Communications of the IIMA

Volume 14
Issue 3 *Double Issue 3/4*

Article 6

2014

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Steven A. Murphy
Ryerson University, Toronto, Ontario, murphy@ryerson.ca

Michael J. Hine
Carleton University, mike.hine@carleton.ca

Sandra Kiffin-Petersen Dr
University of Western Australia, sandra.kiffin-petersen@uwa.edu.au

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Steven A. Murphy
Ryerson University, Toronto, Ontario
murphy@ryerson.ca

Michael J. Hine
Carleton University, Ottawa, Ontario
mike.hine@carleton.ca

Sandra Kiffin-Petersen
The University of Western Australia, Perth, Australia
sandra.kiffin-petersen@uwa.edu.au

ABSTRACT

The purpose of this paper is to examine the role of the behavioural activation system (BAS), the behavioural inhibition system (BIS) and emotions in virtual work. BIS was found to have significant positive relationships with anger, anxiety, annoyance, nervousness, and distress. There were indications of emotional contagion between research confederates and participants. Self-report skill knowledge and the skill role of the research confederate both had significant relationships with performance. Self-report skill knowledge was fully mediated by the skill role played by the research confederate. Managers of virtual teams need to be aware of individual differences such as motivational systems and how these interact with state emotions and performance.

Keywords: computer mediated communication, emotions, motivational systems, behavioural activation, behavioural inhibition

INTRODUCTION

With the increased global expansion of businesses and increased forms and amounts of virtual collaboration enabled by internet-based protocols, organizational personnel are increasingly involved in virtual teams whose participants are from different countries and organizations. These organizational forms, called global virtual teams "(1) are identified by their organization(s) and members as a team; (2) are responsible for making and/or implementing decisions important to the organization's global strategy; (3) use technology-supported communication substantially more than face-to-face communication; and (4) work and live in different countries" (Maznevski & Chudoba, 2000).

The degree of virtuality in which teams operate can be considered a continuum (Leenders, van Engelen, & Kratzer, 2003) between completely co-located members who coordinate exclusively through face-to-face (FtF) interactions (i.e., not at all virtual), to individual members who coordinate without ever meeting in person (i.e., completely virtual). When operating at, or near, the high end of the virtuality continuum, both senders and receivers of electronic communication

have less information about remote workers, their actions, their experiences, their situations and context than if working in a collocated team (Cramton, 2001). In addition, both senders and receivers have information that is of lower quality than in collocated teams (Cramton, 2001), and there will be fewer established operating norms to guide behavior. Global virtual teams typically operate at the high end of the virtuality continuum and rarely, if at all, meet face to face (Dubé & Paré, 2001). The informational and normative gaps are increased when the composition of the team includes members from different countries and cultures. When deriving meaning, global virtual team members will fill in the aforementioned gaps and the manner in which they do so will be heavily influenced by individual differences including personality, motivational systems, emotions and others. Because of the differences in virtual and collocated environments, it follows that individual differences may play stronger and different roles in influencing attributions of meaning than in collocated environments (Murphy, Hine, Lupton, & Zelenski, 2009).

Emotions are experienced by organizational personnel whenever they engage in meaningful work (Barsade & Gibson, 2007), and are thus pervasive in everyday work experiences. Computer mediated communication studies have determined that the content of electronic messages can contain both cognitive and emotional information (Rice & Love, 1987) and that an individual's attributions, decisions, judgments, and negotiation strategies are influenced by both emotion (feeling) and cognition (thinking). As opposed to FtF communication, the relative intensities of positive and negative interaction (and associated emotion) are greater when interacting electronically, thus implying that the impact of said interaction and emotion may be stronger within computer mediated teams (including global virtual teams) than in collocated teams (Moore, Kurtzberg, Thompson, & Morris, 1999). The effect of perceived differences in skill levels on emotions may also be intensified in virtual teams, potentially because of the low social control, reduced feedback and difficulty in building trust (Hertel, Geister & Konradt, 2005). The purpose of this paper is to examine the role of emotions, perceived skill level and underlying motivational systems in the accomplishment of a virtual task. To our knowledge, no other studies exist that have examined underlying motivational systems and their relationship to emotions in a virtual setting. Research examining trait and state level psychological constructs in virtual settings is critical to enhance our understanding of individuals and how they may potentially act in virtual environments.

How and why individuals are motivated to perform certain tasks has been the subject of a voluminous degree of management inquiry. For example, Hertel (2002) developed a process model for individual motivation in virtual teams comprised of four components: valence, instrumentality, self-efficacy, and trust (VIST). This model was subsequently used to assess the effect of process feedback on motivation in virtual teams (Geister, Konradt, & Hertel, 2006). Comparatively little attention has been paid to advances in neuroscience and the growing understanding of the physiological underpinnings of motivation. Specifically, Gray's (1987) reinforcement sensitivity theory (RST) of emotion separates appetitive and aversive motivational systems, referred to as the behavioral activation system (BAS) and behavioral inhibition system (BIS), respectively. Gray argues that we scan the environment for possible punishment cues (to avoid) or reward cues (to approach), but that individuals differ in the strength of their respective BIS and BAS. That is, some individuals are more sensitive to punishment cues, while others are more drawn to reward cues.

The fundamental research question this paper addresses is to what extent underlying motivational systems effect state emotions and ultimately performance. The exploratory research described in this paper utilized the Experience Sampling Methodology (ESM) to examine the role of BIS and BAS on the emotions and performance of undergraduate students participating in an experimental virtual task. The paper will briefly review the motivation and emotion literatures in the context of virtual work. Based on that review a series of hypotheses are developed and presented. The method section details our ESM approach and the intricate laboratory design. The results and discussion sections shed important light upon the relevance of BIS/BAS to motivational research in virtual environments, and how underlying motivational systems regulate emotions and behavior. The final section of the paper discusses limitations of the described research, practical implications, and avenues for future exploration.

BACKGROUND AND HYPOTHESES

Individual differences such as personality, motivational systems and emotions can help explain why people may come to different meanings, given the same objective situation (or context). Both personality (see Balthazard, Potter, & Warren, 2002; Byron & Baldridge, 2007) and motivation (e.g., Geister et al., 2006) have received some attention in the virtual work literature.

Hertel's VIST model is the most well developed work on motivation in virtual teams (2002). VIST is comprised of four components each of which is considered essential for individual motivation within virtual teams. The components include valence, instrumentality, self-efficacy, and trust. Valence is "the subjective importance of team goals for team members" (Geister et al., 2006). Instrumentality is "the perceived indispensability of individual contributions" (Geister et al., 2006). Self-efficacy is "the perceived capability to fulfil the tasks required in a team" (Geister et al., 2006). Trust in the VIST model refers to both interpersonal trust (trust in your team members) and technological trust (trust in the electronic communication infrastructure). In a recent study using VIST, it was found that the use of team-based process feedback increased the motivation (specifically for valence, self-efficacy and interpersonal trust) of virtual team members who scored low in motivation in a pre-experiment questionnaire (Geister et al., 2006). Additional work on motivation in virtual environments has focused on the motivation to contribute content to online communities (Ling et al., 2005), online panels (Daugherty, Lee, Gangadharbatia, Kim, & Outhavong, 2005), and online communities of practice (Ardichvili, Page, & Wentling, 2003).

When studying a movie review online community, Ling et al. found that people are motivated to contribute when they feel their contribution is unique (2005). Daugherty et al. studied motivation to participate in online panels (2005). Unlike typical virtual communities, online panel participants have agreed to provide information at regular intervals over a period of time (Daugherty et al., 2005). Using Katz's functional theory (1960) as a basis, Daugherty et al. found that individuals who have a strong desire to gather information and understand their environment (high knowledge function) were more likely to join an online panel (2005). Similarly, individuals who sought to increase their own self-worth (high ego defensive function) were also more likely to join an online panel. Ardichvili et al. studied motivation and barriers to participating and sharing knowledge in a within-organization virtual community of practice (2003). They found that employees were motivated to share knowledge because: said knowledge is considered a public good; there is a moral obligation to the organization and to the professional community as a whole; they need to

establish themselves as experts; and they had a desire to give back something once they had reached a certain point in their career (Ardichvilli et al., 2003).

In summary, while there has been some work in the area of motivation and virtual work it has focused primarily on motivation as an outcome (operationalized in a variety of different behaviors), rather than as an underlying stable psychological trait system as is the focus this study (through the use of BIS/BAS).

Deriving meaning (both linguistic and non-linguistic) is the result of interaction between both cognitive and emotional processes and underlying traits and trait-like systems such as BIS and BAS. Formulating meaning is not only the product of predispositions, and state emotion and cognitive functioning, but is also highly reliant on the context in which individuals are imbedded. This is a particularly salient point for this paper, as we examine the role of virtual environments (more specifically an instant messaging (IM) task environment), as opposed to FtF contact, to determine the role of underlying motivational systems, as well as state emotions and cognition on the derivation of meaning formed before, during and after a virtual computer programming task. IM as a context was chosen for several reasons. IM has become increasingly prominent in workplace settings for work-related discussions, contrary to previous research suggesting that IM was used primarily for social exchange. Accordingly, it has been shown that IM is used within organizations a variety of different collaborative activities including problem solving (Isaacs, Walendowski, Whittaker, Schiano, & Kamm, 2002; Quan-Hasse, Cothrel, & Wellman, 2005) and negotiation (Johnson & Cooper, 2009). In addition, more recent research argues that workers use IM to manage interruptions so that work-related communication happens at more relevant and less disruptive times (Garrett & Danziger, 2008).

Our research model is presented in Figure 1. The behavioral activation system (BAS) activates behavior in response to signals of reward, whereas the behavioral inhibition system (BIS) stimulates behavior in response to signals of punishment and threat (Gable, Reis, & Elliot, 2000; Gray, 1981). The essential purpose of the BIS is to keep the organism out of trouble, in that it inhibits behavior that might lead to pain, punishment or any other undesirable consequence (Watson, Wiese, Vaidya, & Tellegen, 1999). For instance, most individuals' BIS systems would warn them of oncoming traffic when attempting to cross a street and thereby inhibit the behavior of walking. In short, the primary function of BIS is to help organisms avoid aversive stimuli. Gray (1987) called the BIS a "stop, look, and listen system" to emphasize how it redirects attention toward the environment. BIS promotes a vigilant scanning of the environment for potential threats and motivates the organism to move cautiously. The BIS system can also trigger the fight or flight reaction to threatening stimuli. In contrast, the BAS is an appetitive system of behavioral approach that leads organisms towards situations and experiences that may potentially yield pleasure and reward. The basic adaptive function of BAS is to ensure organisms obtain resources (e.g., food, shelter, companionship) that are essential to both the survival of the individual and the species (Watson et al., 1999). While BIS/BAS has not been explicitly studied in cross-cultural studies, the underlying avoidance and approach behaviors have been shown to be stable across cultures (Harmon-Jones & Allen, 1997).

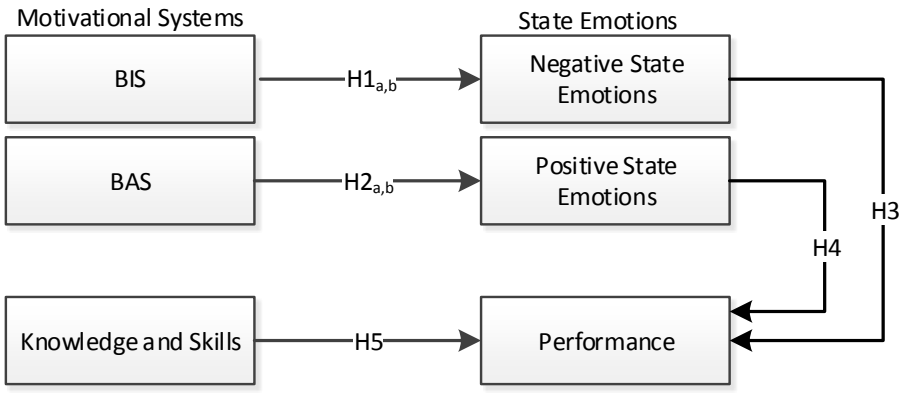

Figure 1: Research Model.

The BIS/BAS systems have not only demonstrated strong predictive validity in self-report studies, but the BIS/BAS scale (Carver & White, 1994) has also demonstrated strong covariation with resting prefrontal asymmetrical measurements with electroencephalographic (EEG) technology (see Harmon-Jones & Allen, 1997; Sutton & Davidson, 1997). Research evidence supports both the neurobiological grounding (e.g., Harmon-Jones & Allen, 1997; Sutton & Davidson, 1997), and the functional independence of BIS and BAS (e.g., Rusting & Larsen, 1998)). Resting levels of right frontal activation reflect BIS and NA while left frontal activation is associated with BAS and PA (Sutton & Davidson, 1997). Tomarken and Keener (1998) concluded that, "these lateralized systems not only influence approach and withdrawal but also the positive and negative emotions that are often linked with approach and withdrawal" (p. 403). This finding is germane to the current paper as we are not only interested in BIS/BAS, but also how and why emotions associated with these aversive and appetitive systems may change over time, within and between persons, depending upon the stimulus (and surrounding context). The functional independence of BIS/BAS suggests that these constructs are related, yet orthogonal. That is, all individuals have a BIS and BAS, yet these motivational systems are triggered by independent stimuli and serve very different functions. Neurobiological evidence strongly suggests that our BIS/BAS systems are quite stable (see Harmon-Jones & Allen, 1997), yet the degree to which BIS/BAS are innate or socialized is not clear. The point to emphasize, for the purposes of this paper, is that BIS and BAS are functionally independent and are activated by different types of stimuli.

Two principal hypotheses have been suggested to explain the BIS/BAS links to behavioral outcomes: the differential exposure hypothesis; and the differential reactivity hypothesis (Gable et al., 2000). The differential exposure hypothesis posits that BIS/BAS may influence tendencies to experience certain types of events. That is, people high in BIS (for example) may actually experience more negative events (linked to their high NA) than people high in BAS. In contrast, the differential reactivity hypothesis suggests that people with high BIS may react more strongly to negative daily events, and people high in BAS may react more strongly to positive daily events. The differential reactivity hypothesis is premised on the notion that people experience largely the same number of positive and negative daily events and it's how they react to them that distinguishes a high BIS or BAS system. By comparison, the differential exposure hypothesis is based on the notion that personality characteristics "colour" our daily experiences, and therefore people high in BIS/BAS may actually be creating more negative/positive daily events in their lives.

We contend that the two approaches are not mutually exclusive. That is, a person may place themselves in positions that are more affect congruent (e.g., a person high in PA acting independently and writing an introductory email to the rest of their virtual team members with whom they have had no previous contact), consistent with the differential exposure hypothesis, and that same person may react to events in the environment (e.g., the reception of an email criticizing the teams work) in very different ways, consistent with the differential reactivity hypothesis.

When operating in virtual teams where team members are reliant on computer-mediated communication, affect-lean statements may leave the receiver in a position to fill any gaps in meaning. Byron (2008) has suggested that communicators have email specific schemata that is grounded in the perception that email is a depersonalized medium. This schemata biases the perception of positive and negative emotion in email such that positive emotions in email may be interpreted in a more neutral fashion than intended and negative emotions will be interpreted in a more negative fashion than intended (Byron, 2008). While the aforementioned research does not explicitly address motivational systems, it does speak to the heightened sensitivity to negative cues versus positive cues in a virtual environment. It is conceivable that BIS/BAS moderate the propositions put forth in Byron (2008). People with a highly sensitive BIS may be more likely to read a message looking for punishment cues and thus interpret neutral messages in a more negative fashion than team members with a highly sensitive BAS. In contrast, people with a highly sensitive BAS, who are known to scan the environment for reward cues, may be more likely to decode such messages in a positive fashion. We thus propose that the valence of the experience of state emotions may be stronger in an affect congruent manner for persons high in BIS and BAS respectively (i.e., virtual team members high in BIS may experience stronger negative emotions than virtual team members high in BAS when presented with negative stimuli; similarly, virtual team members high in BAS may experience stronger positive emotions than virtual team members high in BIS when presented positive stimuli). As a first step in exploring the interaction between motivational systems and state emotions, we hypothesize:

$H1_a$: BIS will be significantly related to the experience of negative state emotions
$H1_b$: For those higher in BIS the effect of high negative affect stimulus on negative state emotions will be greater than for those lower in BIS

$H2_a$: BAS will be significantly related to the experience of positive state emotions.
$H2_b$: For those higher in BAS the effect of high positive affect stimulus on positive state emotions will be greater than for those lower in BAS

Our emotions play a major role in both our cognition and behavior (Barsade & Gibson, 2007; Baumeister, Vohs, DeWall, & Zhang, 2007). That is, how we are feeling influences how we think and behave in most daily situations. These state emotions are primarily caused by external stimulus in the environment and result in feelings of happiness, anger, joy and sorrow (among a host of other state emotions). Traditional models of emotion suggest that the simplest and most parsimonious theory is that emotion has a direct causal relationship with behavior (Russell, 2003). This view argues that fear makes us flee, and anger prepares us for confrontation is suggestive of the notion that while people may explain behavior in terms of "because she was mad", the more clinical description would be "anger directed her cognitive processing to focus disproportionately

on certain possible outcomes, whereupon her behavioral decision process failed to take certain potential risks into account" (Baumeister et al. 2007, p. 168). The salient point is that under certain conditions emotion can and does directly influence behavior.

H3: Negative state emotions will be negatively related to performance.
H4: Positive state emotions will be positively related to performance.

While emotions may influence our behavior, our cognitive abilities (knowledge, skills, etc.) can arguably have a far more direct influence on task specific behavior (Carver & Scheier, 1999; Schwarz & Clore, 1988). That is, especially when faced with complex tasks, our reliance on cognitive functions increases. For instance, our expertise (in computer programming, creative writing, etc.), or skills (in carpentry, welding, etc.) are developed over time, and require cognitive efficiencies (Barsade & Gibson, 2007). This should not be misconstrued as suggestive that emotions play less of a role in complex tasks, however, managing emotions (emotional labor) during times of cognitive complexity (e.g., exams) increases cognitive capacity. We would therefore expect that knowledge of a task specific skill would be directly related to performance.

H5: Knowledge and skills of research participants will be a significant predictor of performance regardless of the state emotions being experienced.

METHOD

This research used a complex experimental design to test the stated hypotheses. Students interacted with a research confederate (who was posing as another student) using an instant messenger (IM) client to complete a programming task. The participants were asked to collaborate with the other "student" on the task and were prompted at four-minute intervals to acknowledge their state emotions (measured using the previously validated positive affect/negative affect scale (PANAS) (Watson, Clark, & Tellegen, 1988). Two research confederates, posing as students, played four roles: high positive affect (PA), high programming skill; high PA, low programming skill; high negative affect (NA), high programming skill; and high NA, low programming skill.

Research participants were recruited from an undergraduate information systems course offered by a Canadian business school. In exchange for voluntary participation, students were awarded a two percent increase in their final grade. In total 107 students (56 men, 51 women) participated ranging in age from 18 to 36 with the mean being 20.4 years. To assess the extent to which participants had prior experience using instant messaging, they were asked whether they currently use such technology: every day, almost every day, once per week, once per month, or never. The data distribution was highly skewed with 91 responding every day or almost every day and 14 responding once per week or per month. No participant was completely unfamiliar with instant messaging.

Four programming tasks of equivalent difficulty were created for the experiment. The tasks are intellective exercises in that they each have a correct solution (McGrath, 1984). Each task had a different context but required identical programming constructs to be solved. Multiple programming experts validated all four tasks. Participants were asked to self-report their ability to solve the task using a five-point Likert scale. The tasks were graded out of 10 by two trained

independent graders. Cronbach's alpha for inter-grader reliability was .78. The Cronbach alpha for internal reliability of the multiple component-grading scheme was .92.

Details of the experiment are summarized in Figure 2. Participants completed a web-based baseline questionnaire to assess their behavioral inhibition/activation systems (BIS/BAS: Carver & White, 1994) and their affective dispositions (PANAS: Watson et al., 1988) prior to the experiment. These instruments displayed high levels of internal consistency with Cronbach alphas ranging from .85 to .88. Participants accessed the questionnaire by entering a randomly generated unique identification code that was provided to them. Through meta-analysis of literature regarding potential distortion of responses to psychological assessments administered online, it appears that allowing participants to complete online questionnaires alone, with anonymity, and with the ability to revisit and alter responses before submitting them, social desirability biases are somewhat lower than in traditional pencil and paper assessments (Richman, Kiesler, Weisband, & Drasgow, 1999). Therefore, participants were required to enter demographic data, as described earlier, but did not provide their names or other identifying information. In addition, they were allowed to complete the online questionnaire, untimed, from wherever they chose, and could edit their responses to instrument items any number of times until they formally submitted them. State emotions were assessed using a short form of the PANAS (Watson et al., 1988). The positive state emotions that were elicited included excitement, happiness and enthusiasm. The negative state emotions elicited included distress, anger, anxiety, annoyance, embarrassment and nervousness.

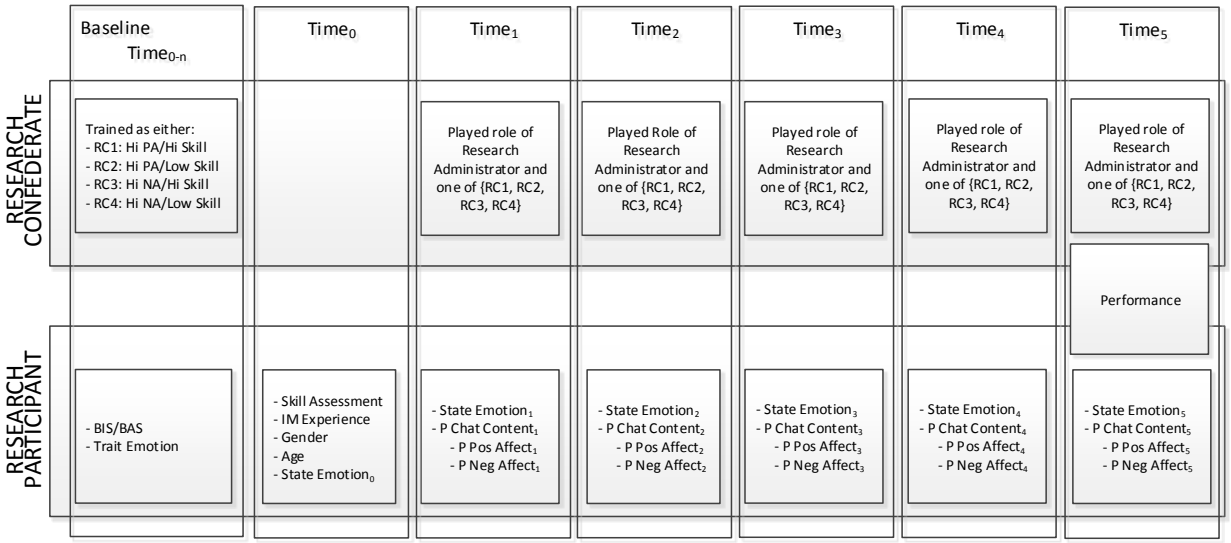

Figure 2: Experiment Details.

The IM experiment sessions were conducted using MSN Messenger. Certain features of the IM client were disabled such as the ability to transfer files or embed graphical images (emoticons). In so doing, participants were restricted to communication using only alphanumeric, English-language keyboard characters. The chat history of each session was automatically saved by the IM client and stored as a text file.

Participants were told that the purpose of the study was to assess the effectiveness and usefulness of an electronic communication tool (the IM client) as a collaboration method for distributed

software developers. Participants were led to believe they would be collaborating with another student in solving the assigned task. In fact, participants were interacting with a research confederate impersonating a student. This deception was deemed necessary in order to simulate a real life experience and to examine the role of motivation and emotions in perception and performance during collaborative problem solving. The experimental nature of the study was disclosed after all data had been collected from participants.

The research confederate played one of four roles based on programming ability and affective disposition. In playing the role of a student with below average programming ability, the research confederate would intentionally make errors in suggesting a solution to the task, or would feign ignorance in how to proceed. In playing the role of a student with above average programming ability, the research assistant would offer correct suggestions on how to proceed. The research confederate had access to several valid solutions to the task that aided in playing the various programming skill roles.

The affective disposition roles included negative and positive biases. A research confederate assuming a positive affective role would send messages that were encouraging, enthusiastic, commending, thankful, and so forth. In assuming a negative affective disposition, the research confederate would feign disinterest in the task, or possibly even criticize the abilities of the actual study participants. The research confederates were trained in each of the four roles and a pilot study was undertaken to ensure that each of the roles was being played appropriately and reliably. Experimental participants were randomly paired with one of the four fake student roles. This pairing process was iterative to ensure an equal number of participants were assigned with each of the four roles. Sample discussion segments, according to roles played by the research confederate, are given in Table 1.

	Below Average Skill	**Above Average Skill**
Positive Affect	***RA:*** wow that is beyond me – you must be a whizkid at this or something ***Participant:*** we need to find the amount of commission for the trade right? ***RA:*** yah, for Annie the broker or whoever	***RA:*** nice 2 meet u ***Participant:*** let me tell you, my programmin isnt very giid :$ ***Participant:*** *good ***RA:*** heehe ***Participant:*** :$ ***RA:*** thats okay ***RA:*** I think I understand the task a bit
Negative Affect	***RA:*** I am not very good at VB ***Participant:*** Neither me. But let's try ***RA:*** ok but it doesnt sound like its going to work out very well	***RA:*** you don't seem to know much about doing this stuff ***Participant:*** i'm here for the marks ***RA:*** yeah well you can have mine too then. You seem like someone who would need them a lot more than me! ***Participant:*** wow, that's harsh

Table 1: Interaction Role Classification and Sample Discussion Segments.

Upon arrival at the study location, participants were presented with their assigned computer-programming task and logged into the browser-based application where they self-reported their ability to perform the assigned task. A collocated research assistant briefed the participant that they would be collaborating with another student who was working from a different location to produce a solution to the assigned task. A research confederate, located in a separate room on a different floor of the same building as the participant, played the role of the fake student as well as the role

of the research administrator. The research administrator role would initiate the chat session between the two students by sending a standardized message including some brief instructions. To achieve the impersonation of two roles at once, the research confederate had two chat clients running on the same computer. A sample screen capture is shown in figure 3.

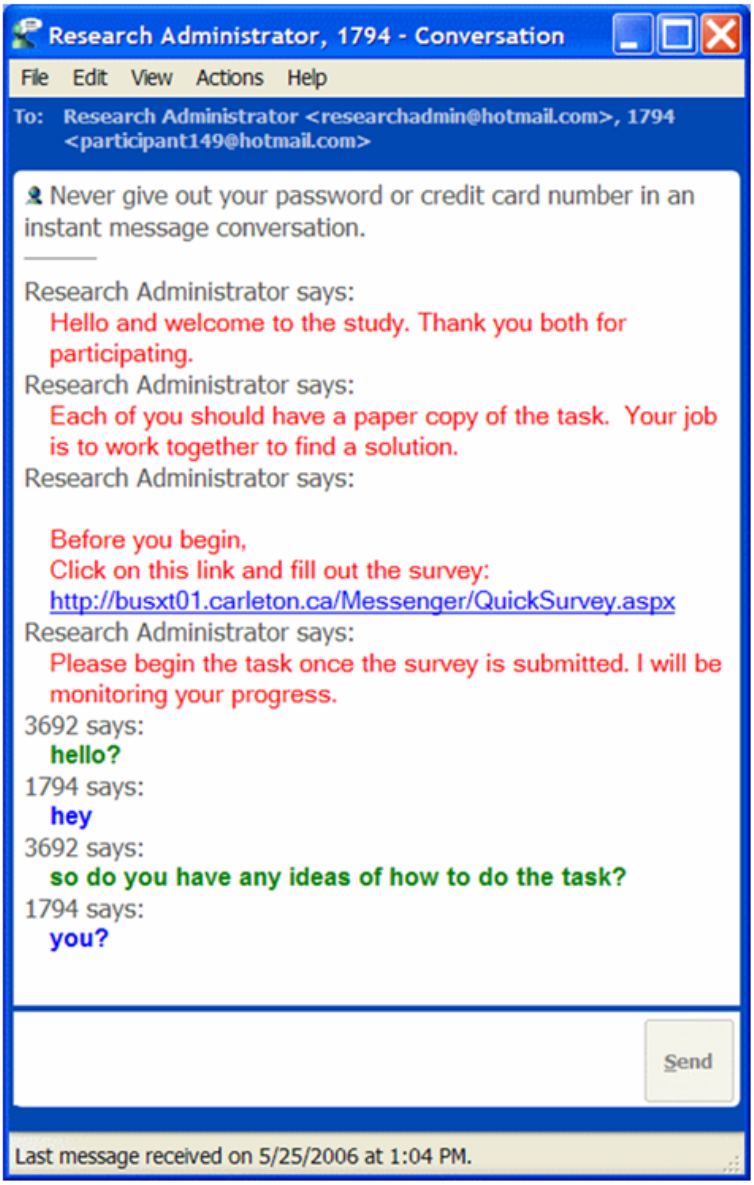

Figure 3: Sample Chat Transcript.

In addition to beginning and ending each chat session, the research administrator would request that all activity be stopped to allow participants to complete an online survey of their current emotional state (based on the PANAS). This survey was administered six times during each chat session. The first administration occurred immediately following the introductory instructions and the last was after the participants had been notified that the allocated time for solving the task had expired. The other four administrations were timed roughly four minutes apart although this

interval was sometimes modified where opportunities arose to capture potentially strong emotional episodes. Examples of such episodes included instances in which the participant appeared to be encoding strong affective content or where the research confederate had sent a message with the potential of eliciting a strong affective response.

The research administrator issued a time warning: approximately 4-5 minutes remaining; also, an announcement was made that a final solution should be entered into the chat window.

Before proceeding with a full analyses of the data, we performed a manipulation check to ensure that positive and negative affect treatments successfully elicited the expected state emotions in the participants. We first calculated how much each state emotion changed (SE Delta) throughout the time of the experimental session (State $Emotion_{t5}$ – $StateEmotion_{t1}$) for each research subject. We performed a t-test between groups receiving positive and negative affect stimulus for the SE Delta means. The results of the manipulation check are in Table 2. As shown, the SE Deltas are significantly different across the positive and negative affect treatments for the majority of the 11 state emotions. Only changes in anxiety, embarrassment and distress do not have significant differences. It is plausible that students entered the experiment in a slightly more anxious, embarrassed and distressed predisposition, and these emotions continued throughout the session, because students were told they would be performing a programming task and that the outcomes had implications for their grades.

State Emotion	t	Sig.
Anger	-3.841	.000**
Anxiety	.403	.688
Excitement	3.183	.002**
Annoyance	-3.412	.001**
Enthusiasm	3.283	.001**
Nervousness	-0.27	.978
Happiness	4.403	.000**
Embarrassment	.006	.995
Disgust	-4.252	.000**
Sadness	-2.853	.005**
Distress	-3.274	.001**

*p< .05, **p< .01

Table 2: Manipulation Check on State Emotion Deltas.

RESULTS

The correlation matrix of the study's primary variables (excluding state levels of emotion) is presented in Table 3.

Variable	1	2	3	4	7	8
1. BAS	.86					
2. BIS	ns	.85				
3. PA	.29	ns	.88			
4. NA	ns	.38	ns	.87		
7. Task Specific Skill	ns	ns	.24	ns	N/A	
8. Performance	ns	ns	Ns	ns	.71	.92

Cronbach's Alphas for reliability reported on the main diagonal where applicable.

Table 3: Correlation Matrix of Primary Variables.

$H1_a$: BIS will be significantly related to the experience of negative state emotions

$H1_b$: For those higher in BIS the effect of high negative affect stimulus on state emotions will be greater than for those lower in BIS

BIS was found to have significant positive relationships with anger, anxiety, annoyance, nervousness, and distress in both correlation and regression analyses (with state emotion (z-scores) as the dependent variables and BIS as the independent variable), the results of which are depicted in Table 4 and thus partially supporting $H1_a$.

State Emotion	Correlation (*r*)	Standardized β	Adjusted R^2
Anger	0.29**	0.29	0.08
Anxiety	0.31**	0.31	0.09
Annoyance	0.22*	0.22	0.04
Nervousness	0.25*	0.25	0.05
Distress	0.31**	0.31	0.09
Embarrassment	.052		
Disgust	.082		
Sadness	.059		

*p< .05, **p< .01

Table 4: Relationships Between BIS (DV) and Negative State Emotions (p<.01).

Results for Hypothesis 1_b are shown in Table 5. We split the sample based on research participant's BIS values with approximately half the sample being categorized as HiBIS and the other half being LoBIS. We then limited the cases considered to only those who received negative affect stimulus. A t-test was run comparing the SE Deltas across LoBIS and HiBIS subjects. As shown there are no significant differences detected although we should be cautionary given the small sample sizes.

State Emotion	BIS Level	N	Mean State Emotion Deltas	t	Sig.
Anger	HiBIS	28	1.64	.211	.834
	LoBIS	24	1.54		
Anxiety	HiBIS	28	-.89	-.621	.537
	LoBIS	24	-.58		
Annoyance	HiBIS	28	2.00	.947	.348
	LoBIS	24	1.50		
Nervousness	HiBIS	28	-1.93	-1.735	.089
	LoBIS	24	-.92		
Embarrassment	HiBIS	28	.04	.707	.483
	LoBIS	24	-.20		
Disgust	HiBIS	28	1.18	.890	.378
	LoBIS	24	.79		
Sadness	HiBIS	28	.25	-1.352	.182
	LoBIS	24	.71		
Distress	HiBIS	28	.25	-1.306	.198
	LoBIS	24	.79		

Table 5: Difference on Negative State Emotion Deltas by BIS Level.

$H2_a$: BAS will be significantly related to the experience of positive state emotions.
$H2_b$: For those higher in BAS the effect of high positive affect stimulus on positive state emotions will be greater than for those lower in BAS

As shown in table 6 and contrary to our predictions, there were no significant relationships between BAS and individual differences (z-scores) in experienced positive state emotions thus refuting hypothesis 2_a.

State Emotion	Correlation (*r*)
Excitement	0.081
Enthusiasm	0.082
Happiness	0.025

Table 6: Relationships between BAS and Positive State Emotions.

Results for Hypothesis 2_b are shown in Table 7. We split the sample based on research participant's BAS values with approximately half the sample being categorized as HiBAS and the other half being LoBAS. We then limited the cases considered to only those who received positive affect stimulus. A t-test was run comparing the SE Deltas across LoBAS and HiBAS subjects. HiBAS participants had larger mean deltas for all of the positive state emotions (with enthusiasm and happiness being significant) than LoBAS participants. Hypothesis 2_b is thus partially supported.

State Emotion	BAS Level	N	Mean Change in State Emotion	t	Sig

Excitement	HiBAS	26	.233	1.724	.09
	LoBAS	27	-.478		
Enthusiasm	HiBAS	26	.200	2.003	.05*
	LoBAS	27	-.609		
Happiness	HiBAS	26	.433	2.330	.02*
	LoBAS	27	-.609		

*p<=.05

Table 7: Difference on Positive State Emotion Deltas by BAS Level.

H3: Negative state emotions will be negatively related to performance.
H4: Positive state emotions will be positively related to performance.

Contrary to our prediction, state emotions (both z-scores and states at ALL time periods) did not have significant direct relationships with performance. Given the insignificant results and the size of the correlation matrix, we have not included the details within this manuscript.

H5: Knowledge and skills of research participants will be a significant predictor of performance regardless of the state emotions being experienced. Specifically, self-report programming knowledge (task specific skill) and research confederates' skill roles will both be significant predictors of performance.

Self-report programming knowledge and the skill role of the research confederate both had significant relationships with performance (respective correlations of r = .27, and r = .71). To better understand the contributions of both self-report programming knowledge and the skill role of research confederates on the performance measure, a series of linear regressions was performed. These regression models are presented below in Tables 8 and 9.

While only skill role was significant in Model 1, because of the significant correlation between self-report programming knowledge and performance, we tested for the presence of mediation or moderation with the creation of an interaction term in model 2, as depicted in Table 9 (Baron & Kenny, 1986).

Taken collectively, models 1 and 2 suggest that self-report skill knowledge was fully mediated by the skill role played by the research confederate. Despite self-report knowledge being insignificant in Model 1, when the interaction term was added in Model 2 both self-report knowledge and the interaction term became significant ($p < .05$). That is, it was only when research confederates skill role was considered that the programming skill of the student had a relationship with performance.

The results of the hypotheses testing are summarized in table 10.

I.V.	Standard. β	Sig.	F- statistic	Adjusted R^2
			56.20	0.51
Self-report knowledge	0.11	0.12		
R.A. Skill Role	0.69	0.00		

Table 8: Relationships between Performance (DV) and Self-Report Knowledge and Research Confederate Skill Role (Model 1).

I.V.	Standard. B	Sig.	F- statistic	Adjusted R^2
			39.79	0.52
1. Self-report knowledge	0.23	0.02		
2. R.A. Skill Role	0.65	0.00		
3. 1X2 (Interaction)	0.49	0.05		

Table 9: Relationships between Performance (DV) and Self-Report Knowledge and Research Confederate Skill Role (Model 2).

	Hypotheses	Results
$H1_a$:	BIS will be significantly related to the experience of negative state emotions	Partially Supported
$H1_b$:	For those higher in BIS the effect of high negative affect stimulus on negative state emotions will be greater than for those lower in BIS	Not Supported
$H2_a$:	BAS will be significantly related to the experience of positive state emotions.	Not Supported
$H2_b$:	For those higher in BAS the effect of high positive affect stimulus on positive state emotions will be greater than for those lower in BAS	Partially Supported
H3:	Negative state emotions will be negatively related to performance.	Not Supported
H4:	Positive state emotions will be positively related to performance.	Not Supported
H5:	Knowledge and skills of research participants will be a significant predictor of performance regardless of the state emotions being experienced. Specifically, self-report programming knowledge (task specific skill) and research confederates' skill roles will both be significant predictors of performance.	Partially Supported

Table 10: Summary of Results of Hypotheses Testing.

DISCUSSION

The relationship between BAS/BIS and state emotions has been the subject of much research and theorizing over the past decade (e.g., Gable et al., 2000; Watson et al., 1999). Consistent with the evidence that trait levels of PA/NA are significantly related to underlying motivational systems (BAS/BIS), this logic has been extended to the experience of state emotions, with individuals high in BAS/BIS believed to experience more positive/negative emotions due to differential exposure or reactivity (Gable et al., 2000). However, when exploring this relationship in a virtual setting, and contrary to expectations, this study found no significant relationships between BAS and state positive emotions (both within and between persons). In contrast, significant relationships were found between BIS and anger, anxiety, annoyance, nervousness, and distress in both correlation and regression analyses (both within and between persons). Taken together, the results of hypotheses 1_a and 2_a were not completely unexpected, as some authors (e.g., Zelenski & Larsen, 1999) have provided evidence that negative state emotions are more viscerally related to threatening stimuli than would be positive emotions to reward stimuli. That is, anger, anxiety, annoyance, nervousness and distress can be argued to be at the very heart of the BIS monitoring system in the sense that they are the very emotions that the BIS is trying to avoid. This study supports the argument that negative state emotions will have a stronger relationship with BIS than positive state emotions will have with BAS. For example, Eysenck (1987) found that the neurotic tendencies of high BIS individuals rendered them more sensitive to changes in threatening stimulation and associated negative state emotions. This line of reasoning is consistent with a differential reactivity model of emotional experience.

Hypotheses $H1_b$ and $H2_b$ each examined the influence of high BIS or BAS on the change in negative or positive state emotions. When participants were grouped into high and low BIS sub-groups and provided with negative affect stimulus, no significant differences emerged between groups in terms of changes in negative state emotions. However, when positive affect stimulus was provided to participants, high BAS individuals were found to experience significantly more positive change in enthusiasm and happiness as opposed to low BAS groups. This finding was also unexpected, as there is little theoretical or empirical support for BAS and PA (by inference) being able to better predict positive emotions than BIS and NA for negative emotions. That said, the emotional contagion literature would suggest that context is key in explaining why emotion states may pass from one individual to another (Barsade, 2002). On this task, the student had to work together with the confederate, and it is possible that when the confederate played a PA role, their positive emotions more readily influenced the enthusiasm and happiness of participants. We observed that participants came into the experiment already nervous, embarrassed and anxious (from our priming results), so it could be that in this context, the PA of the confederate had a contagion effect on enthusiasm and happiness through the process of creating a bond with the participant. Such a result would lend credence to the differential exposure hypothesis, as the participants exposed to the positive affect experimental condition were more likely to express enthusiasm and happiness. The contagion result reported in this paper is important as we saw evidence in the instant messaging transcripts that the affect role of the research confederate had a strong influence on the tone of the communication and the rapport developed between the two students (consistent with the persuasive role of emotions elaborated by Carver and Scheier, 1999). This rationale is consistent with research results in e-negotiation that shows successful e-

negotiation transcripts contained significantly more positive emotion and language than unsuccessful e-negotiation transcripts (Hine, Murphy, Weber, & Kersten, 2009).

Contrary to our prediction, we found that state emotions did not significantly predict performance. The lack of a direct causal link between emotion and performance is supported by the work of Baumeister et al. (2007), who argue that emotions are all too often depicted as having a direct causal role on behavior, when they are more likely to have an indirect feedback role. Some of the most recent and provocative reasoning on how emotion shapes behavior, argues that emotion is a feedback system whose influence on behavior is typically indirect (with obvious exceptions like the fight or flight reaction to perceived threatening stimulus that focuses the bodies cognitive and biological systems on mechanisms designed for survival – e.g., increased blood flow to major muscle groups for running/fighting and limited cognitive processing capacity for focusing on a single avenue of thought). However, Baumeister et al. (2007) take the controversial position that even in these situations a person is not likely to experience the emotion of fear (for example) until they have safely removed themselves from the danger (e.g., after having successfully ran from a bear). This is a provocative argument as it challenges contemporary thinking about the sequencing of emotions and behavior where past research has suggested that the emotional fear of the bear was what caused the cognitive shifts in brain and bodily functioning. Baumeister and colleagues argue for replacing the causation model of emotions with a feedback model (i.e., by providing feedback and stimulating retrospective appraisals of actions, conscious emotional states can promote learning and alter future behavior). Rapid, automatic affective responses, in contrast to full-blown conscious emotions, are argued to inform cognition and behavioral choice and thereby help guide current behavior. While Baumeister et al. (2007) position their views as a radical departure from current theorizing about the nature of the affect-behavior relationship, much of their main line of argumentation is consistent with the affect as learning literature reviewed in this paper. The noteworthy difference being that Baumeister and colleagues are asking the field to rethink the entire causal chain between emotion and behavior while the affect as learning literature perpetuates the notion that while we learn from affective experiences, it is through this learning that behavior (and ultimately the affect that induced it) is altered. Over time, people reflect on what has occurred and learning occurs and other experiential and expertise based constructs often take on greater importance in influencing behavior.

Our findings lend support to this hypothesis, and we advocate for researchers to gain a more detailed understanding of how affect interacts with both cognition and more enduring personality variables to influence behavior (in this case, performance on a programming task). At the risk of over-reaching, we argue that researchers need to be extremely cautious before attributing behavioral causality to emotions (as the human mind is simply too complex, and the field of emotions in organizational research has now developed sufficiently to warrant more sophisticated inquiry).

In contrast to our null findings with state emotions, self-report programming knowledge and the skill role of the research confederate both had significant relationships with performance (respective correlations of $r = .27$, and $r = .71$). This finding is intuitively appealing as both self-report knowledge and research confederate skill role are directly task related (i.e., both have to do with programming ability). When examining these relationships in more detail through a series of regression equations, it was found that the research confederate skill role was the strongest

predictor of performance and that self-report programming knowledge was fully mediated by the skill role of the research confederate. In other words, it was only when a research confederate was playing a high skill role that the programming knowledge of the participant had a significant positive impact on performance. This finding is similar to emotional contagion (see Barsade, 2002), in that research confederates, through their skill roles, were able to utilize or subvert the self-report programming knowledge of the student.

Finally, while not hypothesized it is worth mentioning the successful induction of state emotions in a virtual environment (presented as a manipulation check in the methodology section). High PA research confederates elicited significantly more positive emotions, including excitement, enthusiasm and happiness, and high NA research confederates elicited significantly more negative emotions, including anger, annoyance, disgust and distress. While this was expected, it shows that emotions can indeed be elicited in a high skill, task based, virtual environments. This finding is consistent with the emotional contagion literature (e.g., Barsade, 2002) in the sense that the student participants' emotions were highly influenced by the emotional predisposition of the research confederate. Happiness and anger were the two strongest emotions elicited by the research confederates suggesting that, indeed, emotions can be manipulated by only text in a virtual setting (consistent with Walther, Loh, & Granka, 2005). Further support of the result is from Thompson and Nadler (2002) who suggest that contagion in both the socio-emotional tone and of the linguistic structure of electronic text does occur. It is worth emphasizing that this study found such relationships in a virtual environment on a programming task. Such a finding supports the cues filtered in theorizing by some computer mediated communication authors (Walther et al., 2005) where individuals are believed to adapt to technology, and for these mediums (instant messaging in our case) to be capable of communicating affect.

SUMMARY AND CONCLUSIONS

When we examined the role of trait level variables on state emotions, both within and between persons, only BIS emerged as being related to negative emotions and none of the trait level variables had any direct relationship with the performance outcome. Consistent with a cues filtered in perspective in computer mediated communication, we were able to stimulate both positive and negative emotions using research confederate affective roles in a solely text based environment. This finding lends support to the notion that even on the most mundane of distributed work tasks (in this case a computer programming task), emotions are rather easily aroused, as we reported high levels of anger and happiness (amongst many other state emotion). Emotions were also found to play a feedback role, in the sense that there was no direct causation with our performance measure, yet reported emotions changed the tenor of the IM interaction.

Evidence of emotional contagion was found both with respect to emotions and with respect to skills. That is, the emotional role of the research confederate had direct effects on the levels of positive/negative emotions elicited in respondents, and the skill level of the research confederate also fully mediated the self-reported programming skill knowledge of the participant. The latter finding suggests that individual skill levels (or cognitive abilities) are highly influenced by the ability of a partner on a shared task. Clearly more research is required in virtual environments to replicate this finding and determine both the context and individual differences that coalesce to produce this outcome.

This study has several limitations. First, students may not have been highly motivated to achieve their dictated goal of successfully completing a programming task. In fairness, the IM transcripts showed that the students appeared to be taking the task seriously, but the degree of valence on the outcome remains in question. Carver and Scheier's (1999) control theory rests on the assumption that emotions will only be associated with goals that are intrinsically meaningful, and this may not have been the case with our student sample. Future research could remedy such problems by either creating experimental designs in which participants set their own (highly valenced) goals and then affect could be monitored along with the degree of goal attainment, or research in organizational settings could track the emotions associated with personal career goals (or other intrinsically meaningful work goals). While the results of either design would help to inform the literature, other studies that incorporated virtual working environments would help to shed light on any differences in emotional experience as the result of goal setting in FtF versus virtual environments. In addition, this experiment focused on dyadic communication. For implications to be drawn at a team level, future work should involve groups of three persons or more.

Future research could examine the links between personal and/or career goals and emotion states (consistent with Higgins, 1997). That is, experimental or naturalistic work setting designs could examine how progress/impediments towards attaining personal or career goals (something likely to arouse high levels of affect) influence state emotions (and whether these emotions are mediated or moderated by underlying motivational systems or personality predispositions). In addition, electroencephalographic (EEG) and magnetic resonance imaging (MRI) technologies could be used in combination with self-report state emotions in order to obtain a more objective view of how the brain is functioning and what areas are being influenced by discussions involving the participants perceptions of progress/or the lack thereof toward personal or career goals.

Future research should also examine other virtual work technologies (e.g., e-mail) and environments (e.g., virtual teams) to determine the degree to which emotions play a direct or indirect role on goal attainment in text-based computer mediated communication settings. Should these studies replicate the indirect role of emotions on behavior found in this study (and supported by the work of Baumeister et al., 2007), we still require a much more intricate understanding about emotion feedback loops for learning and attribution formation.

We are cautious in making practitioner recommendations based on this study, as further validation is required. It is clear that managers of virtual teams need to be aware of individual differences such as motivational systems and personality and how these interact with state emotions and performance. We feel the best approach is to develop and nurture a within-team culture based on openness and trust. This recommendation is consistent with recent literature that has acknowledged the importance of trust in the functioning and ultimately performance of virtual teams (Altschuller & Benbunan-Fich, 2010; Dennis, Robert, Curtis, Kowalczyk, & Hasty, 2012; Robert, Dennis, & Hung, 2009). By knowing more about virtual team members and their context, there is a greater likelihood of making informed attributions of meaning based solely on text. This will lessen the chance of cascading negative attributions and communication that is prevalent in text-based computer mediated communication. Further, it may be that certain people are just not well suited to the uncertainty and ambiguity of working in global virtual teams (for example, further exploration is required into the role of Big 5 personality factors, especially extraversion and

neuroticism, given their influence over affect-congruent cognition, and respective links to BAS and BIS). While research has clearly stated that differences such as culture (Massey, Montoya-Weiss, Hung, & Ramesh, 2001) and time need to be acknowledged and accounted for when working in virtual teams, we feel it is important that individual differences such as underlying motivational systems, personality and emotions receive due consideration in the virtual work literature.

Additional data analyses are currently being undertaken to explore whether participant's country of origin and first language mediate or moderate the contagion effect between the affect role of the research confederate and the state emotions of the participant. Given that culture has been previously shown to affect how individuals adapt to technology (Massey et al., 2001), we are exploring cultural proxies such as country of origin and language as potential moderators or mediators between performance and state emotions. The point to emphasize is that social context extends beyond the context of the virtual task (including language, country of origin, culture, etc.). In addition, future work could explore BIS/BAS as potential moderators of the degree of emotional contagion that takes place in virtual environments. Previous research into face-to-face emotional contagion has found that positive and negative emotional linkages between team members are moderated by collectivist and individualistic tendencies (Ilies, Wagner, & Morgeson, 2007). While these tendencies approximate whether a person prefers working in a group or working alone, our focus would be to investigate potential linkages to underlying psychological constructs such as BIS/BAS and personality traits.

In summary, this paper has extended the literature on the underlying motivational systems of BAS/BIS into a virtual environment and found that the BIS system is strongly related to negative state emotions, both within and between persons using experience sampling. In addition, state emotions, captured over the duration of a programming task using IM, were only indirectly associated with performance. Direct performance causation was found to be attributable to self-report programming skill and the skill role played by the research confederate. Future research designs incorporating both experience sampling and EEG or MRI technologies will allow for the development of a more intricate understanding of brain areas influenced by goal attainment/impediment and the role of emotion as a feedback mechanism to behavior.

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