

Design the Future with Emotion: Crucial Cultural Perspectives

Chunchen Xu, Xiao Ge, Nanami Furue, Daigo Misaki, Hazel Markus, Jeanne Tsai

Abstract

No one universal affective route leads to creative ideas. Rather, the designers' affective experience is influenced by the cultural contexts they are in. However, scant research has examined how culture shapes designers' emotion in creative problem-solving activities. We present two survey studies that explore the interplay between affect, culture, and idea generation. The findings suggest that people tend to associate low-arousal, positive emotion with idea generation in Japanese contexts, compared with high-arousal, positive emotion in American contexts. We also found that Japanese participants expressed more socially engaging emotions, had higher levels of emotional fluctuation, and reported lower levels of emotional expressiveness than their American counterparts. This research contributes to the emerging field of emotion research in design by examining the cultural shaping of affect in idea generation. We call for more cultural research to enable designers to provide insights into the profound roles of affective experience and expression in creative processes and how it may vary across cultures. In doing so, we hope to offer new vistas for enhancing creative performance and enabling cross-cultural collaboration in creative work.

(Format to be adjusted if needed)

Chunchen Xu: 450 Jane Stanford Way, Bldg 420, Stanford, CA 94305, USA, email: cxu66@stanford.edu

Xiao Ge, Hazel Markus, Jeanne Tsai: 450 Jane Stanford Way, Bldg 420, Stanford, CA 94305, USA

Nanami Furue: School of Management, Tokyo University of Science, 1-11-2, Fujimi, Chiyoda-ku, Tokyo, Japan

Daigo Misaki: School of Engineering, Department of Mechanical Systems Engineering, Kogakuin University, 1-24-2 Nishishinjuku, Shinjuku, Tokyo, Japan

1. Introduction

The way that designers think, feel and act is constantly influenced by their cultural contexts. For example, while the Chinese saying "急中生智" depicts a calm thinker who comes up with ingenious solutions amid crisis, such as in the famous Chinese folktale about *Sima Guang and the Water Tank*, the American mantra "unleash your creative potential" advocates excited self-expression as a way to elicit a generative state of mind. Nonetheless, most current theories and practices aimed at enhancing creativity in the US have been chiefly based on cultural norms, values and beliefs that are prevalent in European American, middle-class contexts. As a result, these theories and practices are less likely to resonate with or empower people from other cultural backgrounds. As our globalized society continues to evolve, it is of vital importance to uncover cultural groundings of theories and practices in regards to creativity.

One crucial step towards this goal is to understand how people in different cultures *feel* when they engage in creative problem solving. We use the term "designer" to refer to anyone who engages in creative processes. As a rich, dynamic, yet ubiquitous aspect of human experience, emotion can powerfully drive or derail a generation of novel ideas. A competent designer needs to understand their own and others' emotions, as they embark on a journey to bring new ideas and products to the world. However, we currently know little about how emotion impacts creative performance across the globe. The lack of rigorous research on emotion impedes developments of sound practices to guide designers' learning and growth and to facilitate cross-cultural collaboration.

We seek to advance the emerging research field centered on affect in design and contribute to design thinking research by illuminating cultural variations in designers' affective processes in creative problem solving. In the following sections, we first review how emotion is

currently understood in design research and practices. We then introduce our theoretical perspective on the cultural shaping of emotion. After that, we report two empirical studies, which suggest that culturally normative emotions are linked to self-reported creative outcomes such as the novelty of ideas. The studies also explore cultural variations in a few other emotional tendencies in creative contexts. Finally, we discuss implications of this work and describe future directions.

2. Theoretical Background

Scientific theories of emotion have evolved greatly over the past century. Throughout this article, we use the term "emotion" and "affect" to refer to people's subjective feeling states. Classical views of emotion assume categories (e.g., anger, joy) that are distinguishable as fingerprints at surface levels (e.g., facial behavior) and/or at neurological levels (e.g., patterns of autonomic nervous system). These basic views of emotion (also known as classical, essentialist views), though intuitive for people from certain cultures are repeatedly found problematic in light of recent research findings (Barrett, 2017).

Alternative views of emotion have flourished. Appraisal views, for instance, generally expect variability in emotional responses and are agnostic to mechanistic causes of emotion. One of the most adopted views is *Core Affect*. In the core affect model, two subjective feelings are used to characterize all sorts of emotion concepts across cultures; they are considered orthogonal to each other—valence (pleasure-displeasure) and arousal (sleepy-activated). The core affect view provides a potentially more culturally responsive language to talk about emotion. Russell and Barrett (Russell, 2003; Russell & Barrett, 1994) who developed the core affect concept are ambiguous about the causes or the biological mechanisms of basic feelings. Barrett, in her and her colleagues' recent work on the biological and neurological basis of emotion, explicitly took a

complexity-embracing approach and argued that emotion is constructed *in-situ*. This constructed view of emotion proposes that emotion emerges in a brain as it “continually makes meaning of sense data from its body and the world by categorizing those data with situation-specific concepts, thereby constructing experience and guiding action” (Barrett 2012, 2013).

In this paper, we adopt the core affect view to explore self-reported affective states in idea generation. In addition, we use the Affect Valuation Theory to examine people’s ideal and actual affective states based on a broad set of emotion words that are considered common across cultures (Tsai, Knutson & Fung, 2006).

2.1 Emotion and Design Research

Emotion is central to discovery and invention, yet its role is often invisible. As a methodology to make explicit implicit principles of creative acts, design thinking has put an emphasis on “thinking”, not “feeling” (Camacho, 2016). This is partly due to a long-standing stigma about emotion at work, especially in male-dominant engineering professions (Picard, 1997; Adams, 2011). Worse than being a subordinate to design cognition, emotion is sometimes viewed with disdain (Whitfield, 2007). For decades, research on the design process has focused on deriving the rational and analytical basis. For instance, efforts to improve engineering design largely cast skepticism on intuitive design practices that rely on feelings (Ranscombe, Kinsella & Blijlevens, 2017). By contrast, an affective basis, and its roles in design, are less acknowledged and studied (Ge, Leifer & Shui, 2021). In emotion research within design science, researchers have primarily looked at emotion as induced through designed products (e.g., user emotion), popularized through Don Norman’s work (Norman, 2004) or as a way to understand students’ educational experiences (e.g., academic experience) (Lönngren, et al., 2020).

Nevertheless, there has been a burgeoning interest in studying emotion in design due to a confluence of several forces. These factors include the recent technological growth of computational emotion sensing tools and models, the rise of human-centered design (e.g., empathy development for designers), as well as new research evidence in various domains showing how emotion is intertwined with cognition, creativity, learning and performance (e.g., Psychology: Csikszentmihalyi, 2013; Davis, 2009; Gino & Ariely, 2012, Management Science: Barsade, 2002; Amabile, Barsade, Mueller, & Staw, 2005, Learning Sciences: Pekrun, Hall, Goetz, & Perry, 2014).

Researchers have studied designers’ emotion from various perspectives—as a function of context, expertise, and design phase; as internal experiences, a joint social process, or a form of thought (see Ge et al., 2021 for a review of studies). A variety of approaches have also been taken across multiple research contexts to examine different kinds of design activities. We summarize these different approaches in Table 1.

Theoretical perspective	Focus	Examples in design research
Basic views	Mapping physio/psychological status (e.g., facial expression) to “internal” emotional states based on fixed categories	Studies on designers’ comfort using engineering equipment (Bezawada et al. 2017), Emotional experience in engineering design classrooms (Villanueva, et al., 2018) during CAD design (Zhou, et al., 2021)
Neuroscience views	Studying affect and emotion based on its relationship with cognition	“[Emotion is the] highest form of thought” (Olson, 2001), “Affective reasoning is the basis of rationality” (Dong, et al, 2009), “Design physiology” as part of the cognitive process of design (Gero & Milovanovic, 2020)
Core affect views	Investigating arousal and valence of feelings	Group emotional valence across design stages (Ewald, etc al, 2019)

Constructed views	Studying physio/psychological activities as constructed by situations	Situated emotion of experienced designers in co-design process (Ge, et al., 2021)
Mixed views	Taking mixed perspectives based on theoretical considerations, or, in the cases of some papers, as a result of empirical choices rather than adequate theoretical conceptions	Studies on team affective behavior to predict team performance (Jung & Leifer, 2011), software engineers' emotion in remote collaboration (Vrzakova et al., 2020)

Table 1. Emerging research about affect and emotion in design process and behavior.

2.2. Culture and Emotion in Design

Despite a growing research interest in emotion in the creative process, little research has investigated the crucial role of culture. Current creative practices in the US have prioritized emotion-related cultural values that are prevalent in European American contexts while cultural values of many other groups have not received as much attention in theory and practice. As a result, certain design practices surrounding emotion developed in European American contexts may not be applicable to other cultural contexts. For instance, in their qualitative study about creative design thinking practices at IDEO, Sutton and Hargadon (1996) wrote, “*Clients, like others at IDEO brainstorming, are taught to praise ideas, build on suggested ideas, be playful, wait their turn before talking, and not be critical. The justification for such guidelines is that they facilitate the flow of ideas. A side-effect is that participants are **encouraged (nearly required) to express only positive feelings. If designers or clients are negative, or just look grumpy, they are gently reminded to be more upbeat.***” Here, the ideation practices at IDEO prioritized the experience and expression of high-arousal, positive emotions, which tend to be the normative, desirable affective states in European American contexts. Nonetheless, people in other cultural contexts such as East Asian societies tend to value low-arousal, positive emotions or are more

likely to acknowledge the co-existence of both negative and positive emotions. Hence, it is important to understand cultural variations in affective norms and values as they apply to the creative process.

Emotions are “socially shared, collective scripts” (Kitayama & Masuda, 1995). People's experience and expression of their emotions are expected to vary systematically as a function of construals of the self (i.e., cultural schemas that people apply to defining who they are) (Markus & Kitayama, 1991). In societies where the self is typically thought of as being independent from other people and from contextual factors (i.e., *independent* self-construal), emotion is usually thought of as “internal” and defined as generated from individuals (Barrett, 2017; Mesquita & Markus, 2004). In cultural contexts where people perceive the self as overlapping with others (i.e., *interdependent* self-construal), emotion tends to be associated with other people and situational factors (Masuda et al., 2008). Tsai and her colleagues also studied how emotions that people generally value and ideally want to experience (i.e., *ideal affect*) may vary across cultures. They suggest that ideal affect allows people to effectively socialize with others and maintain a sense of self that is generally concordant with their respective contexts (Tsai et al., 2006). In particular, their work showed that high arousal, positive affect (e.g., excitement) is generally valued in American contexts, whereas low-arousal, positive affect (e.g., calmness) is valued in East Asian contexts.

3. Research Question and Hypothesis

Drawing on prior work, we ask the following research questions: 1) What affect do people in different cultural contexts actually and ideally want to experience during idea generation processes? 2) How do these different affective states relate to creative outcomes? As a starting point, we focused on comparing American and Japanese cultural contexts.

We hypothesized that people overall tend to align their emotion in the creative process with "ideal affect"—feeling states that are valued by their cultures. Mesquita and Boiger (2014) argued that to the extent that certain emotions produce better outcomes within a sociocultural context, these emotions tend to be experienced more frequently. It is plausible that aligning affective experience with cultural values is associated with better performance in idea generation. For instance, whereas designers in East Asia prefer to engage in silent and reflective “brainwriting” (Ge & Maisch, 2016), designers in the US enjoy riding on high energy to hunt for novel ideas. This difference in desirable emotion is also readily reflected by different ambiances across cultures. While the Nintendo headquarters in Japan are characterized by calmness and simplicity, Google's workplace is full of colorful facilities for exciting, free exchange of ideas. We propose that when designers' actual emotions are consistent with what is valued in their cultures, they are more likely to excel in creative problem solving.

Hypothesis 1a: People in American contexts are more likely to experience and ideally want high-arousal, positive emotions (HAP) in idea generation processes than people in Japanese contexts.

Hypothesis 1b: People in American contexts are less likely to experience or ideally want low-arousal, positive emotions (LAP) in idea generation processes than people in Japanese contexts.

Hypothesis 2a: Experiencing high-arousal, positive emotions (HAP) in idea generation processes is more likely to predict novelty of ideas among people in American contexts than people in Japanese contexts.

Hypothesis 2b: Experiencing low-arousal, positive emotions (LAP) in idea generation processes is more likely to predict novelty of ideas among people in Japanese contexts than people in American contexts.

In addition to exploring how culture may shape preferred levels of arousal and valence during ideation, we also investigated other dimensions of affect in creative processes, including the extent to which people experience socially engaging (versus disengaging) emotions. While

socially engaging emotions (e.g., guilt and friendly feelings) reflect a desire to build, maintain, and repair one's connection with others and with their surrounding social and physical environments broadly construed, socially disengaging emotions (e.g., anger, pride) are associated with the opposite desire (Kitayama, Mesquita & Karasawa, 2006). Cultural contexts consist of an unevenly distributed set of symbolic resources shared by a group of people—for example, narratives, images, schemas related to seeking harmony can be more easily found in East Asia than in the US. Consequently, culture holds the potential to foster different appraisals of lived experiences and produce different emotions.

Hypothesis 3: During creative problem-solving processes, people in Japanese contexts are more likely to experience socially engaging emotions and less likely to experience socially disengaging emotions than those in American contexts.

For exploratory purposes, we also examined a few other emotional tendencies at different stages of creative problem-solving, including cultural variations in *emotion expressiveness* (how easy or difficult it is for people to express emotion), *emotion fluctuation* (how much people's emotions fluctuate over the course of time), *emotion attentiveness* (the degree to which people pay attention to their emotions), and *emotion ambivalence* (a tendency to experience a mix of negative and positive emotions).

In the following sections, we presented two empirical survey studies testing the hypotheses. We first conducted a pilot study to simply examine potential differences in actual and ideal affect among American participants, and found evidence in support of our theorizing. We then recruited a sample of American and Japanese participants and compared their affective experience and tendencies during creative problem-solving.

4. Pilot Study

4.1 Method

4.1.1 Participants

We analyzed responses from 106 American adult participants ($M_{\text{age}}(SD) = 32.56(11.36)$; 45 men, 59 women, 2 other; 69 White, 11 Black, 6 Latinx, 19 Asian, 2 other). Participants were recruited from Prolific.

4.1.2 Procedure

Participants were asked to briefly write down a recent time that they came up with ideas to solve a particular problem or to create a product. They were instructed to focus on their feelings and emotions when describing their experience, and were required to spend at least 1 minute on this task with 30-200 words. After that, participants reported their ideal and actual affect during idea generation. The order of the questions about ideal and actual affect was randomized. Participants then evaluated their own ideas in terms how useful and novel the ideas were. In the end, they completed demographic questions including age, gender, race and ethnicity, and annual household income. They also completed a short reading comprehension question as an attention check.

4.1.3 Measures

Ideal and actual affect: We adopted six items from Affect Valuation Index (AVI) (Tsai, Knutson, & Fung, 2006). We focused on items examining ideal and actual high-arousal positive states (HAP; elated, excited, enthusiastic) and low-arousal positive states (LAP; calm, peaceful, serene). Participants answered the questions on a 5-pt. scale (1 = "Not at all" to 5 = "Extremely").

Self-appraisal of ideas: We used two items to measure self-reported qualities of ideas (Hennessey & Amabile, 2010): 1) How novel was your idea? 2) How useful was your idea? Participants answered the questions on a 5-pt. scale (1 = "Not at all" to 5 = "Extremely").

4.2. Results

We summarized descriptive statistics and correlations among variables in Table 2.

	1	2	3	4	5	6	7	8	<i>M</i>	<i>SD</i>
1. Self-reported novelty of ideas	-								2.58	1.19
2. Self-reported usefulness of ideas	.42***	-							3.59	1.07
3. Ideal HAP	.12	.24*	-						3.58	1.07
4. Actual HAP	.52***	.41***	.39***	-					2.60	1.28
5. Ideal LAP	.07	.09	.41***	.14	-				3.36	0.97
6. Actual LAP	.40***	.33***	.18	.57***	.28**	-			2.26	0.99
7. Age	-.01	.06	-.12	.09	-.05	.08	-		32.56	11.36
8. Gender	-.35***	-.15	-.17	-.29**	.03	-.12	.07	-	0.58	0.50
9. Annual Household Income	.17	.28**	.04	.18	.05	.28**	-.01	-.17	6.37	3.52

Note: Gender was coded as male = 0, female and other = 1.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 2. Descriptive statistics and correlations among relevant variables in Pilot Study.

4.2.1 Differences in actual and ideal affect

We conducted paired *t*-tests and found significant differences between ideal and actual HAP and LAP in participants' creative problem solving processes. As shown in Figure 1, American participants generally wanted to have both more HAP and LAP than they actually had (HAP: $t(105) = 7.68, p < .001$; LAP: $t(105) = 9.70, p < .001$) during the process of creative problem solving. In addition to experiencing more HAP than LAP ($t(105) = 3.23, p = .002$), American participants also desired more HAP than LAP ($t(105) = 2.00, p = .05$).

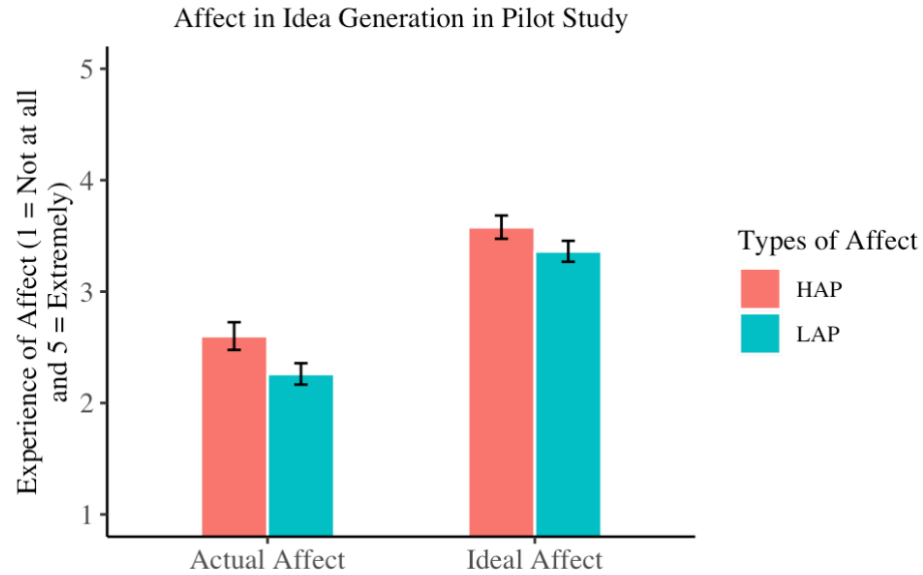


Figure 1. Ideal and actual affect during idea generation among American participants in Pilot Study. Error bars represented standard errors.

4.2.2 Affect and self-reported novelty and usefulness of ideas

We constructed two regression models to predict self-reported novelty and usefulness of ideas with affect (actual and ideal HAP and LAP) while including common demographic variables as covariates including gender ("male" was coded as "0" and "female" and "other" as "1"), age, and annual household income (before tax; measured on a 1-11 scale with each scale representing a range based on a reasonable income distribution in the US). We found that participants' actual HAP, but not others (i.e., ideal HAP, ideal and actual LAP), predicted self-appraisals of idea novelty and usefulness. Table 3 presents these results.

	<i>Dependent variable:</i>	
	Self-reported novelty of ideas	Self-reported usefulness of ideas
	(1)	(2)
Ideal HAP	−0.127 (−0.343, 0.089)	0.127 (−0.082, 0.336)
Actual HAP	0.371*** (0.165, 0.576)	0.212* (0.013, 0.411)
Ideal LAP	0.020 (−0.208, 0.248)	−0.038 (−0.258, 0.183)
Actual LAP	0.199 (−0.055, 0.454)	0.120 (−0.126, 0.367)
Gender	−0.554** (−0.966, −0.142)	−0.016 (−0.415, 0.383)
Age	−0.005 (−0.023, 0.012)	0.004 (−0.012, 0.021)
Annual Household Income	0.007 (−0.051, 0.064)	0.062* (0.006, 0.117)
Constant	2.005*** (0.890, 3.120)	1.913*** (0.833, 2.993)
Observations	106	106
R ²	0.344	0.229
Adjusted R ²	0.297	0.174

Note: Gender was coded as male = 0, female and other = 1. Unstandardized coefficients are presented; 95% confidence intervals are in parentheses.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 3. Regression results predicting novelty and usefulness of ideas in Pilot Study.

4.3. Discussion

In Pilot Study, we found that American participants expressed high-arousal, positive emotions (i.e., HAP) that were generally consistent with what is considered valued in their cultural context. In addition, experiencing culturally normative emotions (i.e., HAP) predicted creative outcomes such as self-reported novelty and usefulness of ideas.

5. Main Study

5.1 Methods

5.1.1 Participants

We analyzed responses from 127 American participants ($M_{\text{age}}(SD) = 39.2(10.5)$; 59 women, 68 men; 110 White, 13 Black, 6 Latinx, 4 Asian, 1 Other) and 155 Japanese participants ($M_{\text{age}}(SD) = 41.7(9.38)$, 59 women, 96 men). Participants were recruited from MTurk (US) and Lancers (Japan) respectively.

5.1.2 Procedure

Participants were first asked to write down a recent time that they came up with ideas to solve a problem or improve a situation. After that, participants were instructed to specifically describe and elaborate on their feelings as they came up with ideas, including what the feelings were like and how the feelings changed during the process. To capture a broader range of people's affective experiences, we instructed participants to describe their subjective feeling states even when they did not readily have words for these feelings. Participants were required to spend at least 1 minute on this task with 30-200 words. Next, participants reported their feelings during idea generation in a different way. They were asked to list up to five feelings that they experienced, if any, during the process of problem-solving that they provided. For each listed feeling, they were asked to rate its intensity as well as its timing relative to the whole process (i.e., early, middle, and/or end). In addition, the participants reflected on how difficult it was to describe their feelings, and how much fluctuation, awareness and ambivalence of feelings they experienced.

Next, participants reported their ideal and actual affect during their processes of idea generation. The order of the questions was randomized. Following that, participants evaluated their own problem solving outcomes. Finally, they completed demographic questions including age, gender, race and ethnicity, and annual household income. They also completed a short reading comprehension question as an attention check. American participants completed the survey in English and Japanese participants completed the same survey in Japanese.

5.1.3 Measures

Ideal and actual affect: We used the same measure as in Pilot Study, focusing on examining ideal and actual high-arousal positive states (HAP) and low-arousal positive states (LAP). We adopted the translation from prior work (De Almeida & Uchida, 2021) for the Japanese version.

Self-described emotion during idea generation: Participants listed up to five different feeling states in their own words (*self-listed feelings*). Participants also described their emotional experience in written forms (*free-form responses of feelings*), which we subsequently coded for their levels of social engagement.

Emotional tendencies: We used a few items to identify participants' emotional tendencies including: *emotion expressiveness* ("How easy or difficult was it for you to describe your feelings?"; 1 = "Extremely Easy", 5 = "Extremely Difficult") (reverse-recoded for subsequent analyses), *emotion fluctuation* ("To what extent did your feelings fluctuate as you came up with the idea?"; 1 = "None at all", and 5 = "A great deal"), *emotion attentiveness* (To what extent did you pay attention to your feelings while you were coming up with the idea?"; 1 = "Never", and 5 = "Always"), and *emotion ambivalence* ("To what extent did you simultaneously experience different feelings in the process of coming up with the idea you described?"; 1 = "Never", and 5 = "Always").

Self-appraisal of ideas: We used the same item to measure novelty of ideas as in Pilot Study. We also asked participants to answer the question, "How good was the idea?" on a 5-pt. scale (1 = "Not at all" and 5 = "Extremely"). We added this item as a more general way to gauge the quality of ideas as novelty may be valued more in American contexts than in Japanese contexts (Ge, et al., 2022). For exploratory purposes, we also measured the extent to which participants believed that their ideas solved the problems they described on a 5-pt. scale (1 = "Not at all" and 5 = "Extremely").

5.2. Results

We summarized descriptive statistics and correlations among variables in Table 4.

	1	2	3	4	5	6	7	8	M	SD
1. Idea novelty	-								2.60	1.12
2. How good ideas are	.39***	-							3.81	0.91
3. Ideal HAP	.15*	.18**	-						0.46	0.58
4. Actual HAP	.23***	.22***	.53***	-					0.44	0.66
5. Ideal LAP	-.13*	0.07	-.17**	-.14*	-				0.62	0.59
6. Actual LAP	-0.09	-0.05	-.21***	-0.11	.39***	-			0.30	0.62
7. Age	0.02	0.05	0.07	.15**	0.05	0.06	-		40.54	9.95
8. Gender	-0.08	0.04	-0.08	0.04	.13*	-0.07	-0.04	-	0.42	0.49
9. Annual Household Income	.12*	.16**	.29***	.15*	-0.02	-.15**	0.04	.19**	5.49	3.02

Note: Gender was coded as male = 0, female and other = 1.

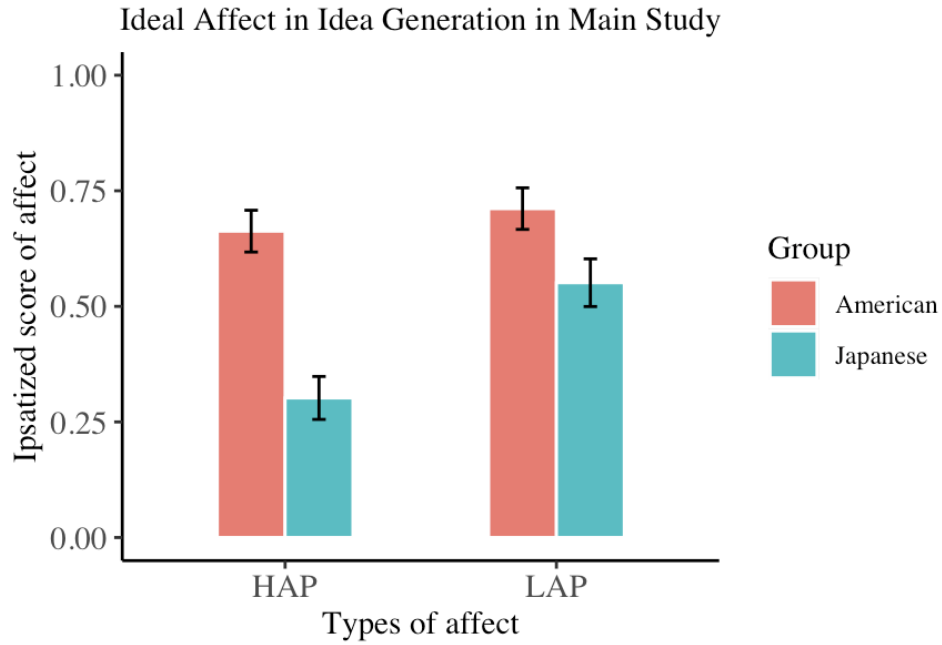
* $p < .05$; ** $p < .01$; *** $p < .001$

Table 4. Descriptive statistics and correlations among relevant variables in Main Study.

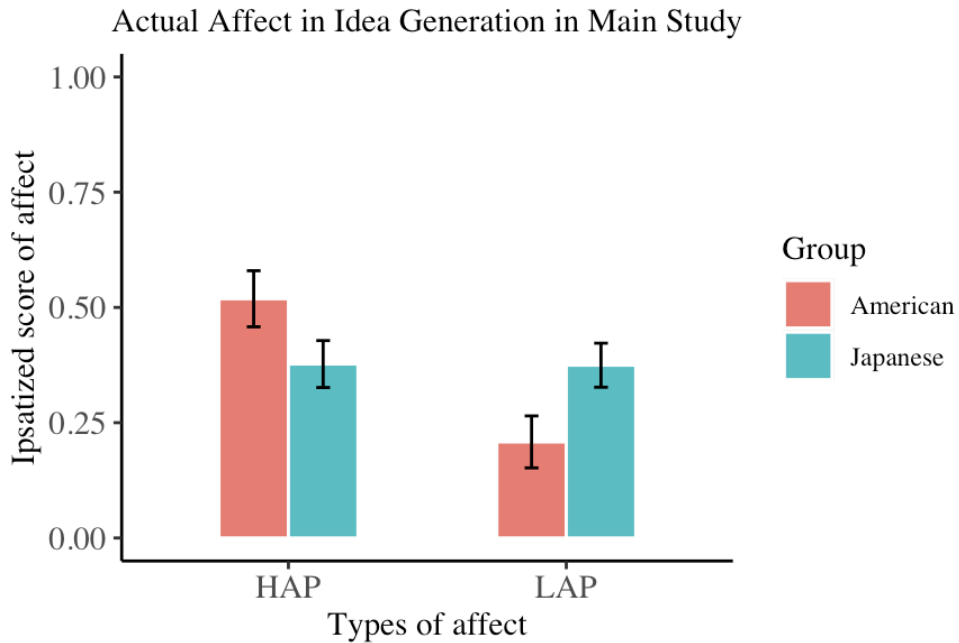
5.2.1 Actual and ideal affect in idea generation

We conducted one-way ANOVA tests to examine group differences in actual and ideal affect. Here, we used ipsatized score to control for potential response style differences in all subsequent analyses (Tsai et al., 2006). In terms of ideal affect, American participants ideally wanted to experience more HAP and more LAP than Japanese participants, $F_s(1, 280) = 30.2$ and 5.25 , $p <$

.001 and $p = .02$ respectively. In terms of actual affect, American participants reported higher actual HAP than Japanese participants, $F(1, 280) = 3.23, p = .07$. Japanese participants reported actually experiencing more LAP than American participants, $F(1, 280) = 5.13, p = .02$.



(a)



(b)

Figures 2a and 2b. Ideal and actual affect in idea generation across American and Japanese participants in Main Study. Error bars represented standard errors.

To examine whether participants' ideal and actual HAP and LAP would predict self-appraisals of idea outcomes, in particular, how novel the idea is and how good the idea is, we initially constructed linear regression models controlling for the same demographic variables as in Pilot Study. Due to lack of model fit, backward stepwise regression was performed separately for American and Japanese participants to include other relevant variables. Results for both groups showed that, in addition to some of the ideal and actual affect variables, the *problem-solved* variable (i.e., how much the problem was solved) emerged as a significant predictor. Therefore, we constructed linear regression models based on demographic variables and the problem-solved variable.

As shown in Table 5, we found that for American participants, actual HAP, but not other factors (i.e., ideal HAP, ideal and actual LAP), predicted how good the idea is perceived to be ($\beta = .29, t(118) = 3.12, p = .008$) and how novel the idea is perceived to be ($\beta = .30, t(118) = 2.94, p = .004$). Due to lack of model fit in *Model 1-American*, we included other ideal and actual affect variables—P (positive), N (negative), HA (high arousal) and LA (low arousal)—as additional predictors, which improved the model (Adjusted R^2 from .07 to .12). We found that American participants' actual HAP ($\beta = .35, t(112) = 2.87, p = 0.005$), but not other affect variables, predicted self-appraisals of ideal novelty. For Japanese participants, affect related variables did not predict idea novelty; actual LAP, but not other affect variables, marginally predicted self-appraisals of how good the idea is ($\beta = .12, t(146) = 1.72, p = .09$).

	<i>Dependent variable:</i>			
	How Novel Ideas Are (1)		How Good Ideas are (2)	
	Japanese	American	Japanese	American
Ideal HAP	-0.117 (-0.445, 0.211)	-0.403 (-0.865, 0.059)	0.054 (-0.189, 0.297)	-0.239 (-0.525, 0.047)
Ideal LAP	-0.202 (-0.465, 0.062)	-0.466* (-0.906, -0.025)	-0.075 (-0.269, 0.120)	0.198 (-0.075, 0.470)
Actual HAP	0.216 (-0.065, 0.497)	0.520** (0.174, 0.866)	0.036 (-0.173, 0.244)	0.341** (0.127, 0.555)
Actual LAP	-0.070 (-0.348, 0.209)	0.116 (-0.227, 0.460)	0.180 (-0.026, 0.386)	-0.171 (-0.383, 0.042)
Problem solved	0.340*** (0.185, 0.494)	-0.004 (-0.280, 0.272)	0.608*** (0.494, 0.723)	0.399*** (0.229, 0.570)
Gender	-0.385* (-0.697, -0.072)	-0.078 (-0.509, 0.354)	-0.065 (-0.297, 0.166)	0.143 (-0.124, 0.410)
Age	0.008 (-0.008, 0.024)	-0.003 (-0.022, 0.017)	0.004 (-0.008, 0.015)	0.001 (-0.011, 0.013)
Annual Household Income	-0.026 (-0.081, 0.029)	0.043 (-0.029, 0.115)	0.006 (-0.034, 0.047)	-0.003 (-0.047, 0.042)
Constant	1.170** (0.311, 2.030)	3.120*** (1.690, 4.570)	1.200*** (0.561, 1.830)	2.220*** (1.330, 3.110)
Observations	155	127	155	127
R ²	.195	.127	.443	.267
Adjusted R ²	0.151	.068	0.413	0.217

Note: Gender was coded as male = 0, female and other = 1. Unstandardized coefficients are presented; 95% confidence intervals are in parentheses.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 5. Regression results predicting idea novelty and how good ideas are in Main Study.

5.2.2. Self-listed feeling states during idea generation.

We conducted sentiment analysis using feelings that participants described in their own words (i.e., *self-listed feelings*). Valence and arousal scores of self-listed feelings ranging from 0 (lowest) to 1 (highest) were derived based on National Research Council Canada (NRC) sentiment and emotion lexicons (Version 0.92, Mohammad & Turney, 2013). The Japanese responses were first translated using AI translator *Deeply.com* and then double-checked by one of our Japanese collaborators. We conducted one-way ANOVA tests and found that Japanese participants generally expressed emotions with lower valence ($M = 0.35$, $SD = 0.17$) than the American participants ($M = 0.45$, $SD = 0.22$), $F(1,280) = 17.07$, $p < .001$. Similarly, Japanese participants expressed emotions with lower arousal ($M = 0.36$, $SD = 0.13$) than American participants ($M = 0.42$, $SD = 0.12$), $F(1,280) = 19.24$, $p < .001$. Figure. 3 shows the results.

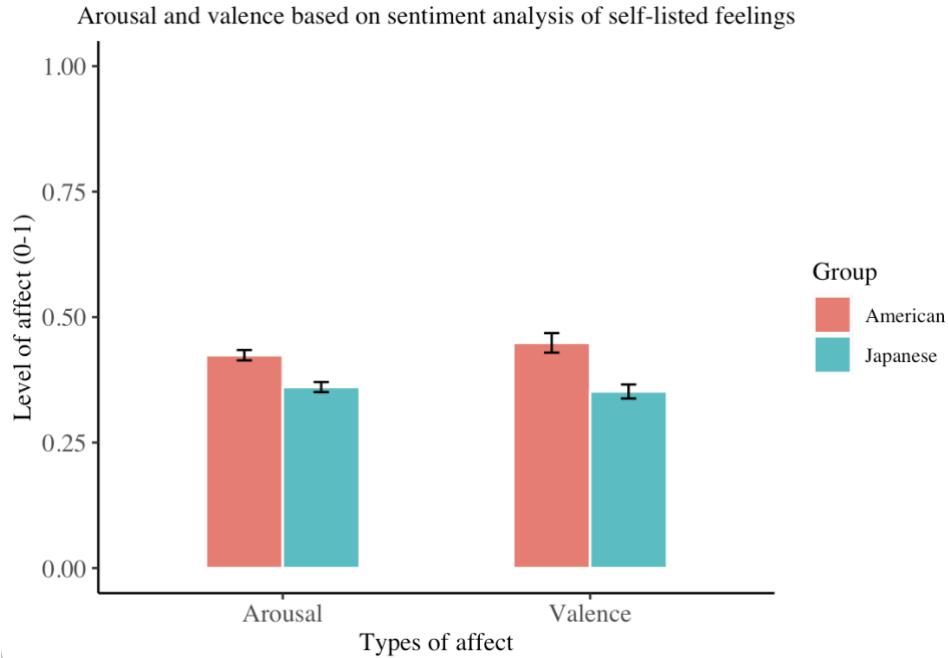


Figure 3. Cultural differences in levels of arousal and valence as indicated by self-listed feelings.

5.2.3. Change in affect across different stages of idea generation

Using the "wordcloud" package in R, we conducted a preliminary text data analysis to examine participants' emotions at different stages of ideation. We removed common words (e.g., *the, and, for, in, to*, etc.) and starter words (e.g., "I feel", "I had the feeling of"), and extracted word stems for frequency analysis. American participants' average word frequency in describing feelings is higher than Japanese ($t(281) = 6, p < .001$). This result suggests that American participants are more likely to have a shared model about emotion than Japanese participants. In the American context, through socialization, people may have incorporated a set of common emotion concepts (e.g., frustration, happiness, anger) to explain their experiences and behaviors related to creative problem-solving. By comparison, Japanese may have a more diverse understanding about what emotions they associate with idea generation, and their emotional

Figure 4. Word clouds of listed feelings across different stages of idea generation for Japanese and American samples. Larger fonts indicate higher frequency.

5.2.4. Cultural variations in socially engaging emotion during ideation

Two of the authors coded participants' free-form responses of feelings based on their expressed levels of social engagement (Markus & Kitayama, 1991). Responses expressing one's inner feelings independent from others were coded as "1", and responses expressing feelings related to social engagement in reference to others were coded as "0". We found 41 socially engaging feelings out of 155 responses (25.8%) in the Japanese sample, compared with 13 out of 127 responses (10.2%) in the American sample. A Chi-squared test of independence was performed to examine the relation between cultural group and levels of social engagement versus disengagement regarding emotion. Overall, Japanese participants were more likely to construct their emotions in reference to other people than were American participants, $\chi^2(1, N = 282) = 10, p = .001$.

Examples of interdependent feelings from the Japanese sample included: "I wonder how my friends are feeling" and "...I was so angry...[but] I managed to adjust it because of the other people involved in the project." Examples of interdependent feelings from the American sample include: "I felt really happy with myself when I came up with this idea. I thought others would be proud of me and that I could help others at work with my idea," and "I felt pretty great contributing to the whole team and providing them with ideas that made the supervisor very happy."

5.2.5. Other dimensions of affective tendencies during idea generation

To examine differences in emotional tendencies, we conducted a one-way Multiple Analysis of Variance (MANOVA) combining all four DVs (emotion expressiveness, emotion

fluctuation, emotion attentiveness, emotion ambivalence) as dependent variables, and found a significant multivariate effect of participants' cultural backgrounds, Pillai's Trace = .15, $F(4, 276) = 12$, $p < .001$, partial $\eta^2 = 0.15$. Taken separately, this was only significant for emotion expressiveness, $F(1, 279) = 45.7$, $p < .001$, and emotion fluctuation, $F(1, 279) = 4.28$, $p = .039$. This means that Japanese participants found it more difficult to express emotion and experienced a higher level of fluctuation in their emotional states than did their American counterparts.

	Emotion fluctuation		Emotion attentiveness		Emotion ambivalence		Emotion Expressiveness	
	American	Japanese	American	Japanese	American	Japanese	American	Japanese
How novel was my idea?	0.02	0.27***	0.13	0.24**	0.05	0.25**	-0.02	-0.10
How good was my idea?	0.00	0.17*	0.20*	0.14	0.02	0.19*	0.23**	0.07
How much did I learn during this process?	0.19*	0.31****	0.14	0.31***	0.15	0.32****	0.05	0.00

Note: * $p < .05$; ** $p < .01$; *** $p < .001$

Table 5. Correlations between emotional tendencies and various dependent variables in Main Study.

We examined how participants' emotional tendencies may predict outcomes including how novel and how good they perceived their ideas to be. First, we conducted an exploratory correlation analysis as shown in Table 5. The correlation analyses show that emotional tendency variables differentially predicted idea generation outcomes for these two samples. For instance, emotion fluctuation was positively associated with qualities of ideas and learning among Japanese participants whereas it only predicted learning for Americans. Furthermore, we again constructed regression models to predict the three outcome variables (e.g., novelty of ideas, how good the ideas were, and levels of learning) using these four emotion tendency variables while

controlling for common demographic characteristics including age, gender and annual household income and how much their problem was solved. Overall, we found that only emotion fluctuation and emotion attentiveness predicted Japanese participants' self-appraisal of idea novelty ($ps = .08$ and $.03$ respectively). By comparison, none of these emotional tendencies predicted outcome variables for American participants.

5.3. Discussion

In this study, we found evidence supporting H2a that experiencing HAP during idea generation is more likely to predict novelty of ideas for people in American contexts than those in Japanese contexts, despite that no significant difference in actual HAP was found across the two groups. This finding suggests that Americans may use their own emotion to judge ideas whereas Japanese may take into considerations multiple factors (e.g., others' opinions) and rely less on their own emotions to evaluate ideas.

We did not find evidence supporting H2b. Yet we found that for Japanese, experiencing LAP during idea generation tended to predict how good the idea was. It is important to note that these two cultures may place relatively different emphases on how important it is for an idea to be novel. Hence, a question such as "how good is this idea?" may prove to be a general way to gauge the quality of ideas as valued by people in different cultural contexts.

Results of exploratory text and sentiment analyses were generally consistent with respective cultural models of emotion in these two contexts. We found people in Japanese contexts were more likely to experience socially engaging emotions and less likely to experience socially disengaging emotions than those in American contexts. In addition, a series of emotional tendencies (e.g., ambivalence, fluctuations) showed different associations with the self-appraised creative outcomes for these two samples.

6. General Discussion

Overall, emotion-shaping through culture has been under-recognized in creative research and practices. Popular practices tend to prescribe a particular emotional route to ideation in the US — high-arousal, positive emotions (e.g., excitement). However, we argue that people's experiences and expressions of emotion in creative problem-solving are influenced by historically derived cultural norms and values. While an excitement-oriented affective route is consistent with cultural norms regarding emotion in the European American contexts, people in many interdependent contexts ideally want to experience low-arousal, positive emotions and they normatively acknowledge mix-valenced emotions. Furthermore, people in these contexts often construct their emotion in reference to other people or to their socio-physical surroundings. Hence, they are more likely to experience socially engaging emotions that motivate building and maintaining social connection.

As shown by our empirical data, compared with American participants, Japanese participants reported more frequent experiences of low-arousal, positive emotion (e.g., calmness) as well as more socially engaging emotions in an idea generation task. Our findings serve to remind designers of the critical role emotion plays in provoking a generative mind state. We also encourage future researchers to further explore how culture underpins expressions of emotion, and why and in what ways emotion can be leveraged to make creative practices culturally responsive.

6.1. Limitations

We acknowledge some important limitations of the current work. First, our study designs were correlational in nature and we used self-reported creative outcomes, which are the participants' own subjective evaluations of their ideas. However, given that emotion casts an influence on

people's cognitive processes, it is plausible that experiencing positive emotion can lead people to appraise their ideas more positively (these associations, however, are likely to be culturally variable as well). In the meanwhile, having positive idea generation outcomes may produce positive emotion. Although participants were asked to report their emotion during idea generation, they may not have perfectly separated emotion at different stages. Hence, it would be important to design studies to determine the causal mechanism and to use other ratings for qualities of ideas.

Second, in this study, we did not address the within-culture diversity in American society. The foregoing theorizing regarding high-arousal, positive emotion as the ideal affect mainly applies to middle-class, European American contexts. Different socio-cultural groups in the US likely have different norms and values regarding emotional experience and expression. It would be critical to replicate our findings with more diverse samples to include clear comparisons between European American participants (as opposed to Americans in general) with participants in different East Asian societies (e.g., Korean, Chinese).

Third, there is immense heterogeneity in how creativity manifests in different domains. For example, artistic creativity may involve different affective experience from pragmatic problem-solving creativity. Our study design used a recall paradigm to ask participants to describe any recent creative problem-solving experience. Thus, it is possible that our American and Japanese samples may have provided ideas for solving different problems, which may in turn account for different affect being reported. Fourth, we used a one-time, self-reported measure of emotion in our studies. However, given that emotion is fleeting and dynamic, it would be important to collect data at various points using designs such as repeated measure

studies with *Experience Sampling Methods* and adopt multiple diverse measures of emotion (e.g., physiological measures).

6.2. Implications

Emotion profoundly influences people's cognitive processes, including idea generation, judgment and decision-making (Lerner, Li, Valdesolo & Kassam, 2015). Hence, attending to how emotion affects creative outcomes pinpoints a promising new route to encourage people to come up with better ideas to solve problems in their respective contexts. Research on affect in design can shed light on how to foster an environment conducive to idea generation in a culturally resonant way. For instance, should a particular social and physical environment for idea generation be designed to evoke high-arousal, positive (versus low-arousal, positive) emotion? Should educators highlight and encourage emotion ambivalence or fluctuation? How does expressing one's or acknowledging others' emotions affect the quality of ideas generated? Insights into managing the affective dimension of creative problem-solving could bolster creative performance.

Highlighting emotion as a cultural product can also guide people to incorporate diverse cultural values in designing products with a direct link to emotion. At a fundamental level, the very concept of emotion is culturally variable. But such variability in emotional experience has not been well reflected in design practices. For instance, there has been a lot of enthusiasm about building artificially intelligent models that detect and perform emotion. Current conceptual models of emotion that guide the algorithmic developments are likely to be based on theories of emotion connected with cultural assumptions in European American contexts (White & Katsuno, 2022). Popular theories about emotion (e.g., basic emotion) adopted in affective AI products tend to encode a universalistic fallacy that people around the globe experience a set of similar, "basic"

feelings. Nonetheless, such AI products may be less effective or biased when used in diverse cultural contexts. A cultural consideration of affective AI products is important to ensure equitable design that benefits a broader range of the population across the globe.

Finally, emotion is an intuitive way for people to empathize with and relate to others. It is thus a key factor to fostering effective cross-cultural collaboration. For example, in multicultural teams, people from different cultural backgrounds are likely to experience and exhibit different emotional patterns when interacting with each other. A lack of cultural perspective and knowledge about emotion can cause confusion and conflict to the detriment of team cohesion and performance. On the other hand, adequately understanding cultural underpinnings of affect would encourage team members to better negotiate communication norms. Such a scenario would encourage people from minoritized backgrounds to voice their viewpoints.

6.3. Future Direction

It would be interesting to examine whether experiencing culturally counter-normative emotions may yield better creative performance under certain circumstances as well. This is because emotions that do not conform to cultural norms may be less frequently experienced, and hence may elicit more novelty in thoughts. Future research could examine this possibility by treating creative processes as a continuous experience and taking a longer horizon in study designs.

Another fruitful direction is to examine cultural norms regarding the expression of emotion. Culture can be viewed as a toolkit and instruments (e.g., languages) for people to encode and express their emotion. However, languages are powerful tools for activating existing cultural values and may constrain the experience and expression of emotion. Many fleeting emotions may not be readily recorded and thereby may go unnoticed, as participants do not have the tools to capture their own subjective experience or to share it with others. These subjective

experiences, however, may present a window to capturing novelty. For instance, Isbister et al. (2006) explored a body-based, nonverbal means for evaluating a system's affective impact on users. The authors created a set of Sensual Evaluation Instrument objects as a way to measure affect. Their approach presents a way to record affect by bypassing languages as a constraint.

Future research can investigate if providing participants with the means to record their emotion may lead participants to generate more ideas that are novel. For example, can integrating visual means (e.g., drawing and sketching) or movements (e.g., dancing) based on people's emotion boost performance in creative problem-solving? Likewise, it is worthwhile to explore if creating novel symbols for recording emotion can serve as vehicles to enhance awareness of one's subjective experience and help facilitate the expression of novel ideas.

7. Conclusion

Emotion is a ubiquitous part of the creative process in different societies. The ways that people experience and express emotion are profoundly shaped by the particular cultural contexts they are in. We seek to advance nascent field of scientific research on the cultural shaping of emotion in creative activities. Our exploratory work has shown that Japanese and American participants report distinct emotional patterns, which then differentially predict self-appraised creative outcomes. We call for future work to build upon our findings and further investigate how understanding emotion can pinpoint new ways to encourage creative problem-solving in different cultures.

8. References

- Adams, R., Evangelou, D., English, L., De Figueiredo, A. D., Mousoulides, N., Pawley, A. L., Schiefellite C., Stevens R., Svinicki M., Trenor J. M., & Wilson, D. M. (2011). Multiple perspectives on engaging future engineers. *Journal of Engineering Education*, 100(1), 48-88.
- Barrett LF. 2012. Emotions are real. *Emotion* 12(3):413–29
- Barrett LF. 2013. Psychological construction: the Darwinian approach to the science of emotion. *Emot. Rev.* 5(4):379–89
- Barrett LF. 2017. *How Emotions Are Made: The Secret Life of the Brain*. London: Palgrave Macmillan.
- Barsade, S. G. (2002). The ripple effect: Emotional contagion and its influence on group behavior. *Administrative science quarterly*, 47 , 644-675.
- Bezawada, S., Hu, Q., Gray, A., Brick, T., & Tucker, C. (2017). Automatic facial feature extraction for predicting designers' comfort with engineering equipment during prototype creation. *Journal of Mechanical Design*, 139(2).
- Camacho, M. (2016). David Kelley: From Design to Design Thinking at Stanford and IDEO. *She Ji: The Journal of Design, Economics, and Innovation*, 2 (1). doi: 10.1016/j.sheji.2016.01.009
- Csikszentmihalyi, M. (2013). *Flow: The psychology of happiness*. Random House.
- Davis, M. A. (2009). Understanding the relationship between mood and creativity: A meta-analysis. *Organizational behavior and human decision processes*, 108 , 25-38.
- De Almeida, I., & Uchida, Y. (2021). Who Can Buffer Marginalization Risk? Affect Experience, Affect Valuation, and Social Marginalization in Japan and Brazil. *Frontiers in Psychology*, 12, 501165.
- Dong, A., Kleinsmann, M., & Valkenburg, R. (2009). Affect-in-cognition through the language of appraisals. *Design Studies*, 30(2), 138e153.
- Ewald, B., Menning, A., Nicolai, C., & Weinberg, U. (2019). Emotions along the design thinking process. In *Design thinking research* (pp. 41e60). Cham: Springer.
- Ge, X., Leifer, L., & Shui, L. (2021). Situated emotion and its constructive role in collaborative design: A mixed-method study of experienced designers. *Design Studies*, 75, 101020.
- Ge, X., & Maisch, B. (2016). Industrial Design Thinking at Siemens Corporate Technology, China. In *Design Thinking for Innovation* (pp. 165-181). Springer International Publishing.
- Ge, X., Xu, C., Furue, N., Misaki, D., Lee, C., & Markus, H. R. (2022). The Cultural Construction of Creative Problem-Solving: A Critical Reflection on Creative Design Thinking,

Teaching, and Learning. In *Design Thinking Research: Achieving Real Innovation* (pp. 291-323). Cham: Springer International Publishing.

Gero, J. S., & Milovanovic, J. (2020). A framework for studying design thinking through measuring designers' minds, bodies and brains. *Design Science*, 6.

Gino, F., & Ariely, D. (2012). The dark side of creativity: original thinkers can be more dishonest. *Journal of personality and social psychology*, 102 , 445.

Hennessey, B. A., & Amabile, T. M. (2010). Creativity. *Annual review of psychology*, 61, 569-598.

Imada, T., & Ellsworth, P. C. (2011). Proud Americans and lucky Japanese: Cultural differences in appraisal and corresponding emotion. *Emotion*, 11(2), 329–345.

Isbister, K., Höök, K., Sharp, M., & Laaksolahti, J. (2006, April). The sensual evaluation instrument: developing an affective evaluation tool. In *Proceedings of the SIGCHI conference on Human Factors in computing systems* (pp. 1163-1172).

Jung, M. F., & Leifer, L. J. (2011). A method to study affective dynamics and performance in engineering design teams. In *DS 68-7: Proceedings of the 18th International Conference on Engineering Design (ICED 11), Impacting Society through Engineering Design, Vol. 7: Human Behaviour in Design, Lyngby/Copenhagen, Denmark, 15.-19.08. 2011*.

Kitayama, S., Mesquita, B., & Karasawa, M. (2006). Cultural affordances and emotional experience: socially engaging and disengaging emotions in Japan and the United States. *Journal of personality and social psychology*, 91(5), 890–903. <https://doi.org/10.1037/0022-3514.91.5.890>

Kitayama, S., & Masuda, T. (1995). Reappraising cognitive appraisal from a cultural perspective. *Psychological Inquiry*, 6(3), 217-223.

Tsai, J.L. Knutson, B., & Fung, H. H. (2006). Cultural variation in affect valuation. *Journal of Personality and Social Psychology*, 90, 288-307.

Lerner, J. S., Li, Y., Valdesolo, P., & Kassam, K. S. (2015). Emotion and decision making. *Annual review of psychology*, 66, 799-823.

Lönngrén, J., Adawi, T., Berge, M., Huff, J., Murzi, H., Direito, I., ... & Sultan, U. (2020, October). Emotions in engineering education: Towards a research agenda. In *2020 IEEE Frontiers in Education Conference (FIE)* (pp. 1-5). IEEE.

- Masuda, T., Ellsworth, P. C., Mesquita, B., Leu, J., Tanida, S., & Van de Veerdonk, E. (2008). Placing the face in context: Cultural differences in the perception of facial emotion. (Vol. 94) (No. 3). *American Psychological Association*. doi: 10.1037/0022-3514.94.3.365
- Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological review*, 98(2), 224.
- Mesquita, B., & Markus, H. R. (2004, April). Culture and emotion: Models of agency as sources of cultural variation in emotion. In *Feelings and emotions: The Amsterdam symposium* (pp. 341-358).
- Mesquita, B., & Boiger, M. (2014). Emotions in context: A sociodynamic model of emotions. *Emotion Review*, 6(4), 298-302.
- Mohammad, S. M., & Turney, P. D. (2013). Nrc emotion lexicon. *National Research Council, Canada*, 2, 234.
- Miyamoto, Y., Uchida, Y., & Ellsworth, P. C. (2010). Culture and mixed emotions: co-occurrence of positive and negative emotions in Japan and the United States. *Emotion* (Washington, D.C.), 10(3), 404–415. <https://doi.org/10.1037/a0018430>.
- Norman, D. A. (2004). *Emotional design: Why we love (or hate) everyday things*. Civitas Books.
- Olson, G. B. (2001). Brains of steel: mind melding with materials. *International Journal of Engineering Education*, 17(4/5), 468-471.
- Pekrun, R., Hall, N. C., Goetz, T., & Perry, R. P. (2014). Boredom and academic achievement: Testing a model of reciprocal causation. *Journal of Educational Psychology*, 106, 696.
- Picard, R. W. (1997). *Affective computing*. MIT press.
- Ranscombe, C., Kinsella, P., & Blijlevens, J. (2017). Data-driven styling: augmenting intuition in the product design process using holistic styling analysis. *Journal of Mechanical Design*, 139(11).
- Russell, J. A., & Barrett, L. F. (1999). Core affect, prototypical emotional episodes, and other things called emotion: dissecting the elephant. *Journal of personality and social psychology*, 76 , 805.
- Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review*, 110 , 145-172. (Publisher: American Psychological Association)
- Sutton, R. I., & Hargadon, A. (1996). Brainstorming groups in context: Effectiveness in a product design firm. *Administrative science quarterly*, 685-718.
- Tsai, J. L., Knutson, B., & Fung, H. H. (2006). Cultural variation in affect valuation. *Journal of personality and social psychology*, 90(2), 288.

Villanueva, I., Campbell, B. D., Raikes, A. C., Jones, S. H., & Putney, L. G. (2018). A multimodal exploration of engineering students' emotions and electrodermal activity in design activities. *Journal of Engineering Education*, 107(3), 414e441.

Vrzakova, H., Begel, A., Mehtätalo, L., & Bednarik, R. (2020). Affect recognition in code review: An in-situ biometric study of reviewer's affect. *Journal of Systems and Software*, 159, 110434.

White, D., & Katsuno, H. (2022). Artificial emotional intelligence beyond East and West. *Internet Policy Review*, 11(1), 1-17.

Whitfield, T. A. (2007). Feelings in design—a neuroevolutionary perspective on process and knowledge. *The Design Journal*, 10(3), 3-15.

Zhou, J. J., Phadnis, V., & Olechowski, A. (2021). Analysis of designer emotions in collaborative and traditional computer-aided design. *Journal of Mechanical Design*, 143(2).