Red and risk preferences: The effects of culture and individual differences

Feng Jiang[1*], Rui Zhang[2] and Su Lu[3]

[1]Department of Organization and Human Resource Management, Central University of Finance and Economics, Beijing, China
[2]Department of Psychology, Dickinson College, Carlisle, Pennsylvania, USA
[3]Department of Psychology, De Montfort University, Leicester, UK

Feng Jiang, Rui Zhang, and Su Lu have equal first authorship

*Correspondence
Feng Jiang, Department of Organization and Human Resource Management, Central University of Finance and Economics, 39 South College Road, Haidian District, Beijing, China.
Email: fengjiang0205@gmail.com.

Funding information
National Natural Science Foundation of China, Grant/Award Number: 71971225

How to cite this article: Jiang F, Zhang R, Lu S. Red and risk preferences: The effects of culture and individual differences. J Behav Dec Making. 2021;1–14. https://doi.org/10.1002/ bdm.2233

Abstract

Color is shown to affect decision-making and judgment. However, no prior research has examined both between- and within-culture variations in color associations. To this end, we test the red (vs. green) effects on risk preferences in the United States and China while assessing individual differences in color associations. Across three studies, we find cultural reactance effects, that is, in the domain of risk aversion, the color associated with gain (American: green/Chinese: red) leads participants to become more risk averse when they personally associate green (in America) and red (in China) with loss. In the domain of risk seeking, the color associated with loss (American: red/Chinese: green) leads participants to become more risk seeking when they personally associate green (in China) and red (in America) with gain. By providing a novel perspective that integrates between- and within-culture variations, our findings have implications for understanding the generalizability of the color effects across individuals and cultures.

Keywords: culture, individual differences, red, risk preferences

Red and Risk Preferences: The Effects of Culture and Individual Differences

Introduction

Color, a ubiquitous stimulus, affects psychological functioning in a myriad of ways (for a review, see Elliot &Maier, 2014). For example, people performing creative tasks tend to be less mentally flexible if they are simultaneously exposed to color red (e.g., Elliot, Maier, Moller, Friedman, & Meinhardt, 2007,Shi, Zhang, & Jiang, 2015, Thorstenson, 2015), while red is also shown to increase men's sexual attraction to women (e.g., Elliot & Niesta, 2008, Guéguen, 2012, Young, 2015). Behavioral scientists are increasingly interested in how color influences decision-making and judgment, such as risk preferences under uncertainty, interpretation of ambiguous economic news, and perception of financial data (e.g., Bazley, Cronqvist, & Mormann, 2019, Choi, Lee, & Banerjee, 2019, Greiner & Stephanides, 2020, Leong, Sung, Williams, Andoniou, & Sun, 2019). Recognizing that cultural context influences color associations, researchers have started exploring color psychology across cultures, especially how culturally variable color associations influence subsequent judgment and behavior (e.g., Bazley et al., 2019, Jiang, Lu, Yao, Au, & Yue, 2014). However, those recent findings are far from being unequivocal and are somewhat contradictory, thus casting doubt on the replicability of cultural differences in red effects (Bazley et al., 2019; Leong et al., 2019; Jiang et al., 2014). This has prompted some behavioral economists to argue that the entire enterprise of color effects on decision making and judgment is not worth investigating (e.g., Greiner & Stephanides, 2020). We maintain that this conclusion may be a bit premature; heterogeneity of findings from different cultures also calls for more work to deepen our understanding on color effects.

Each culture has its own cultural syndrome, which is a loosely organized constellation of values, beliefs, and practices (Adams & Markus, 2004; Kitayama, Park, Sevincer, Karasawa, & Uskul, 2009).

However, this does not mean individuals of a culture are carbon copies of the overall cultural syndrome; in fact, individual variation with a culture typically far outweighs variation across cultures (e.g., Fischer & Schwartz, 2011). Similarly, Kitayama and colleagues (2009) found that even if the same cultural syndrome of individualism-collectivism appears coherent at the group level, cultural tasks of the syndrome fail to converge at the individual level. Individuals pursue or achieve culturally normative goals in idiosyncratic ways, aligning with them on some tasks but deviating from them on others (also see, Na et al., 2010). Speaking of color associations, while it is true that color red is associated with upward movement, flourishing, and growth in the mainland Chinese financial market, it would be bizarre to assume all – or even most – mainland Chinese people would hold the same red-gain association. Thus, we should not equate individuals as culture writ small. Past research that examined color effects across cultures tends to overlook individual variation and we believe that individual differences in color associations should be modeled as another source of variance in color effects.

To this end, we adopt a Culture ✕ Person ✕ Situation (CuPS) approach (Leung & Cohen, 2011) in this research by considering culture (culturally dominant color associations) and situation (risk seeking or risk aversion) along with individual differences in color associations. Altogether, we conducted three studies using American and Chinese samples, with self-report and behavioral measures of risk aversion and risk seeking and explicit and implicit measures of individual color associations. Our main finding is that the color effects on risk preference depend on culture as well as individual color associations. More important, we highlight the need to go beyond the sweeping cultural categorization of color connotations to consider the role of individual perception regarding links between color and gain/loss.

Next, we review the literature on color, culture, and risk preferences; describe the methodology and results of our studies; and discuss implications.

Color and Risk Preferences

In Western stock markets, red arrows commonly denote losses and green arrows gains. Color psychology explains that colors such as red evoke affect, cognition, and behaviors through genetically and biologically ingrained responses. Red–danger associations may be an evolutionary default setting: humans survived to reproduce if they were alert to red dangers, such as from blood, fire, and the faces of angry aggressors (Archer, 2006; Changizi, Zhang, & Shimojo, 2006). Animals show similar biologically ingrained color associations. For instance, when male rhesus macaques were given opportunities to steal food from two experimenters, they avoided the experimenter wearing red (Khan, Levine, Dobson, & Kralik, 2011). Consequently, culture-universal aversion to red may have evolutionary origins.

Red has been consistently associated with hazard and danger signaling failure or loss (Pravossoudovitch, Cury, Young, & Elliot, 2014). An investigation into gamers' behaviors when playing online risky games showed that exposure to red made them more cautious and more likely to choose safe options (Gnambs, Appel, & Oeberst, 2015). Similarly, a study of poker game betting showed that study participants were likely to bet less money when their opponents used red chips in a poker game (Ten Velden, Baas, Shalvi, Preenen, & De Dreu, 2012). Red has been also tested for increasing the salience of value losses, for activating flight rather than fight strategies for confronting risk (Kliger & Gilad, 2012), and causing venture investments to appear less favorable (Chan & Park, 2015).

Beyond biologically ingrained associations, colors are repeatedly paired with particular messages, concepts, or experiences via social conditioning (Elliot & Maier, 2012). Thus, color associations are also socially learned and culturally embedded. The color effects might be culturally specific, depending on culturally-laden cues, symbols, metaphors, assumptions, and background knowledge (Peng, Ames,

& Knowles, 2001). Indeed, color-in-context theory defines context "not only in terms of domain but also in terms of culture" (Elliot & Maier 2007, p.253). For example, as mentioned, in Western stock markets, television programs, and elevators, red is used to indicate downward trends and green to indicate upward trends. As people encounter color pairings on a daily basis, mere color exposure can activate those associations, which in turn influence judgment and decision making (Jiang et al. 2014).

Color between and within Cultures

Cultural norms are well-known to influence color associations (Chattopadhyay, Gorn, & Darke, 2010, Labrecque, Patrick, & Milne, 2013). In contrast to Western stock markets, red is used in the mainland Chinese market to indicate up-markets and green to represent down-markets. Although Westerners use "red flagging" to indicate financial fraud and "red alert" to signal imminent danger, Chinese traditional culture often uses red and fire as metaphors for business prosperity. For example, wealthy people are said to live behind the "red door." In support of this opposite connotation in the financial context, Chinese stockbrokers were shown to perform better on IQ tests after they were exposed to red (Zhang & Han, 2014). More interestingly, a cross cultural comparison indicated that red led mainland Chinese participants to perceive upward financial trends, goodness, gains, flourishing, and growth in economics and consumption outcomes, whereas green led mainland Chinese to feel downward trends, languishing, and decrease in economics, resulting in a red-up-green-down psychological association. The opposite association—red-down-green-up—is true for Hong Kong people (Jiang et al., 2014). Such positive connotations are also at play with the founding of People's Republic of China, which is often refered to as the red regime with a red army and a red national flag. This contrasts sharply with equating red with communism during the Cold War (e.g., red scare). On the other hand, besides representing a downward market, color of green is often associated with bad things.

For instances, Chinese folklores claim that robbers and criminals are coming from “the green forest”. Additionally, prostitutes in ancient China are required to wear “green scarf” and worse still, a cuckold husband is commonly referred to as wearing a “green hat” (Xu, 2007; Zhao, 2010). Therefore, in the financial and several other contexts, mainland China presents a major exception to the red-loss/green-gain association found in previous research with non-Chinese samples.

In addition to cultural shaping of color associations, individual experience also matters when it comes to processing color stimuli. That is, within-culture variation in color associations may exist in the form of relatively stable individual differences. First, despite cultural variation in norms and practices, individual members of a culture may develop idiosyncratic color associations that run counter to the culturally dominant associations. Second, color associations may be variable across contexts within the same culture. As mentioned above, red may carry some similar meanings across cultures, such as potency and activity (Adams & Osgood, 1973), love, and adventure (Jacobs, Keown, Worthley, & Ghymn, 1991), or happiness, force, strength, elegance, warmth, and calm (Wright & Rainwater, 1962). Indeed, red in mainland China often conveys danger outside the financial context, as seen in fire alarms, stop signs, and danger-related warning signs. Given such mixed connotations across contexts, mainland Chinese may show considerable variations in their personal associations, such that some associate red more readily with loss, while others with gain. To the best of our knowledge, only one study considered the impact of individual experience (Choi et al., 2019). Unfortunately, Choi and colleagues (2019) did not directly examine the degree of red association with gain or loss.

To summarize, our review indicates that although there is a potentially universal tendency of red aversion, red connotations in financial contexts differ between Western societies and mainland China. Western participants tend to associate red with loss in financial contexts, matching a risk averse profile in response to red, while the opposite is true among mainland Chinese participants. Meanwhile, considerable individual differences in color associations may exist within cultures, which remain unaccounted for in previous research.

Overview of the Present Research

In this research, we adopt a CuPS approach by considering both between-culture and within-culture variation together (Leung & Chen, 2011). Importantly, unlike the traditional approach in which individual differences are thought of as vehicles of cultural differences (thus statistically mediating cultural differences), the CuPS approach treats individuals as interacting with cultural prototypes. For example, one pattern of cultural difference is seen among individuals who endorse a certain cultural ideal, whereas the opposite pattern can be present among those who oppose such an ideal. In line with this framework, we propose that individual differences in color associations may interact with culture in specifying the color effects on risk preferences. That is, those who share the culturally dominant color associations are expected to show culturally prototypical responses. Among Americans with red-loss/green-gain associations, red should lead to more risk aversion or less risk seeking compared with green. Among mainland Chinese with red-gain/green-loss associations, the opposite should be true.

What about those with color associations incompatible with the cultural mainstream? According to the CuPS approach, “individuals are always in a cultural context, though they are not always of it.” (Leung & Cohen, 2011, p. 522). In other words, dominant cultural syndromes remain relevant to “cultural deviants” as a frame of reference, against which they react (cultural reactance). Research on people with multiple cultural identities (Benet-Martínez, Leu, Lee, & Morris, 2002; Cheng, Lee, & Benet-Martínez, 2006; Mok & Morris, 2009) provide a complementary perspective for making sense of cultural reactance. This work suggests that individuals who hold beliefs incongruent with the mainstream often show extreme reactions or overcorrection of consistent responses. This psychological process is analogous to the well-known contrast effect, which happens when the stimuli are perceived as incongruent with perceiver's covert belief (Koole, Dijksterhuis, & Van Knippenberg, 2001).When external cues appear self-incongruent, individuals tend to engage in more cognitive processing of those stimuli, which results in overcorrection. In the context of this research, cultural reactance predicts that Americans with stronger red-gain/green-loss associations and mainland Chinese with stronger red-loss/green-gain association are likely to be most overreactive in response to color stimuli. Specifically, among mainland Chinese with stronger red-loss/green-gain associations (culturally incongruent), red may evoke risk aversion more greatly than red evokes risk seeking among those with stronger red-gain/green-loss associations (culturally congruent). In a similar vein, red may evoke risk seeking more strongly among Americans with stronger red-gain/green-loss associations (culturally incongruent) than red evokes risk aversion among those with stronger red-loss/green-gain associations (culturally congruent).

In short, combining insights from CuPS and cultural reactance, we argue that both between-culture and within-culture variations need to be considered to understand the color effects and that people with color associations incongruent with the cultural mainstream may be particularly liable to react against the implied cultural meaning of color stimuli. Specifically, we tested whether the joint effects of color and culture would be moderated by individual differences in color associations. In unpacking the culture x person x situation interaction, we examined whether those with culturally incongruent color associations would show cultural reactance. Thus, **we hypothesized that:** for each culture, individuals holding culturally incongruent color association would show greater cultural reactance in risk preferences. Specifically, in the domain of risk aversion, color normatively associated with gain

(American: green/Chinese: red) would lead participants to become more risk averse if they personally associated them with loss. In the domain of risk seeking, color normatively associated with loss (American: red/Chinese: green) would lead participants to become more risk seeking if they personally associated them with gain. To this end, across three studies, we presented American and Chinese participants with tasks involving risk choices in either red or green. Additionally, we assessed individual differences in color-gain/loss associations (CGLA).

STUDY 1

In Study 1, we showed participants lottery questions with different colors. Participants were asked to indicate their willingness to pay and report their CGLA. We aimed to examine whether the color effect on risk preferences would be moderated by culture and CGLA. As red and green are paired in financial contexts, we focused on comparing these two colors in all three studies. In addition, risk preference was measured with risk aversion in Studies 1 and 2, and risk seeking in Study 3.

Participants[1]

We recruited American and Chinese participants from crowdsourcing platforms, Prolific Academic and WJX respectively. As a reward, American and Chinese participants were paid 1.8£ and 15¥, respectively. After we removed 8 participants who failed to complete the survey, the final sample consisted of 160 Americans and 128 Chinese, aged 18 to 30 years-old. Participants in the American sample averaged 22.14 years of age (SD=2.37); 53% were women. Participants in the Chinese sample averaged 23.03 years of age (SD=2.07); 55% were women. The number of eligible participants provided the power of 0.97 to detect a small to moderate effect size of $f^2 = 0.13$ (Faul, Erdfelder, Lang, & Buchner, 2007).

[1]In Studies 1 and 2, both American and Chinese women reported being more risk averse (*ps*<.05), but in Study 3, no gender differences were found for risk seeking (*ps*>.80).

Procedure

Participants first read and signed consent forms before responding to lottery scenarios that assessed their risk aversion. Importantly, they were randomly assigned to seeing the payoff in each scenario printed in either red or green fonts, using the RGB color model: red (255, 0, 0); green (0, 255, 0). This section was followed by a manipulation check on the next page asking participants to recall the color. All participants made the correct identification. Depending on the color condition (red or green), they were then asked to indicate the extent to which they associated this color with gain/loss. In the final section, they indicated their risk attitude and provided basic demographic information. We used translation/back-translation procedures to obtain Chinese and English versions.

Measures

Risk Aversion. To measure risk aversion, we asked how much money participants would be willing to pay in each of the six hypothetical lottery scenarios, which were adopted from Rieger et al. (2015). An example of the gain scenario in the red condition is as follows:

90% chance	**Win of 10$**
10% chance	**Win of 100$**

Question: “How much are you willing to pay at most to play the lottery (   )?”

For the Chinese participants, we adjusted the payoff to RMB according to the exchange rate.

Color-Gain/Loss Association (CGLA). To measure individual differences in associating color (red or green) with gain/loss, we provided participants with six pairs of bipolar words (i.e., loss-gain, cost-benefit, downward-upward, deficit-harvest, scarcity-abundance, decay-growth) to rate on a 1-7 scale. In the red condition, participants indicated the extent to which they associated red with those gain/loss-related concepts. Similarly, those in the green condition indicated green-gain/loss associations. Scores across the six bipolar pairs were averaged (the internal consistencies for Chinese and American samples, were .93 and .98, respectively), with high values indicating stronger color-gain associations. Specifically, American participants (M=5.76, SD=1.06) tended to associate green with more gains than did Chinese participants (M=4.47, SD=1.65), $F(1,278)=25.34$, $p<.001$. In contrast, Chinese participants (M=4.43, SD=1.86) tended to associate red with more gains than did American participants (M=2.30, SD=1.05), $F(1,278)=87.55$, $p<.001$.

Risk Attitude. Risk attitude, which is highly related to risk preferences, was included as a control variable (Warneryd, 1996, Weber, Blais, & Betz., 2002). Risk attitude was assessed by four items by Wärneryd (1996), rated on a 5-point scale, from 1=*do not agree* to 5=*agree* (e.g., "I think it is more important make a safe investment with a safe return than to take a chance").

Data Analysis and Results

Before analyzing the data, we checked the quality of willingness to pay (WTP) data in the lottery scenarios. The indicator, commonly called *violation of internality*, indicates whether WTPs have outcomes that are lower or higher than possible. Table 1 depicts expected values. We compared the participant-provided values with the expected values in each scenario, and identified two kinds of violations: *strong* and *weak violations (the difference between the two violations is that strong but not weak violations count the maximum or minimum payoff as violations)*. Only 6.81% of the participant-provided values violated weak internality, while 7.9% violated strong internality. In each case, smaller percentages of violations indicate better data quality (Gneezy, List, & Wu, 2006, Rieger et al., 2015). Thus, no data were eliminated due to violations of internality. However, to reduce the influence of outliers, we excluded WTP responses that were three standard deviations from the mean, resulting in a valid sample of 282.

Table 1. Payoffs for the lotteries (A=American, C=Chinese)

Lottery	Outcome A A($)/C(¥)	Pr(A)	Outcome B A($)/C(¥)	Pr(B)	Expected Value A($)/C(¥)
1	10/70	0.1	100/700	0.9	91/637
2	0	0.4	100/700	0.6	60/420
3	0	0.1	100/700	0.9	90/630
4	10/70	0.4	10000/70000	0.6	6004/42028
5	10/70	0.9	100/700	0.1	19/133
6	10/70	0.4	400/2800	0.6	244/1708

Note: A($) means USD used for American participants; C(¥) means CNY used for Chinese participants.

A robust way to indicate risk aversion is to calculate the relative risk premium (RRP) for each lottery question (Rieger et al., 2015), according to RRP=(EV-CE)/|EV|, where EV refers to the expected value of the lottery, and CE indicates the certainty equivalent provided by participants. A larger RRP score indicates greater risk aversion. We used the six lottery responses to compute mean RRP.

We first fitted a regression model in which the color manipulation, culture, and CGLA predicted RRP (Table 2). To test the interaction effects, we also included all interactive terms while controlling for risk attitude. First, color (red=1, green=-1) failed to predict RRP, but culture (American=1, Chinese=-1) did (B=.07, p=.02), indicating that American participants showed more risk aversion. Second, CGLA was negatively related to RRP (B=-.03, p=.03): the more strongly the color was associated with gain, the less risk aversion that color evoked. Moreover, there was a three-way interaction between color, culture, and CGLA (B=.04, p=.006). Thus, both culture and individual color associations moderated the color effects.

To visualize the three-way interaction, we divided CGLA into three categories, from the highest to lowest using the 84th, 50th, and 16th percentiles of CGLA scores. Again, higher scores of CGLA indicate that the color (red or green, depending on the condition) was more strongly associated with gain. Figure 1 displays the results as a function of color, culture, and CGLA (due to culture and color being categorical variables, the results are shown in a bar graph rather than linear graph). The three-way interaction was probed using simple slope analysis. Results indicated that green led those American participants with weaker green-gain associations to be more risk averse than those with stronger green-gain associations (simple slope b=-.10, p=.006). Interestingly, green-gain associations did not affect risk aversion in the Chinese sample (simple slope b=-.01, p=.49) (slope difference=-.08, p=.04). On the other hand, red led those Chinese participants with weaker red-gain associations to be more risk averse than those with stronger red-gain associations (b=-.05, p=.009). Red did not affect risk aversion in the American sample, regardless of their red-gain associations (b=.03, p=.40) (slope difference=.08, p=.04).

Table 2. The moderation effects of culture and red/green-gain/loss association on the relationship between color and risk aversion

	Risk Aversion		
	coefficient	*SE*	95% *CI*
Constant	.32**	.10	[.12, .52]
Risk attitude	.14	.03	[.07, .20]
Color	-.02	.03	[-.08, .04]
Culture	.07*	.03	[.01, .12]
CGLA	-.03*	.02	[-.06, -.003]
Color × Culture	.02	.03	[-.04, .07]
Color ×CGLA	.02	.02	[-.01, .05]
Culture ×CGLA	.0001	.01	[-.03, .03]
Color × Culture ×CGLA	.04**	.03	[.01, .07]
F			4.89***
R^2			.13***

Note: CGLA=Color-Gain/Loss Association.

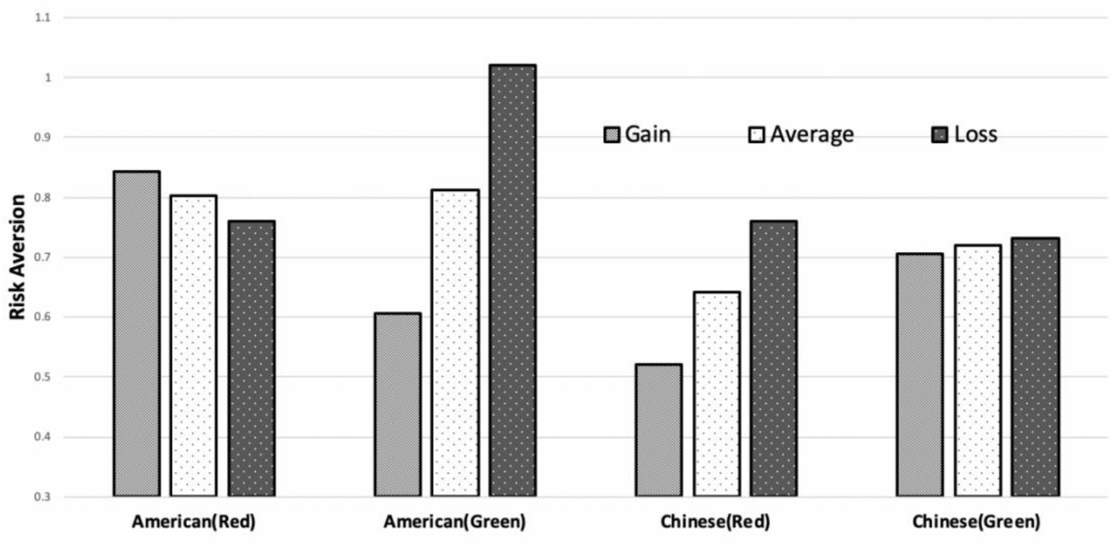

Figure 1. Color effects on risk aversion as a function of culture and color-gain/loss associations

Discussion

Study 1 provided existence proof for the idea that color effects may depend on culture and individual color associations. Consistent with expectations of cultural reactance, our hypotheses were supported that cuing green led those American participants with weaker green-gain associations to be more risk averse than those with stronger green-gain associations, while cuing red led those Chinese participants with weaker red-gain associations to be more risk averse than those with stronger red-gain associations. In both cultures, one color caused risk aversion only among those who associated that color with loss.

STUDY 2

In Study 2, we used the Implicit Association Test (IAT) to measure implicit associations between red/green and gain/loss and conducted the same analysis examining the moderation effects of implicit CGLA as well as culture. By doing so, we aimed to extend the previous studies in two ways. First, we wanted to test whether the three-way interaction between color, culture, and CGLA would be replicated with an implicit measure of color associations. Second, with the procedure employed to assess individual color associations (i.e. depending on the manipulation, participants indicated gain/loss associations with one single color), we could not test the extent of the perception of red (relative to green). The IAT procedure would make this comparison possible.

Method

Participants

Participants were 125 Chinese undergraduates from a university in Northern China, who received course credit (38 men and 86 women, average age=18.96, *SD*=1.25) and 104 American undergraduates[2] (57 men and 37 women, average age=20.18, *SD*=1.78). Six American participants were removed for failing the color manipulation check, and another four removed because their IAT data could not be matched with their questionnaire data, leaving a valid sample of 94. The number of eligible participants provided the power of 0.99 to detect a moderate to large effect size of $f^2 = 0.29$.

Design and Procedure

Participants read and signed informed consent forms. They then completed the Implicit Association Test (IAT, Greenwald et al. 1998), followed by a questionnaire measuring risk preferences and risk attitude.

We used the IAT task to examine associations between red/green and gain/loss. Red or green shapes served as color stimuli, following Jiang et al. (2014). The words *gain*, *interest*, *benefit*, *profit*, and *harvest* were used to verbally stimulate gain; *loss*, *lose*, *damage*, *drop*, and *deficit* were used for loss indices. Inquisit Lab software administered the task. Following common practices, participants categorized each red versus green picture and each gain versus loss word by pressing the left *E* or the

[2]There were two sources for the American data, one at a college in North East, where we collected data from 66 participants and gave them course credit as a reward; the other from Prolific Academic, where we collected data from 38 participants and gave them 1.8£ as a reward. As there were no differences in risk preference or D scores between the two data sources, we merged them.

right *I* keys (Greenwald et al., 1998, McConnell & Leibold, 2001).

When participants finished the IAT, each received a unique digital code, which they copied and pasted at the head of the questionnaire, allowing us to match questionnaire and IAT data. In the questionnaire section, participants were randomly assigned to the red or green experimental conditions, as in Studies 1 and 2. Participants were then thanked and debriefed.

Measures

Risk Aversion. To assess risk aversion, we presented four scenarios about lottery decisions, developed by Rosenboim et al. (2010). (We replaced NIS currency with CNY and USD.) For each scenario, participants indicated the maximum amount they would pay for a given lottery. An example item is "What is the maximum price you are willing to pay for a lottery ticket with equal odds of winning $100 and $20?" Following Study 1, we computed RRP of each lottery, with a higher score indicating stronger risk aversion. We then averaged RRP scores from the four scenarios to create composite scores.

Risk Attitude. We used the risk attitude measure from Study 1.

Results

IAT results

According to standard procedures proposed by Greenwald et al. (1998), we recorded reaction times below 300ms as 300ms and above 3,000ms as 3000ms. Also, we discarded incorrect responses, such as responding "loss" to a gain stimulus. Participants responded incorrectly to less than 25% of the task demands, so the data analysis included all valid participants.

The IAT task has *red-gain, green-loss* and *red-loss, green-gain* combinations. For Chinese participants, the mean latency for *red-gain, green-loss* was 672.21ms (*SD*= 149.05); for *red-loss, green-gain* it was697.98ms (*SD*=165.24). For American participants, the mean latency for *red-gain, green-*

loss was 727.02ms (*SD*= 141.13); for *red-loss, green-gain* it was 725.57ms (*SD*=135.59). Paired-samples *t* test suggested that Chinese participants responded more rapidly to combinations of *red-gain, green-loss* than to *red-loss, green-gain*, *t*(124)=-2.07, *p* <.05, indicating generally stronger associations of red-gain/green-loss. However, results of paired-samples *t* tests were nonsignificant for the American participants: *t*(93)=.10, *p* =.92, *ns.* Taken together, the results indicate a stronger average tendency for the Chinese participants to associate red with gain (relative to loss), compared with the American participants.

The moderation effects of culture and implicit color associations

To represent IAT outcomes, we used *D* scores instead of two average latencies of two combinations (Greenwald et al., 2003). The *D* score divides the difference between two association means by the standard deviation of all the latencies in the two associations. Following recommended formulae (Hummert, Garstka, O'Brien, Greenwald, & Mellott, 2002 see the Appendix for details), we obtained *D* scores for each participant, with higher scores indicating stronger red-loss/green-gain associations. As in Study 1, we then fitted a regression model with color, culture, CGLA, and all possible interaction terms as predictors (Table 3). The relationship between risk attitude and risk aversion was not significant (*B*=.04, *p*=.354, *ns*). After controlling for risk attitude, color (red=1, green=-1), culture (Chinese=-1, American=1), and D were significantly related to risk aversion (*B*=.08, *p*=.006; *B*=.16, *p*<.001; *B*=.24, *p*=.0005, respectively), indicating that red evoked more risk aversion and that Americans were more risk averse.

Next, we unpacked the interaction effects. First, culture significantly interacted with *D* (*B*=-.22, *p*=.001): although the American participants showed stronger risk aversion compard with the Chinese couterpart, this cultural difference was greater for participants with stronger red-gain/green-loss (*b*=.28, *p*<.001) than red-loss/green-gain associations (*b*=.09, *p*=.06). Second, color significantly interacted with D (*B*=.13, *p*=.05): among those with stronger red-loss/green-gain associations, red (*b*=.45, *p*<.001) led to greater risk aversion than did green (*b*=.13, *p*=.22). Finally, the analysis revealed a significant three-way interaction between color, culture, and *D* (*B*=-.13, *p*=.05). Figure 2 shows the interaction by color, culture, and *D*. Follow-up simple slope analysis indicated that as participants' red-loss/green-gain associations became stronger, red led the Chinese (*b*=.72, *p*<.001), but not the Americans (*b*=.02, *p*=.91), to more risk aversion (slope difference=-.71, *p*<.001).Those results are consistent with what was found Study 1. However, as participants' red-loss/green-gain associations became stronger, green did not lead the Americans to less risk aversion. This is inconsistent with what was found in Study 1. Thus, our hypotheses were partially supported.

Table 3. Culture and D moderate the color effects on risk aversion

	Risk Aversion		
	coefficient	*SE*	95% *CI*
Constant	.36*	.16	[.04, .68]
Risk attitude	.04	.04	[-.04, .12]
Color	.08**	.03	[.02, .14]
Culture	.16***	.03	[.09, .23]
D	.24***	.07	[.10, .37]
Color × Culture	-.04	.03	[-.10, .02]
Color × D	.13*	.07	[-.0003, .26]
Culture × D	-.22**	.07	[-.35, -.09]
Color × Culture × D	-.13*	.07	[-.27, -.0001]
F			10.55***
R^2			.29***

Note: * *p*<.05; ** *p*<.01; *** *p*<.001. For D, higher scores indicate stronger red-loss/green-gain implicit associations.

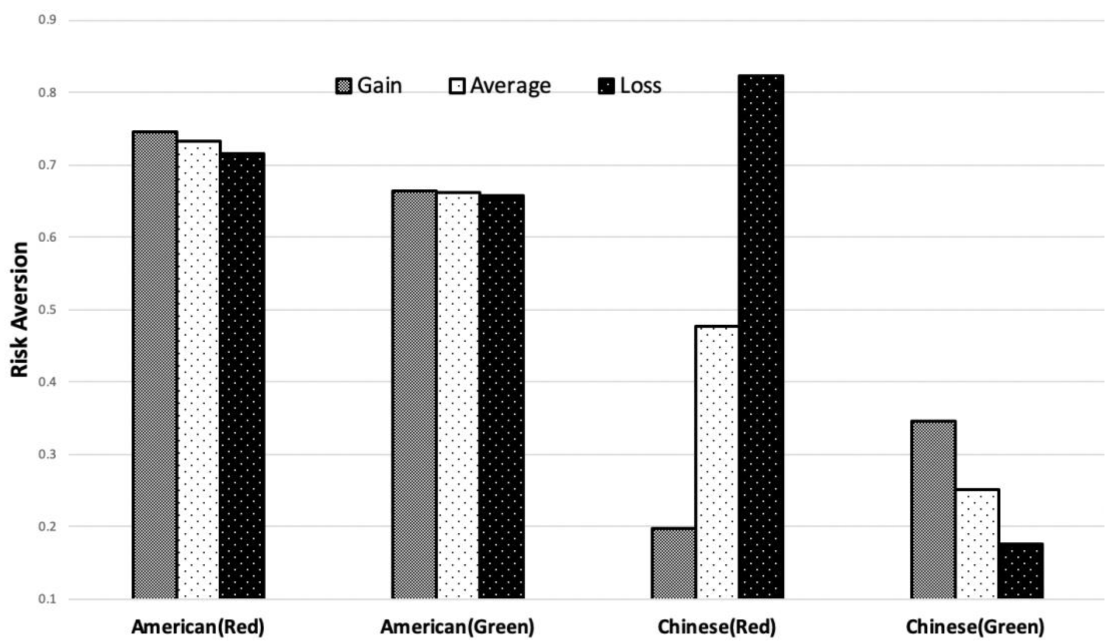

Figure 2. Color effects on risk aversion as a function of culture and implicit color associations

Discussion

In Study 2, we replicated a three-way interaction between color, culture, and CGLA on risk aversion. Specifically, cuing red led those Chinese participants with red-loss/green-gain associations to be more risk aversive than those with green-loss/red-gain associations. Contrary to Study 1, however, risk aversion of the American participants was unaffected by green, regardless of individual differences in color associations. The latter finding may be due to smaller variability in color associations in the American sample. First, unlike the Chinese, the Americans responded to the red-gain/green-loss pairs at a similar speed to the red-loss/green-gain pairs. Second, to directly compare the dispersion of red/green-gain/loss associations between the two samples, we computed the ratio of the standard deviation to the mean, namely coefficient of variation (CV) (Eldridge, Ashby, & Kerry, 2006, Everitt, 2006). For the red-loss/green-gain association, the Chinese CV was 23.67%; the American CV was 18.69%. For the contrast red-gain/green-loss association, the Chinese CV was 22.17%; the American

CV was 19.41%. In both cases, the American sample showed less variability in implicit color associations. Overall, the Study 2 results partially support the role of individual color associations in the color effects on risk aversion.

STUDY 3

In Study 3, we focused on risk seeking as the outcome. Moreover, we used a behavioral measure of risk seeking because some individuals have shown strong aversion toward risky behaviors on self-report measures (Ladouceur, Gosselin, & Dugas, 2000) and it is difficult to determine whether self-reports accurately predict general risk preferences (Greene, Krcmar, Walters, Rubin, & Hale, 2000).

Participants

As in Study 1, we used Prolific to collect American data online, and each participant was paid 1.8£ as a reward. Those who participated in Study 1 were prevented from completing this study. The Chinese data were collected in the lab, where participants completed the study on computers and got 15¥ as a reward. In total, data from 202 American and 161 Chinese participants were collected. Because five failed the color manipulation check, the final sample consisted of 199 Americans and 159 Chinese. The American participants averaged 21.72 years of age (*SD*=2.47); 54.2% women; The Chinese participants averaged 21.33 years of age (*SD*=3.15); 60.6%women. The number of eligible participants provided the power of 0.99 to detect a moderate to large effect size of $f^2 = 0.19$.

Materials and Procedure

The materials and procedure were identical to those used in Study 1 with one exception. Regarding the cultural differences in CGLA , similar with what we found in Study 1, American participants (M=5.57, SD=.92) tended to associate green with more gains than did Chinese participants (M=4.78, SD=1.17), $F(1,317)=16.62$, $p<.001$. Partial $\eta^2=.05$. In contrast, Chinese participants (M=4.68, SD=1.22) tended to associate red with more gains than did American participants (M=3.43, SD=1.39), $F(1,317)=45.33$, $p<.001$. Partial $\eta^2=.13$.

We replaced the lottery measure with the Balloon Analogue Risk Task (BART, Lejuez et al., 2002), a computerized measure that simulates risky behaviors and has been shown to powerfully predict real-world risk seeking in addictive health and safety behaviors (Fernie, Cole, Goudie, & Field, 2010). Based on *Joyfulwei's* coding, (https://github.com/joyfulwei/Balloon-task-in-Qualtrics), we set up an online version of BART. Participants were randomly assigned to viewing a series of 10 balloons either in red or in green (Figure 3). When they clicked the "inflate balloon" button, the balloon would start swelling and eventually pop. Crucially, the point at which a balloon would explode varied randomly. That is, some popped after just one pump; others stayed inflated until they filled the screen. Each click to inflate the balloon earned the participants 0.25 point, but points were deducted if the balloon popped. To incentivize earning as many points as possible, we informed participants that the highest scorer would receive a bonus payment (10 US dollars or 70 Chinese Yuan). The number of clicks participants selected to inflate the balloon in each round served as the risk seeking measure, with a higher score indicating more risk seeking.

Data Analysis and Results

We first summed the number of pumps across the 10 rounds for each participant. Due to its large variance (ranging from 52 to 165 pumps, standard deviations for Chinese and American samples were 21.32 and 27.08, respectively),we excluded the highest and lowest 5% total number of pumps, in accordance with Rieger et al. (2015), to reduce the influence of outliers. This resulted in a valid sample of 321. We conducted the same regression analysis predicting risk seeking with color manipulation, culture, CGLA, and all possible interactions, while controlling for risk attitude (Table 4). As expected, CGLA was significantly related to risk seeking (*B*=4.26, *p*=.0003): the more participants associated the color with gain, the higher risk seeking they demonstrated at the task. More important, there was a three-way interaction effect of color, culture, and CGLA on risk seeking (*B*=2.37, *p*=.04).

The three-way interaction is decomposed in Figure 4 in the same way as in Studies 1 and 2. It was also probed using simple slope analysis. Results indicated that green led those Chinese participants with stronger green-gain associations to became more risk seeking than those with weaker green-gain associations (simple slope *b*=14.84, *p*=.005). However, this did not occur among the American participants (simple slope *b*=-.4.16, *p*=.45). Instead, red led those American participants with stronger red-gain associations to become more risk seeking than those with weaker green-gain associations (simple slope *b*=12.66, *p*=.03). Again, the same was not found among the Chinese participants (simple slope *b*=-6.3, *p*=.36). Thus, our hypotheses were supported.

Table 4. The moderation effects of culture and red/green-gain/loss association on the relationship between red and risk seeking

	Risk Seeking		
	coefficient	*SE*	95% *CI*
Constant	121.90***	6.92	[108.28, 135.53]
Risk attitude	-.72	2.10	[-4.84, 3.41]
Color	-1.70	1.63	[-4.92, 1.51]
Culture	-6.38***	1.58	[-9.49, -3.26]
CGLA	4.26***	1.17	[1.95, 6.57]
Color × Culture	1.65	1.59	[-1.48, 4.78]
Color ×CGLA	.54	1.18	[-1.78, 2.87]
Culture ×CGLA	.005	1.17	[-2.30, 2.30]
Color × Culture ×CGLA	2.37*	1.78	[.06, 4.69]
F			9.29***
R^2			.19***

Note: CGLA=Color-Gain/Loss Association.

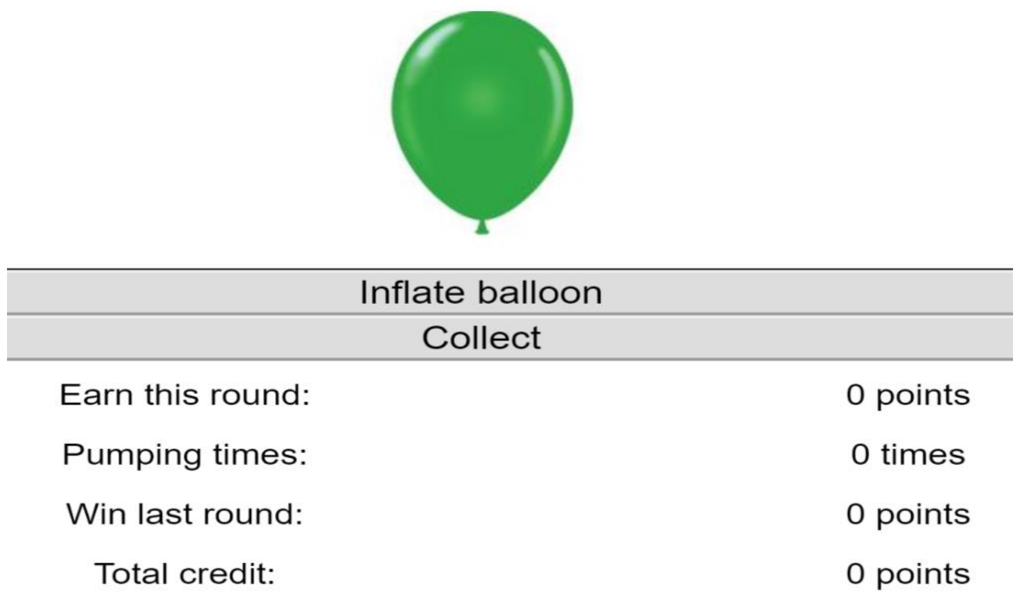

Figure 3. BART demonstration in Study 3

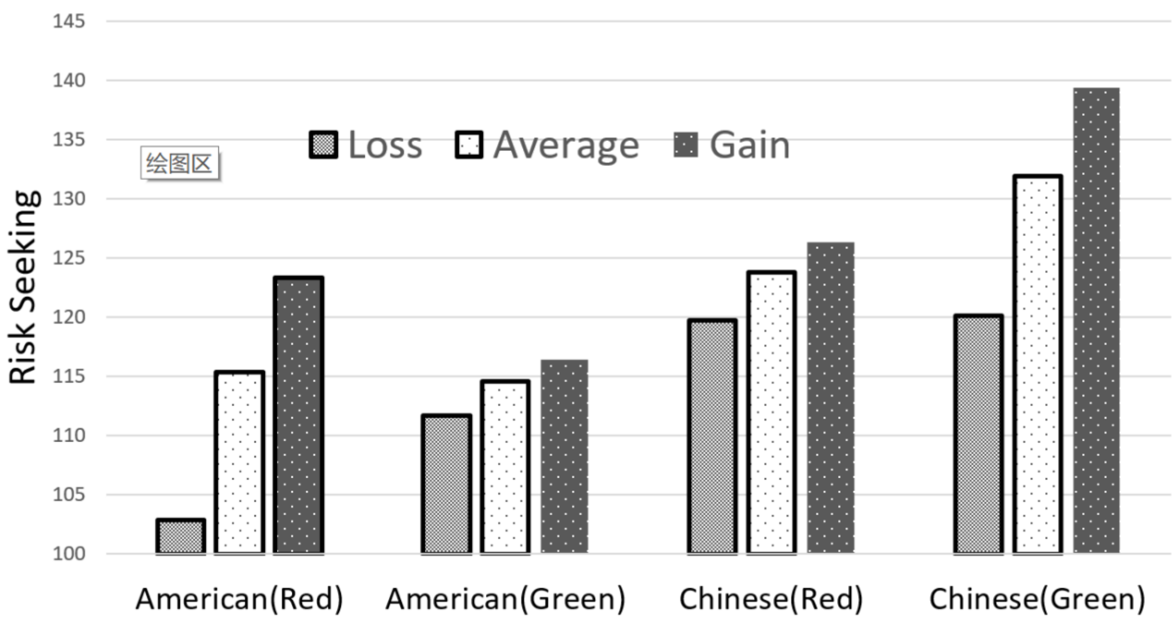

Figure 4. Color effects on risk seeking as a function of culture and color-gain/loss associations

Discussion

Conceptually consistent with Studies 1 and 2, we found a three-way interaction between color, culture, and CGLA on risk seeking. In both cultures, one color caused more risk seeking only among those who associated that color with gain. Consistent with expectations of cultural reactance, it was color green that led those Chinese participants with stronger green-gain associations to become more risk seeking than those with weaker green-gain associations; it was color red that led those American participants with stronger red-gain associations to become more risk seeking than those with weaker green-gain associations. In the general discussion, we will further discuss color effects on risk preferences under the frame of cultural reactance.

GENERAL DISCUSSION

The mainstream American norm represents downward and languishing financial trends in color red and upward and flourishing trends in color green. The opposite norm is true in China. Across three studies, we exposed American and Chinese participants to red or green when they indicated their risk preferences, while assessing their individual color associations with gain/loss-related concepts. The main finding is that culture and individual color associations moderated the color effects on risk preference. In accordance with cultural reactance, those whose color associations are incongruent with the cultural mainstream show opposite reactions to color stimuli. In Study 1, cuing green led those American participants with stronger green-loss associations (culturally incongruent) to be more risk averse than those with weaker green-loss associations (culturally congruent), while cuing red led those Chinese participants with stronger red-loss associations (culturally incongruent) to be more risk averse than those with weaker red-loss associations (culturally congruent). In Study 2, with the use of an implicit measure of individual color associations, we partially replicated the Study 1 effects observed in the Chinese sample. In Study 3, exposure to green led those Chinese participations with stronger green-gain associations (culturally incongruent) to become more risk seeking than those with weaker green-gain associations (culturally congruent); exposure to red led those American participants with stronger red-gain associations (culturally incongruent) to become more risk seeking than those with weaker red-gain associations (culturally congruent).

The current research contributes to color psychology in risk preferences by integrating cross-cultural with individual-difference perspectives. That is, we clarify when to expect color effects by jointly considering between-culture and within-culture variations in color associations. We show one important boundary condition of the red effects to be a person's red associations. Even within the American samples, we failed to observe any color main effects on risk preferences. Nor did we replicate any culture x color interactions (i.e., cultural difference in color effects). These null findings suggest the widely documented color effects may not be as robust as previously thought, in part due to the existence of individual variation in color associations that remains unaccounted for. Coincidentally, color research has been disputed recently, particularly because some findings are difficult to replicate (Lehmann & Calin-Jageman, 2017, Peperkoorn Roberts, & Pollet, 2016, Seibt & Klement, 2015, Wen, Zuo, Wu, Sun, & Liu, 2014). By detecting moderation effects of individual variation in color associations, the current research points to an alternative explanation for mixed findings and highlights new research possibilities for color effects on judgment and decision making (Baribault et al., 2018).

More importantly, individual differences in color associations were found to interact with salient cultural norms to produce unique patterns of color effects. That is, colors associated with gain (i.e., American: green/Chinese: red) tend to augment individual differences in risk aversion, whereas colors associated with loss (i.e., American: red/Chinese: green) tend to augment individual differences in risk seeking. In their prominent work on loss/gain framing, Kahneman and Tversky (1979) demonstrated that facing gains, individuals gravitate toward risk aversion, whereas facing losses, individuals favor risk seeking. Due to the connection between gain framing and risk aversion (Studies 1 & 2), participants with culturally incongruent associations became more risk averse relative to those with culturally congruent associations only in response to the color that conveys gain in their respective cultures (American: green; Chinese: red). Similarly, due to the linkage between loss framing and risk seeking (Study 3), participants with culturally incongruent associations became more risk seeking relative to those with culturally congruent associations only in response to the color that conveys loss in the respective cultures (American: red; Chinese: green). Therefore, the nature of our risk preference measures may explain why individual color associations were notable only in reaction to one color in each culture. Those results are also consistent with CuPS and cultural reactance views and suggest that people with culturally incongruent color associations react extremely against the cultural norm.

We think the best way to make sense of those patterns is precisely interactive in nature, namely, understanding individual differences in light of the mainstream color associations toward or against which people react. Alternatively, what may have occurred is the influence of individual differences became stronger when the cultural meaning of the cued color was discrepant with the task at hand. For Americans, such a discrepancy arose when green was presented in the context of a task of risk aversion or red in the context of a task of risk seeking. For Chinese, it was when red was presented in the context of risk aversion or green in the context of risk seeking. In both cultures, individual differences were strongly predictive of risk preferences whenever such a discrepancy occurred. On the flip side, the influence of individual differences diminished to being virtually non-existent when the cultural meaning of the cued color was congruent with the task implication (i.e., no discrepancy). A tradeoff can be said to exist between culturally dominant color norm and individual color association such that when one prevails, the other is muted. Take the American sample in Study 1 as an example. Based on previous research, we would have expected red to result in higher risk aversion, compared with green. However, this pattern was reversed when comparing Americans holding stronger green-loss associations with Americans holding stronger red-loss associations. It was rather green that led Americans with stronger green-loss associations to become more risk averse.

The current work has some critical implications for culture and decision making in general. Previous research in decision making such as loss aversion, reference point adaptation, and indecisiveness has focused mostly on well-established cultural dimensions as explanations for observed cultural variations—individualism/collectivism, uncertainty avoidance, and holistic/analytic thinking styles (e.g., Li, Masuda, & Jiang, 2016; Li, Masuda, & Russell, 2014; Rieger et al., 2015). As one example, cultures higher in individualism and uncertainty avoidance are associated with stronger loss aversion (Rieger et al, 2015). Although such broad strokes are valuable in explaining global variations, they may obscure more local or proximal differences. For instance, while all belonging to collectivistic cultures in geographic proximity, mainland Chinese, Hong Kong Chinese, Taiwan Chinese, and Japanese people nonetheless show differences in decision processes and prediction in trends (Chu, Spires, Farn & Sueyoshi, 2005; Jiang et al., 2014). Besides sweeping systems of historically transmitted values and thinking styles, cultures may still differ in local meaning making (Ames, 1999), which is verbally or nonverbally coded in symbols and metaphors. Thus, two societies similar in overall values and thinking styles could differ in the structure of everyday situations, which in turn cause psychological variations in decision making and judgment.

Compared with those cardinal cultural dimensions, contextual factors such as how individual make sense of their ongoing experience have received relatively little attention in judgment and decision making. Color representations, which are shown to be variable both between and within cultures in the current work, contribute to an account of what situated factors influence risk preferences (Oyserman, Sorensen, Reber & Chen, 2009). Thus, future research in risk preferences may pay more attention to concrete overt factors rather than covert abstract determinants.

Another contribution of the current work lies in jointly investigating the effects of cultural meaning systems and individual sensemaking on judgment and decision making. In the literature so far, cultural and individual sources of influence have been investigated separately (Li et al., 2016; Jiang et al., 2014; Rieger et al, 2015). As is shown here, there may be a mismatch between cultural and individual meaning, which raises the interesting question of whether they work additively or antagnostically to impact risk perceptions, predictions, and decision-making. As there is a lack of theoretical understanding of the mechanisms driving the interaction between cultural and individual factors, this would be challenging yet promising to explore in future research.

A potential challenge for cross-cultural color research is that color's cultural meanings can shift over time. For example, in the 1950s through the 1970s, Chinese loved military green—the color used by the People's Liberation Army. Since the 1980s when Chinese society started to reform and open to the world, the situation changed dramatically. The intensification of globalization and expansion of Western influence have been extended to Chinese color associations. A vivid example is that Chinese brides once preferred red wedding clothes, but white gowns are increasingly popular. Thus, to ensure the validity of findings, future research must consider culture mix (Chiu & Cheng, 2007), which may further increase individual variations.

Our studies have several limitations that warrant the exercise of caution in drawing any firm conclusions. First, although we showed that personal associations of color with gain/loss serve as a boundary condition for color and culture effects on risk preferences, we did not explore the underlying mechanism. Instead, we built on previous findings assuming that colors associated with danger induce risk aversion, while colors associated with success induce risk-seeking (Gnambs et al., 2015, Pravossoudovitch et al., 2014, Ten Velden et al., 2012). Future studies should explore potential mechanisms to further verify color theory and solidify empirical findings. Second, we used only risk attitude as a control variable. Although risk attitude is closely related to risk preferences, future research should control for more individual factors such as personality and income (Bazely et al., 2019). Moreover, we did not test where individual differences in color connotations may have come from. We can only speculate such differences might be rooted in one's early socialization experience, environmental cues to which one is repeatedly exposed, and social networks one develops. As one's relationship with their overall culture is partial, there is ample room for various forms of subcultures and personal experience to shape individual color associations. It is worth investigating those sources of individual differences in future work. A third limitation regards lightness and chroma control. Some participants participated via Internet. Although we used the RGB model to produce red and green, the various devices participants used may have failed to show the colors as intended. A fourth limitation is the cross-cultural equivalence of monetary payoff. When preparing the lotteries materials, we simply converted USD into Chinese Yuan based on the exchange rate at the time. Although this is a common practice (e.g., Su & Hynie, 2011), direct currency exchange may not account for purchasing power discrepancy between the two countires. For this reason, we focused our analyses on within-culture comparisons rather than direct between-culture comparisons. However, to ensure equivalence, monetary stimuli should be adapted across countries in future research by considering several factors, such as inflation, price index, and the minimum wages in different countries.

Conclusion

Psychologists and behavioral economists are particularly interested in culture and color effects on risk preferences. We have identified a clear boundary in showing that individual associations of color with gains or losses affect risk preferences across cultures. Particularly notable is that we find contrasting moderation effects: incongruent or incompatible associations with mainstream cultural meanings tend to exaggerate color effects on risk preferences. Although the complex topic has been understudied, we anticipate increased future research into the effects of color on risk preferences.

References:

Adams, F. M., & Osgood, C. E. (1973). A cross-cultural study of the affective meanings of color. *Journal of Cross-Cultural Psychology*, *4(2)*, 135-156.

Ames, D. (1999). *Folk psychology and social inference: Everyday solutions to the problem of other minds.* Doctoral dissertation, University of California, Berkeley.

Archer, J. (2006). Cross-Cultural Differences in Physical Aggression Between Partners: A Social-Role Analysis. *Personality and Social Psychology Review, 10(2)*, 133–153.

Baribault, B., Donkin, C., Little, D. R., Trueblood, J. S., Oravecz, Z., Van Ravenzwaaij, D., ... & Vandekerckhove, J. (2018). Meta studies for robust tests of theory. *Proceedings of the National Academy of Sciences, 115(11)*, 2607-2612.

Bazley, W. J., Cronqvist, H., & Mormann, M. M. (2019). Visual Finance: The Pervasive Effects of Red on Investor Behavior. *Swedish House of Finance Research Paper, (17-16)*, 18-77.

Benet-Martínez, V., Leu, J., Lee, F., & Morris, M. W. (2002). Negotiating biculturalism: Cultural frame switching in biculturals with oppositional versus compatible cultural identities. *Journal of Cross-cultural psychology, 33*(5), 492-516.

Chan, R., & Park, H. D. (2015). How images and color in business plans influence venture investment screening decisions. *Journal of Business Venturing*, *30*, 732-748.

Changizi, M. A., Zhang, Q., & Shimojo, S. (2006). Bare skin, blood and the evolution of primate colour vision. *Biology Letters, 2(2)*, 217-221.

Chattopadhyay, A., Gorn, G. J., & Darke, P. (2010). Differences and similarities in hue preferences between Chinese and Caucasians. In A. Krishna (Ed.) *Sensory marketing: Research on the sensuality of products* (pp.219-239). Routledge.

Cheng, C. Y., Lee, F., & Benet-Martínez, V. (2006). Assimilation and contrast effects in cultural frame switching: Bicultural identity integration and valence of cultural cues. *Journal of Cross-Cultural Psychology, 37(6)*, 742-760.

Chiu, C. Y., & Cheng, S. Y. (2007). Toward a social psychology of culture and globalization: Some social cognitive consequences of activating two cultures simultaneously. *Social and Personality Psychology Compass, 1(1)*, 84-100.

Choi, J., Lee, K., & Banerjee, P. (2019). Asymmetric effect of context-specific color priming on interpretation of ambiguous news articles. *Journal of Consumer Behaviour, 18*, 219-232.

Chu, P. C., Spires, E. E., Farn, C. K., & Sueyoshi, T. (2005). Decision processes and use of decision aids: Comparing two closely related nations in East Asia. *Journal of Cross-Cultural Psychology, 36*(3), 304-320.

Eldridge, S. M., Ashby, D., & Kerry, S. (2006). Sample size for cluster randomized trials: effect of coefficient of variation of cluster size and analysis method. *International Journal of Epidemiology, 35(5)*, 1292-1300.

Elliot, A. J., & Maier, M. A. (2007). Color and psychological functioning. *Current Directions in Psychological Science*, *16(5)*, 250-254.

Elliot, A. J., & Maier, M. A. (2012). Color-in-context theory. In *Advances in experimental social psychology* (Vol. 45, pp. 61-125). Academic Press.

Elliot, A. J., & Maier, M. A. (2014). Color psychology: Effects of perceiving color on psychological functioning in humans. *Annual Review of Psychology, 65,* 95-120.

Elliot, A. J., Maier, M. A., Moller, A. C., Friedman, R., & Meinhardt, J. (2007). Color and psychological functioning: the effect of red on performance attainment. *Journal of Experimental Psychology: General*, *136*(1), 154-168.

Elliot, A. J., & Niesta, D. (2008). Romantic red: red enhances men's attraction to women. *Journal of Personality and Social Psychology*, *95*(5), 1150-1164.

Everitt, B. S. (2006). *The Cambridge dictionary of statistics*. Cambridge University Press.

Fernie, G., Cole, J. C., Goudie, A. J., & Field, M. (2010). Risk-taking but not response inhibition or delay discounting predict alcohol consumption in social drinkers. *Drug and Alcohol Dependence, 112(1-2),* 54-61.

Fischer, R., & Schwartz, S. H. (2011). Whence differences in value priorities? Individual, cultural, or artifactual sources. *Journal of Cross- Cultural Psychology*, *42*(7), 1127–1144.

Gnambs, T., Appel, M., & Oeberst, A. (2015). Red color and risk-taking behavior in online environments. *PloS one*, *10*(7), 1-12.

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. (1998). Measuring individual differences in implicit cognition: the implicit association test. *Journal of Personality and Social Psychology*, *74*(6), 1464-1480.

Greenwald, A. G., Nosek, B. A., & Banaji, M. R. (2003). Understanding and using the implicit association test: I. An improved scoring algorithm. *Journal of Personality and Social*

Psychology, *85*(2), 197-216.

Greiner, B., & Stephanides, M. (2020). The Economics of Color: A Null Result. *Working Paper*, Vienna University of Economics and Business.

Guéguen, N. (2012). Color and women attractiveness: When red clothed women are perceived to have more intense sexual intent. *Journal of Social Psychology, 152*, 261-265.

Gneezy, U., List, J. A., & Wu, G. (2006). The uncertainty effect: when a risky prospect is valued less than its worst possible outcome. *Quarterly Journal of Economics, 121(4)*, 1283-1309.

Greene, K.,Krcmar, M., Walters, L. H., Rubin, D. L., & Hale, L.(2000). Targeting adolescent risk-taking behaviors: the contributions of egocentrism and sensation-seeking. *Journal of Adolescence*, *23*(4), 0-461.

Hummert, M. L., Garstka, T. A., O'Brien, L. T., Greenwald, A. G., & Mellott, D. S. (2002). Using the implicit association test to measure age differences in implicit social cognitions. *Psychology and Aging*, *17*(3), 482-495.

Jacobs, L., Keown, C., Worthley, R. & Ghymn, K.-I. (1991). 'Cross-Cultural Colour Comparisons: Global Marketers Beware!' *International Marketing Review, 8(30)*, 21–30.

Jiang, F., Lu, S., Yao, X., Yue, X., & Au, W. (2014). Up or down? How culture and color affect judgments. *Journal of Behavioral Decision Making, 27(3)*, 226-234.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decisions under risk. *Econometrica*, *47*, 263-291.

Khan, S. A., Levine, W. J., Dobson, S. D., & Kralik, J. D. (2011). Red signals dominance in male rhesus macaques. *Psychological Science, 22*(8), 1001-1003.

Kitayama, S., Park, H., Sevincer, A. T., Karasawa, M., & Uskul, A. K. (2009). A cultural task analysis of implicit independence: comparing North America, Western Europe, and East Asia. *Journal of Personality and Social Psychology, 97*(2), 236-255.

Kliger, D., & Gilad, D. (2012). Red light, green light: Color priming in financial decisions. *The Journal of Socio-Economics, 41*(5), 738-745.

Labrecque, L. I., Patrick, V. M., & Milne, G. R. (2013). The marketers' prismatic palette: a review of color research and future directions. *Psychology and Marketing*, *30*(2), 187-202.

Ladouceur, R., Gosselin, P., & Dugas, M. J. (2000). Experimental manipulation of intolerance of uncertainty: a study of a theoretical model of worry. *Behaviour Research and Therapy, 38(9)*, 933-

941.

Lehmann, G. K., & Calin-Jageman, R. J. (2017). Is red really romantic?. *Social Psychology*, *48*, 174-183.

Leong, K., Sung, A., Williams, T., Andoniou, C. and Sun, F. (2019), "The importance of colour on the communication of financial data in management", *Journal of Work-Applied Management, 11,* 92-100.

Lejuez, C. W., Read, J. P., Kahler, C. W., Richards, J. B., Ramsey, S. E., & Stuart, G. L., et al. (2002). Evaluation of a behavioral measure of risk taking: the balloon analogue risk task (bart). *Journal of Experimental Psychology: Applied, 8(2)*, 75-84.

Leung, A. K. Y., & Cohen, D. (2011). Within-and between-culture variation: individual differences and the cultural logics of honor, face, and dignity cultures. *Journal of Personality and Social Psychology, 100*(3), 507-526.

Li, L. M. W., Masuda, T., & Jiang, F. (2016). Influence of cultural meaning system and socioeconomic change on indecisiveness in three cultures. *Journal of Cross-Cultural Psychology, 4*7(4), 508-524.

Li, L. M. W., Masuda, T., & Russell, M. J. (2014). The influence of cultural lay beliefs: Dialecticism and indecisiveness in European Canadians and Hong Kong Chinese. *Personality and Individual Differences, 68*, 6-12.

Madden, T. J., Hewett, K. and Roth, M. S. (2000), 'Managing Images in Different Cultures: A Cross-National Study of Color Meanings and Preferences', *Journal of International Marketing 8(4)*, 90–107.

Mao, T., Yang, J., Ru, T., Chen, Q., Shi, H., Zhou, J., & Zhou, G. (2018). Does red light induce people to be riskier? Exploring the colored light effect on the Balloon Analogue Risk Task (BART). *Journal of Environmental Psychology, 57*, 73-82.

McConnell, A. R., & Leibold, J. M. (2001). Relations among the Implicit Association Test, discriminatory behavior, and explicit measures of racial attitudes. *Journal of Experimental Social Psychology, 37(5)*, 435-442.

Mok, A., & Morris, M. W. (2009). Cultural chameleons and iconoclasts: Assimilation and reactanceto cultural cues in biculturals' expressed personalities as a function of identity conflict. *Journal of Experimental Social Psychology, 45*, 884–889.

Na, J., Grossmann, I., Varnum, M.E.W., Gonzalez, R., Kitayama, S., & Nisbett, R.E. (2010). When cultural differences are not reducible to individual differences. *Proceedings of the National Academy of Sciences of the United States of America, 107*(14), 6192-6197.

Oyserman, D., Sorensen, N., Reber, R., & Chen, S. X. (2009). Connecting and separating mind-sets: Culture as situated cognition. *Journal of personality and social psychology, 97*(2), 217-235.

Peperkoorn, L. S., Roberts, S. C., & Pollet, T. V. (2016). Revisiting the red effect on attractiveness and sexual receptivity: No effect of the color red on human mate preferences. *Evolutionary Psychology, 14(4),* 1-13.

Pravossoudovitch, K., Cury, F., Young, S. G., & Elliot, A. J. (2014). Is red the colour of danger? Testing an implicit red–danger association. *Ergonomics*, *57*(4), 503-510.

Peng, K., Ames, D. R., & Knowles, E. D. (2001). Culture and human inference: perspectives from three traditions. In David Matsumoto (Ed.) *The Handbook of Culture and Psychology* (pp.245-264). Oxford University Press, New York.

Rosenboim, M., Shavit, T., & Shoham, A. (2010). Financial decision making in collective society—A field test on Israeli kibbutz members and city residents. *The Journal of Socio-Economics*, *39*(1), 30-36.

Rieger, M. O., Wang, M., & Hens, T. (2015). Risk preferences around the world. *Management Science, 61(3)*, 637-648.

Seibt, T., &Klement, V. (2015). The impact of the colour red on attractiveness perception. In M. Mokrys& S. Badura (Eds.), *4thAdvanced Research in Scientific Areas* (pp. 20–24). Zilina, Slovakia: EDIS – Publishing Institution of the University of Zilina.

Shi, J., Zhang, C., & Jiang, F. (2015). Does red undermine individuals' intellectual performance? A test in China. *International Journal of Psychology*, *50*(1), 81-84.

Silic, M., Cyr, D., Back, A., & Holzer, A. (2017). Effects of color appeal, perceived risk and culture on user's decision in presence of warning banner message. *Social Science Electronic Publishing.*

Su, C., & Hynie, M. (2011). Effects of life stress, social support, and cultural norms on parenting styles among mainland Chinese, European Canadian, and Chinese Canadian immigrant mothers. *Journal of Cross-Cultural Psychology, 42*(6), 944-962.

Ten Velden, F. S., Baas, M., Shalvi, S., Preenen, P. T., & De Dreu, C. K. (2012). In competitive interaction displays of red increase actors' competitive approach and perceivers' withdrawal. *Journal of Experimental Social Psychology*, *48*(5), 1205-1208.

Thorstenson, C. A. (2015). Functional equivalence of the color red and enacted avoidance behavior? Replication and empirical integration. *Social Psychology, 46*, 306-311.

Wärneryd, K. E. (1996). Risk attitudes and risky behavior. *Journal of Economic Psychology*, *17*(6), 749-770.

Weber, E. U., Blais, A. R., & Betz, N. E. (2002). A domain‐specific risk‐attitude scale: Measuring risk perceptions and risk behaviors. *Journal of Behavioral Decision Making, 15*(4), 263-290.

Wen, F., Zuo, B., Wu, Y., Sun, S., & Liu, K. (2014). Red is romantic, but only for feminine females: Sexual dimorphism moderates red effect on sexual attraction. *Evolutionary Psychology, 12(4).*

Wright, B., & Rainwater, L. (1962). The meanings of color. *The Journal of General Psychology, 67(1)*, 89-99.

Xu, X. P. (2007). Viewing the cultural differences between China and the West by color words [in Chinese]. *Journal of Huaihua University, 26*, 108-109.

Young, S. (2015). The effect of red on male perceptions of female attractiveness: Moderation by baseline attractiveness of female faces. *European Journal of Social Psychology, 45,* 146-151.

Zhang, T., & Han, B. (2014). Experience reverses the red effect among Chinese stockbrokers. *PloS one, 9*(2), 1-4.

Zhao, L. Q. (2010). A discussion on color words' cultural and symbolic meaning between West and East [in Chinese]. *China Education Innovation Herald, 19*, 74-76.

APPENDIX

The equations for D score

Numerator_for_D = $(m_2 - m_1)$.   Equation (1)

Denominator_for_D = $\sqrt{[(n_1 - 1) \times sd_1^2 + (n_2 - 1) \times sd_2^2] + \frac{(n_1+n_2)(m_2-m_1)^2}{4} / (n_1 + n_2 - 1)}$

Equation (2)

D = Numerator_for_D / Denominator_for_D.   Equation (3)

1= compatible combination (red-loss, green-gain);

2= incompatible combination (red-gain, green-loss).