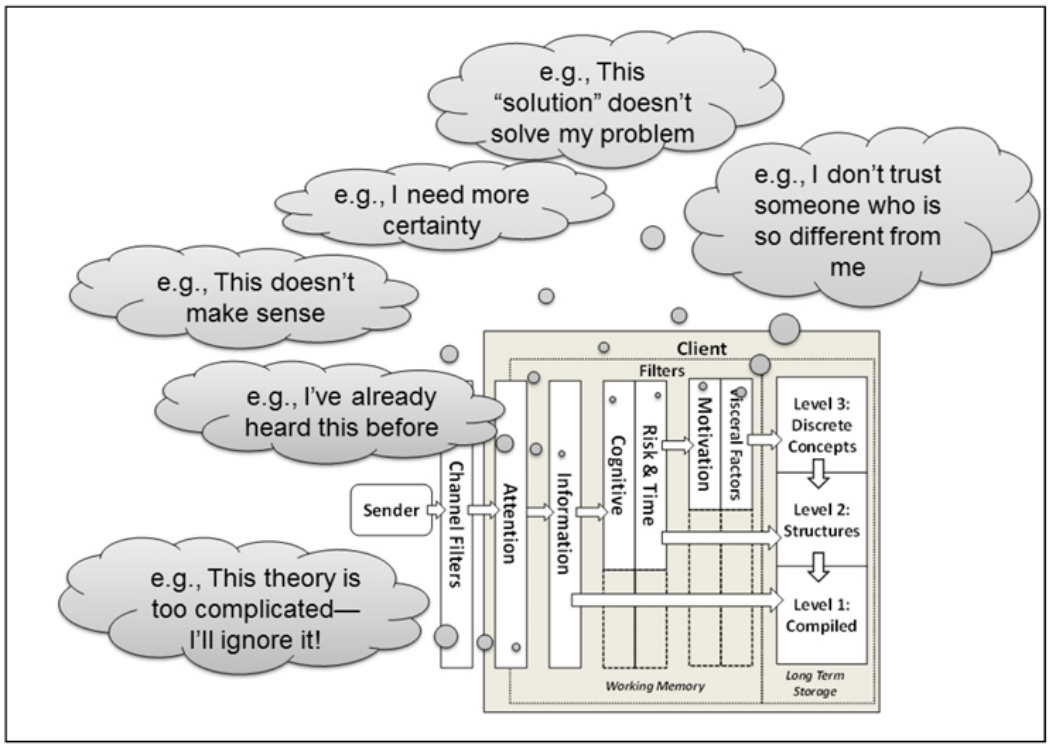

Figure 2: Single Client Resonance Model (Gill, 2015, p. 268)

The attention filter is used to describe situations when clients ignore messages sent to them. Attention may be withheld either intentionally (e.g., by focusing attention elsewhere) or unintentionally (e.g., by not attending to the channel used to send the message). It can serve to reduce experienced complexity by limiting the client's information processing load.

The potential role that increasing IT-driven complexity can play with respect to attention should be self-evident. IT has enabled numerous channels that could not have otherwise existed: email, text, social networks, communication apps, etc. The result is not only more channels than we can attend, but also more content than we can possibly absorb. Deskilling may also prevent clients from attending to messages that they perceive to fall outside of their domain of understanding.

The information, cognitive and risk/time filters can subject messages to distortion or interference as well as preventing messages from being absorbed. The challenge here is that incoming messages do not exist in a vacuum. Instead, they are interpreted subject to what we already know or believe. The information filter screens out information that we perceive that we already know—whether that is the case or not—and limits the rate of information transfer. The cognitive filters assess the consistency of the message with our existing beliefs, in some cases distorting it to achieve greater consistency or blocking it altogether. Not only do these filters potentially impact experienced complexity through reducing the amount of information being processed, they can also reduce the difficulty, uncertainty and ambiguity that can stem from conflicting information.

With respect to the impact of systemic risks, the erosion of explainable causality makes it harder to present simple explanations. That, in turn, is likely to make pre-existing knowledge harder to disrupt (the cognitive filter) and to make it more likely that we will treat an incoming message as something we already know (the information filter). A similar argument can be made for the effect of perpetuation of

past practices. Shorter time horizons, resulting from increasing extrinsic complexity, are likely to encourage us to focus mainly on the immediate consequences of a message. Long-term implications are therefore more likely to be ignored. The motivation/visceral factors filters can lead to rejection of messages regardless of their veracity. If we do not trust the source of the message, or if accepting a message as true might threaten our position in the community, we will tend to reject it. A similar rejection is likely if a message generates negative emotions. By the same token, a client may be motivated to suspend critical judgment of a message from a trusted source or one consisting of content that the client wants to hear.

The most obvious systemic risk for these filters is tribalism, which is built around a common set of shared core beliefs. Polarization of political beliefs could be used as an example of this phenomenon. In a world of high extrinsic complexity, assessing the veracity of a message through logical analysis may be impossible (i.e., erosion of explainable causality). In such cases, reinforcing tribal membership though achieving consistency with core beliefs may be the operative motivation in accepting or rejecting a message.

THE PARADOX OF ADDRESSING COMPLEXITY'S INFORMING CHALLENGES

We do not foresee any all-purpose solution to addressing complexity's informing challenges. Nevertheless, if we choose to attack the challenges directly, it is relatively easy to propose potential approaches—nearly all of which involve information technology. For example:

• AI systems could be constructed that attend all channels and provide clients with all information that they perceive would be relevant to the client. Such curation systems could work collaboratively with the attention filter.

• Creating multi-sensory channels that take advantage of our ability to absorb content more rapidly when presented simultaneously in multiple formats. These channels can potentially increase the effective capacity of the information filter.

• New channels could be devised that are specifically constructed to limit the potential information content of messages, making them more easily absorbed and more immediate. This would reduce the load on the cognitive and risk/time filters.

• AI-enabled aggregator systems could be constructed that provide the client with only content that is unlikely to be rejected or distorted. This would limit the demands on the motivation and visceral filters.

Unfortunately, these approaches (and many others that we could propose) are not novel. Indeed, every one of them is already in place or advancing rapidly (e.g., ChatGPT, the Metaverse, Tik Tok, Flipboard). More to the point, however, widespread adoption of fixes such as these will ultimately serve to increase the overall extrinsic complexity of our environment for the reasons previously described. We would then expect experienced complexity to rise, creating a need for new solutions.

And the complexity cycle persists…

The other approach to addressing the negative consequences of the complexity cycle would be to abandon or drastically limit the use and evolution of IT. We have already seen efforts along these lines with respect to AI (Levin & Downes, 2023). Our own view, however, is that nothing short of complete societal collapse—as occurred with the advent of the Dark Ages in Europe—will put the IT genie back in the bottle.

Fortunately, we believe that addressing the effects of the complexity cycle does not require us to become a Luddite. Our view is that the greatest danger presented by over-reliance on IT is that we—as a society—loose the capacity to process information without IT. We can already see some examples of this. Just ask typical young adults to perform two-digit multiplications in their head or read a paragraph written in cursive. From a practical standpoint, these skills are nearly useless in a world where IT is ubiquitous. Nevertheless, we see them as being representative of a class of cognitive skills that, as a society, we should be concerned about losing.

Rather than attempting to disable the complexity cycle—assuming that would be even remotely possible—our recommendation would be twofold:
1. Recognize the cycle's potential effects and treat them as an externality—the term economists use to describe broader negative impacts of locally beneficial activities.
2. Build activities into our education system and everyday life that develop and maintain cognitive capacities that are likely to atrophy through overuse of IT.
Economists have already considered a variety of remedies for the first of these—typically a mix of regulation and taxation. These have become increasingly challenging to implement in a global context. For example, what happens if one super-power regulates the development of AI while another allows it to run free? Despite these practical obstacles, the first step will necessarily be to recognize that a problem does exist.

To implement the second of these recommendations would require us to reconsider current trends, many of which seem to be going in the opposite direction. Activities that served to develop cognitive skills that traditionally do not rely on IT—such as the arts, music, and languages—have been de-emphasized in K-12 curricula (e.g., Commission of the Arts, 2021; Commission on Language Learning, 2017). In higher education, enrollments in the humanities are dropping (Pergola, 2014; Townsend & Bradburn, 2022). Moreover, the humanities departments that remain have become increasingly uniform in their politics (Magness & Waugh, 2022/2023), presenting a significant visceral barrier to participation by individuals outside of the tribe.
Reversing these trends would not be easy. The motivation filter could present a significant barrier, since the relative short-term advantages that these cognitive skills confer have likely declined owing to technological advancements, such as mathematical equation solvers, computer generated artwork, recorded music, generative AI, and automated translators. To prevent further atrophying of such skills, a compelling case needs to be established for their benefits to the individual in an increasingly automated world. Such a case will need to be made through rigorous research—emotional appeals are likely to fall short. Unfortunately, anecdotal arguments coming from older individuals who already acquired such skills in a world where IT was not ubiquitous are unlikely to be persuasive to Millennial and Z-generations that grew up relying on technology and connectivity.

LIMITATIONS

We have referred to the complexity cycle as a theory based on the widespread acceptance of the term "theory". Convenience aside, we might have better described it as a conceptual scheme (Gill, 2011) for a couple of reasons:

DUBIOUS FALSIFIABILITY

First, given the nature of the complexity cycle and the general difficulty of establishing meaningful causality in complex systems, we are not sure how it could be tested rigorously. Having said this, it

would certainly be possible to design investigations that could lead to results consistent or inconsistent with the complexity cycle's predictions. For example:

• Interpretive of individual tasks and performers studies could assess the degree to which adoption of supporting technologies (a) was motivated or partially motivated by performers experiencing high cognitive loads, and (b) if these options were initially successful in bringing cognitive demands to acceptable levels. The proposed theory would predict both (a) and (b) to be the case, but that, over time, increases in the extrinsic complexity of the broader environment would necessitate further IT adoption.

• Longitudinal studies could be conducted that examine the behaviors of industry environments before and after the widespread adoption of a technology. The proposed theory would predict that indicators of system complexity (e.g., frequency and size of discontinuities, emergence of power law distributions of participant performance, increasing diversity in successful participants/business models) would increase.

Unfortunately, these types of studies—particularly the latter—would be prone to demonstrating correlation rather than proving causality. We certainly would not assert that the complexity cycle is the sole force involved when a technology is implemented. As such, excuses could always be found not to reject the theory upon encountering inconsistent results. As Popper (1963) suggested, an unfalsifiable theory is not scientific.

SENSEMAKING

Second, one of the most valuable uses of a conceptual scheme is to provide a means of sense-making (Gill, 2011). We believe that the three forms of task complexity and their cyclical relationship provide a useful way of framing IT's impact on tasks and the broader environment. As is the case for conceptual schemes in general, it is up to the individual to assess whether it seems applicable (and useful) in a particular situation.

We further note that despite this paper's focus on the dark side of IT, our view of technology is nowhere near as grim as the paper would suggest. Nor would we recommend draconian measures to inhibit future IT implementation. We simply seek to build awareness of possible negative consequences. For future research, our greatest concern with the conceptual scheme is its vacillation between task-specific effects (which are relatively easy to detect and illustrate) and broader system effects, which are interesting but not necessarily intuitive or testable. More thoroughly researched examples are needed to better illustrate the relationships we propose, as well as counterexamples to establish their limits.

CONCLUSIONS

This paper's goal has been to propose a relationship between the use of IT to address task complexity and widely observed unintended negative consequences. By increasing our reliance on technology, we change tasks in positive ways, but open ourselves up to unintended and undesired side-effects at the task and broader environment levels. As regards task-level effects—such as deskilling and perpetuation of undesirable past practices—we believe that recognizing the danger and employing thoughtful task redesign can go a long way towards reducing the damage.

The more speculative element of the paper is the role IT may play in making co-evolving environments more extrinsically complex. We acknowledge that for this phenomenon, remediation is more difficult. It would be a fool's errand to try to halt the use of all IT that could increase extrinsic complexity. IT provides far too many direct benefits. We instead believe that extrinsic complexity should be treated as a negative externality of the creation and modification of information technologies and systems. Unfortunately, externalities are always difficult to deal with and the most readily available cures (e.g.,

taxing the behavior or regulating it) are often worse than the disease. If we decide that ITenabled complexity must be contained, we must be careful lest the measures we put in place to combat complexity end up making the task environment even more complex.

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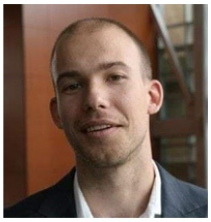

Thomas R. Gill is a doctoral student in the School of Information Sys tems and Management at the University of South Florida's Muma College of Business. He has a Bachelor of Science in Computer Science from the College of William and Mary and a Master of Science in Business Analyt ics and Information Systems from the University of South Florida. He co-authored an article published in Cancer Informatics and has co-au thored an article on research rigor published in Informing Science: The Inter national Journal of an Emerging Transdiscipline.

Grandon Gill is a professor in the School of Information Systems and Management at the University of South Florida's Muma College of Busi ness.. He is also the Academic Director of the Doctor of Business Ad ministration Program at the Muma College of Business. He is Editor-in Chief of the Muma Business Review and the past Editor-in-Chief of Informing Science: The International Journal of an Emerging Transdiscipline and the Journal of IT Education: Discussion Cases, also serving as a Governor and Fellow of the Informing Science Institute, where he was elected President in 2019.

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