심리학석사 학위논문

Human Perception on Artificial Intelligence: Blessing or Threat?

인공지능을 바라보는 인간의 시선: 축복인가 위협인가?

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Abstract

While excitement surrounds new technological frontiers in society, there is also public fear of artificial intelligence (AI), a new technology that holds the potential to contribute much to humanity. For AI technology to become useful in society, it is crucial to determine how ordinary people perceive and accept AI. Surprisingly little research has been done on the actual origins of such fear and anxiety over new technology – especially concerning AI. Our six studies have examined the nature and content of the general threat that people perceive from AI. We found that (a) a good amount of incongruence exists among people who see AI as either a blessing or a threat; (b) the logic-intuition frame – whether people perceive AI to be logical or intuitive – is a key mechanism in formulating any perceived threat; (c) one's perception of blessing versus threat is a strong indicator of one's intention of engaging with AI technology in real life; (d) and most interestingly, this perception of threat can be shifted via a simple frame manipulation. The implications from these findings, which can shed light for those in academia and society at large, are discussed here.

*Keywords : a*rtificial intelligence, threat perception, intuition, logic

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Table of Contents

Tables

Figures

From Mary Shelley's 1818 novel *Frankenstein* to the contemporary *Matrix* film series, the dark side of new technology has been a popular theme used in art and media to mirror public anxiety. The fourth industrial revolution (4IR), which encompasses advances in digital, bio-tech, and physics, includes artificial intelligence (AI) as a main attainable goal (Schwab, 2016). Though governments and IT giants are investing heavily on AI, one cannot truly predict where artificial intelligence will take humanity despite the prevalence of its precursors. Handheld smartphones, Amazon's auto recommendation program, Tesla's automatic driving features, and Google's search and translation engines are current real-life examples of weak artificial intelligence (Goertzel, Pennachin, Geisweiller, 2014). With the exponential increase in AI technology (Kurzweil, 2005), at the same time, comes an expected loss of approximately five million jobs globally (Davos Forum, 2016). Some human job tasks, and a few occupations entirely, in areas such as simple computation, law, medicine, and even arts and music, have already been transferred to AI.

March 15, 2016. The match of the century ended in a 4–1 victory for artificial intelligence over a human. Google's AI AlphaGo defeated Lee Se-dol, a South Korean master in the ancient Asian board game Go. Lee's grimace adorned the pages of renowned newspapers, and the global public was shocked. As a result of this reaction to AlphaGo, the number of search in South Korea for the phrase "artificial intelligence" surged up to 95 in March 2016, as compared to 10 from 2011, according to Google Trends.

Concurrently, the South Korean government raised their 2017 AI budget to $13 million USD, an 80.2% increase from 2016 (Ministry of Science, ICT, and Future Planning, 2017). About a year later in May 29, 2017, AlphaGo retired after defeating Ke Jie, prodigious world Go champion. Ke Jie in tears decorated another headlines (Koo, 2017).

People often compare AlphaGo's victories to "judgment day" in the film *The Terminator*, a scene where AI robots are shown to become sentient and act to wipe out humankind. Some attempt to alleviate this fear by explaining that AlphaGo is not yet a completely self-learning autonomous AI (Baillie, 2017) – a far cry from the terrifying machines of science fiction. However, most AI experts share ambivalence towards this uncharted territory of AI (Kaplan, 2015; Sharkey & Sharkey, 2007). Those who regard AI as a blessing insist that the benefits outweigh the risks regarding AI. They argue that machines can complete tasks in much faster, more accurate, and economical ways (Kaplan, 2015). For them, AI is a new opportunity to create a larger variety of jobs despite replacing some human jobs (Smith & Anderson, 2014, on canvass which a total of 1,896 AI experts participated in). However, others take a reserved stance on AI because machines cannot perform tasks that require subtle emotional engagement such as eldercare (Sharkey and Sharkey, 2010). In addition, they expect technological unemployment by AI will only harshly impact blue-collar employment. Well-known scientists like Stephen Hawking and Elon Musk consider AI an existential threat and warn that the advent of AI that matches or surpasses

human thought could spell the end of the human race (Cellan – Jones, 2014). Thus, the concern becomes how will AI experts in technological, economical, ethical, legal, and sociological debates reach an agreement. Whether or not AI will be a blessing or threat in their fields is an issue that will affect the progression and future direction of AI technology. However, we must not forget to consider the effects of AI on ordinary individuals who will be affected the most by advancements in AI.

In order for AI technology to be usefully settled on ordinary daily life, we must examine how average people perceive AI. Human history has taught us that public acceptance is just as important as technological stability and necessity (Rogers, 1995). Nuclear facilities and genetic recombination technologies are good examples. Despite the potential of their contribution to humanity, the majority of the general public is hesitant to accept them psychologically (Tanaka, 2004). For example, simply one reported accident at the hands of Google's self-driving car was enough for the public to question its technological application despite its proven rates of accidents lower than that of human drivers (Google, 2016). While there is excitement and expectation for new frontiers within the community, there remains a public fear of AI. If the general public does not accept AI, the technology will not be useful because people will be hesitant to utilize such technologies. Thus, for AI to become useful to society, it is crucial to study how an ordinary person perceives AI. This includes looking into the psychological background for why individuals have differing opinions on AI.

Possible points of analysis consist of whether they regard it as a blessing or a threat, what underlying mechanisms operate to create these individual differences, and what actual behavioral implications such diversions would have.

Existing Research on Resistance to Innovation

Resistance to innovation has historically been seen quite frequently. From attacks on coffee in the Middle East during the medieval times to criticisms of modern computers, perceptional incongruity on transformative innovations has been prevalent for approximately 600 years (Juma, 2016). Emotional resistance to new technology, manifested in the form of avoidance of innovation, is well presented in literature, elucidated by the term "technophobia" (Frideres, Goldenberg, Disanto, & Fleming, 1983). Roughly 50% of the population possesses a natural skepticism, irrational fear, dislike, or anxiety of advanced technology, especially with regard to computers (Osiceanu, 2015). Concerning the advent of computing, social psychologists found that a segment of people possesses a positive view while others have a negative view (Lee, 1970). Since then, many empirical studies have delved into the phenomenon in depth – also interchangeably known as computerphobia (Jay, 1981), technostress (Brod, 1984), computer aversion (Meier, 1985), and computer anxiety (Raub, 1982).

However, the majority of past literature has focused on computer technology rather than AI and has only examined the contextual, individual, and demographical factors such as gender, age, and culture that have

affected negative attitudes toward new technology. The reason for this focus may be because the majority of researches consider technophobia as a pathological status and attempt to find the methods to reduce fear in various contexts (Rosen, Sears, and Weil, 1993) and social settings including public school classrooms (Rosen and Weil, 1995), legal courts (Toohey, 2015), consumer market and business settings (Coppola and Verneau, 2014). Technophobes rarely adopt new forms of technology, even innovations that can improve their own living conditions (Amichai-Hambruger, 2011; Vankatesh and Davis, 1996). As new technology emerges in an unstoppable rhythm, some researchers consider technophobia "a condition that must and can be overcome" for successful integration with society (Gorayska, & Mey, 1996). When considering the years where technophobia research was blooming, it might have been important for researches to study which segment of society primarily holds such aversion toward computers. Gilbert, Lee-Kelley, and Barton (2003) showed no gender difference in computer anxiety; however, major lines of studies found females express higher level of anxiety to new technology (Brosnan and Davidson, 1996; Raub, 1981; Wilder, Makie, & Cooper, 1985). Whiteley (1998) showed that females masculinize technology and females with high feminist beliefs display higher levels of anxiety. In fact, 99% of computers in the USA were bought by men in the 1990s (Brosnan, 1998). Raub (1998) suggests that older generations are more prone to such phobia, however, the prejudice that technophobia severely affects the elderly has been disproved by other

researchers (Brosnan, 1998). Given that culture and technological development are inter-connected, cultural differences in attitudes toward computers are also present (Collins and Williams, 1987; Li and Kirkup, 2007; Marcoulides and Wang, 1990; Rosen and Weil, 1995). For instance, Allwood and Wang (1990) reported that Chinese students hold a more optimistic view on how future technology will impact their society. Although familiarity with a particular technology does not affect one's attitude (Mahmood and Medewitz, 1985), individuals with high self-efficacy (Compeau, Higgins, and Huff, 1999), internal locus of control, low neuroticism, high openness, and extravert personalities (Korukonda, 2005) illustrated a lower degree of anxiety. However, only a few studies have been done on the actual contents of the threat, fear, anxiety that individuals hold. What are the actual fears individuals have? At what point do they perceive such threat from the new technology? Many questions are still left unanswered.

Even with the few studies that expanded technophobia from computers to robots and artificial intelligence, our knowledge on why people may perceive AI as a threat is still limited. Nomura and researchers (2006) discovered that individuals with high negative attitudes towards robots as measured through a scale deemed NARS (Negative Attitude toward Robots Scale) have higher fears and anxiety regarding robots. These individuals illustrated their negative attitudes through behaviors such as avoidance (Sakamoto et al, 1998) and adverse utterance toward robots. They

divided their NARS scale into three: 1) situations of interaction with robots, 2) social influence of robots, and 3) emotions in interaction with robots. However, they did not clarify which psychological mechanism caused such anxiety or fear in experimental settings. Similar to studies on technophobia, several researches called for cultural differences in the perception of robots. For example, the Japanese are significantly more concerned with the societal impact of robots and the personal impact of interacting emotionally with human-like robots. (Bartneck et al., 2005; Nomura et al. 2006). Meanwhile, American participants hold the least negative attitudes towards robots. Many argue that these cultural differences are derived from different degrees of familiarity with and exposure to mass media (Bartneck, Suzuki, Kanda, and Nomura, 2006). Recently, researchers designed a Fear of Autonomous Robots and Artificial Intelligence (FARAI) score which has been shown to be positively correlated with one's exposure to mass media or other types of fear such as technological unemployment or loneliness. Other researchers like Liang and Lee (2017) focus more on general fear as "a preconceived stronger and more emotionally-based anticipation that people might have towards artificial intelligence".

However, surprisingly little empirical research has assessed possible mechanisms behind the fear, anxiety, and perceived threat people feel about artificial intelligence. This may be because many studies do not necessarily differentiate AI technology from computer technology. We believe there are certain findings of previous studies that should be applied to the artificial

intelligence area, considering AI is also the new technology. However, AI, at the same time, must be differentiated from the regular computer technology, especially regarding unique properties of its threat perceived by the general public. We would like to propose that AI is not just another new technology created in order to increase efficiency. Therefore, the perceived threat reaches beyond the fear of AI replacing an individual's job. At the core of its definition, artificial intelligence attacks humans in the name of anthropomorphism. AI challenges the very essence of what makes humans unique: our human intuition.

Why Artificial Intelligence Serves as a Challenge to Human Intuition

"We are on the edge of change comparable to the rise of human life on Earth."

– Vernor Vinge

Naturally, the primary fear of new technology stems from technological unemployment – the fear of losing jobs to automation (Piston and Yampolskiy, 2016). However, AI differs from computer technology in that unlike "robots" or "computers," the term "artificial intelligence" naturally triggers individuals to attribute human-like characteristics to inanimate machines. In doing so, we anthropomorphize these objects. Anthropomorphism is the tendency to attribute human characteristics to inanimate objects and other non-humans as a way to help us rationalize their actions (Duffy, 2003). Studies by Barrett and Keil (1996) demonstrate that participants consciously visualize scenarios in experiments as if AI were

anthropomorphic, even when they consciously believe AI is unlike human beings (Epley, Waytz, and Cacioppo, 2007).

However, this innate anthropomorphizing process can have unexpected side-effects that threaten ordinary people. The uncanny valley hypothesis claims that people perceive a threat when non-human objects possess human-like physical properties. When replicas, such as robots and dolls, seem somewhat like, but not completely the same as, human beings in appearance or motion, people feel revulsion or dread toward these objects (Mori, 1970). Since the primary goal of robotics is to make robots look, act, and behave like real humans, many researchers focus on how they can avoid the uncanny valley in designing robots or interfaces in fields such as the military (Wark & Lambert, 2007) and health care (Bickmore, Gruber, & Picard, 2005). The key factor lies in whether robots are developed to be perfect human beings or not. Imagine feeling awkward when you see clumsy prosthetic hands or characters in videogames or movies with computer graphics (Seyama, 2007). In fact, research on the Uncanny Valley has been extended to the expression of artificial human facial emotions. However, most studies focus solely on the physical appearance of robots: there are still only a limited number of studies that apply the uncanny valley of AI to the non-physical characteristics of humans (Ho, 2008; Tinwell et al., 2011). We advance the idea further and speculate that humans may perceive artificial intelligence as a threat if the machines both resemble humans in appearance and mimic how we think and behave, while never being able to

seem perfectly human.

People tend to define their own cultural group as epitomizing what it means to be uniquely human (Vaes, Heflick, and Goldenberg, 2010). Goldenberg et al. (2009) and Vaes et al. (2010) argued that ascribing uniquely human attributes selectively to the self and the in-group is a plausible way to do so. However, artificial intelligence is now attempting to imitate human intuition, an area that has not yet been conquered by computer technology, thus posing an existential threat – the threat of losing control of one's identity – even greater than the threat of computers. Turkle (1986) and Haslam (2006) both suggest that the unique characteristics distinguishing humans from machines are emotion, spontaneity, spirit, and intuition (Haslam, 2006; Haslam, Bain, Douge, Lee, & Bastian 2005). A series of experiments by Tversky and Kahneman also show that many human behaviors are intuitive and irrational (Tversky & Kahneman, 1982; Kahneman and Klein, 2009). In other words, logical thinking, fast computation, and accuracy, the dominant characteristics of machines, are not innately human. However, intuitive thinking, creativity, subjective experience, and inspiration are innately human. Existing studies support the human expectation that robots will not be able to mimic intuition. Many individuals want robots to replace mundane and routine tasks that do not require deep thinking process (Ray, Mondada, and Seigwart, 2008) and do not expect them to perform task that required capabilities deemed as human qualities such as empathy, caring, or independent decision making (Syrdal et

al., 2011). Khan (1998) concludes that people want robots to be domestic machines that can be controlled and do not wish for them to behave in manners other than machines. In fact, Goldenberg et al. (2000) suggested that in order to minimize the existential threat – a threat of death explained in terror management theory (Becker, 1973) – individuals not only deny their similarities to animals but also engage in strategies to emphasize the uniquely human aspects of the self, over and in contrast with other people. This deliberate mental process of humanizing in-group and dehumanizing out-group was also examined in researches about xenophobia, the fear towards foreigners (Yakushko, 2009), or ethnocentrism (Bain, Vaes, and Leyens, 2014). For example, some Jewish participants dehumanized Palestinians in order to cope with the threat Palestinians presented (Maoz & McCauley, 2008). The perception of threat increases when this dehumanizing process fails. Thus, negative perceptions of AI may be exacerbated as numerous AI scientists are already attempting to replicate human brains via neural networks in the hopes of gaining insight and intuitive thinking in neuroscience. In *The Most Human Human* (2011), Brian Christian remarks that the ultimate goal of AI is to develop the most humane computer. However, when AI evolves to gain the capacity to self-teach with self-awareness (Martinez-Miranda and Aldea, 2005; Minsky, 2007), people will have to prepare for unexpected and possibly unwanted outcomes. All of the above – the abilities of AI to mimic human intuition – are efforts to eliminate the dehumanization process on AI (once considered

as an out-group); as a result, people will feel an existential threat.

In fact, after preliminary analysis of 1,524 online comments on seven major news articles about the Go matches between Lee Se-dol and the computer AlphaGo, we found that a major determining factor in threat perception of AI was whether one perceives the task to be mostly logical or mostly intuitive – whether one perceives the AI as simply calculating faster, or as capable of intuitive thought. Those who feel unthreatened by AI believed that Go is a game of logical computation in which a player needs to quickly calculate the number of possible outcomes. For them, AI is merely a computer that can relieve a burden. On the other hand, those who believe that AI poses an existential threat considered Go to be a creative game that requires human intuition. For this reason, they originally expected Lee Se-dol, the human expert, to win. Combining the uncanny valley hypothesis, which originally failed to look at humanlike non-physical characteristics, and aspects of humanness that current AI technology is aiming to imitate, we could hypothesize that humans perceive AI as a threat because they are now infiltrating intuition, which many consider a unique aspect of humans. If AI replaces tasks that were originally considered 'uniquely human' – resembling human thought too closely – people will experience fear and revulsion as their response falls into the uncanny valley. When AlphaGo defeated Lee and Ke Jie, they remarked in shock, "[the loss] made me question human intuition" (Koo, 2017). Now, Ke Jie's tears make more sense in the context of our present study.

Current Studies

While there is hope for the new frontier within the community, there remains a public anxiety of AI. If fear is present, AI will be prevented from being widely accepted in society. In order to fully understand the public's fear, it is crucial to examine what underlying mechanisms cause such a fear and what the implications such fears have on the development of AI.

Previous studies regarding people's negative attitudes toward the new technology have some limitations. First, most studies fail to investigate the origins and contents of individuals' threat and fear. Second, they primarily focus on computer technology. Thus, there is a need for studies to be done in the field of artificial intelligence alone seeing as the threat posed by computers and AI is fundamentally different. AI poses an existential threat as it imitates human intuition.

To assess whether people anticipate a general threat from Artificial Intelligence and to discover the possible mechanism and behavioral implications behind such subjective perception – and of course, to supplement limitations of previous studies – we propose a series of exploratory and empirical studies based on three respective hypotheses. First, individuals have different perceptions on AI. Some see AI as a threat while others a blessing. Second, this diversion on perception derives from the logic-intuition frame that one has – whether individuals perceive a task to be logical or intuitive or perceive artificial intelligence to operate in through a logical or intuitive process. Third, individuals' perception on AI

affects actual behavior regarding AI, such as purchasing AI-related products, utilizing AI-powered services, or expressing opinions on a government's aggressive investment plan to foster AI technology.

In Studies 1 and 2, we conducted two correlational studies to find out general public perception on AI and if there is a perceptual gap between people who see AI as a blessing and those who view AI as a threat. In Study 1, we focused on overall perception on AI. Study 2 expands the findings of Study 1 in particular areas of human occupations. In order to address the limitations that Study 1 and 2 have as correlational studies, we conducted another two studies (Studies 3 and 4) in which participants reported their perception on AI as a blessing or a threat after reading a few articles about AI trumping humans in math and art competitions. We speculated that even within the same task, whether individuals frame the task to be intuition-driven or logic-driven (logic-intuition frame) can affect their threat perception on AI. We predicted that an individual's general perception or anticipation of a threat can simply be shifted as to how we frame AI given that threat perception is the result state of interpreting a particular situation (Levine & Scotch, 2013; Tversky & Kahneman, 1981; Yap & Tong, 2009). As information about artificial intelligence spreads, the public's perception towards AI may also be altered.

Given that we also believed that such perception on AI can have behavioral implications, in Studies 5 and 6 we asked participants how likely they were to engage in AI-related activities. This included whether a

participant would buy or utilize AI services that are happening in real life (5) and if there was potential to also manipulate behavioral implications with a logic-intuition frame (6).

Study 1

In Study 1, we examined public perceptions of artificial intelligence. We aimed to gather individual differences in perceiving the threats and blessings of AI, and to discover if those perceptions are correlated with how much people think AI can replace logical and intuitive work. First, we predicted that the more people think AI could replace work that requires logic, the more likely they would see AI as a blessing. Second, we predicted that the more that people think AI could replace work that requires intuition, the more likely they would see AI as a threat.

Method

Participants

A total of 98 participants responded to a 20-minute online survey for monetary compensation, including 50 U.S. participants (30 male, 20 female) ranging in age from 19 to 70 years old (M_{age} = 35.24, SD_{age} = 10.95) who were recruited through Amazon's Mechanical Turk service (Buhrmester, Kwang, & Gosling, 2011). To conduct a cultural comparison, 48 South Korean undergraduate students (22 male, 26 female, M_{age} = 22.65, SD_{age} = 1.23) at Seoul National University were recruited through an online community. The basic demography included socio-economic status (SES), college major, and current career.

Materials

Perception on AI. To see how much people perceive AI as a threat and a blessing, we asked two respective questions. First, we asked about *Perception of Threat*: "To what extent do you think the development of AI will be a threat to humankind?" The participants rated their responses on a seven-point Likert scale (from 1 = *definitely not a threat* to 7 = *definitely a threat*, counterbalanced) (M = 4.03, SD = 1.63, M_{US} = 3.98, SD_{US} = 1.78, M_{KOR} = 4.08, SD_{KOR} = 1.47). Then we asked the participants to rate *Perception of Blessing*: "To what extent do you think the development of AI will be a blessing to humankind?" on a seven-point Likert scale (from 1 = *definitely not a blessing* to 7 = *definitely a blessing*, counterbalanced) (M = 4.55, SD = 1.56, M_{US} = 4.82, SD_{US} = 1.55, M_{KOR} = 4.27, SD_{KOR} = 1.54).

Beliefs in what AI can replace. We also asked two respective questions to measure how much people think AI can replace intuitive work and logical work. The participants rated their *Belief in AI Replacing Intuitive Jobs* – "To what extent do you agree AI can replace jobs that require intuition?" – using a seven-point Likert scale (from 1 = *strongly disagree* to 7 = *strongly agree*, counterbalanced) (M = 3.43, SD = 1.74, M_{US} = 3.38, SD_{US} = 1.82, M_{KOR} = 3.48, SD_{KOR} = 1.68). Then we asked about their *Belief in AI Replacing Logical Jobs* – "To what extent do you agree AI can replace jobs that require logic?" – using a seven-point Likert scale (from 1 = *strongly disagree* to 7 = *strongly agree*, counterbalanced) (M = 5.24, SD = 1.58, M_{US} = 5.34, SD_{US} = 1.59, M_{KOR} = 5.15, SD_{KOR} = 1.58).

Covariates. An individual's familiarity with AI technology (Mahmood & Medewitz, 1985) and gender (Brosnan & Davidson, 1996) were controlled as covariates, as suggested by the literature on technophobia. Thus, we do not report the results on familiarity and gender hereafter.

Familiarity With AI Technology was measured via the question, "To what extent do you think you are familiar with current AI technology?" The participants rated their responses on a seven-point Likert scale (from 1 = *I am not familiar at all* to 7 = *I am very familiar,* counterbalanced) (M = 3.38, SD = 1.70, M_{US} = 3.34, SD_{US} = 1.79, M_{KOR} = 3.42, SD_{KOR} = 1.62).

Results

Perception on AI: Threat or Blessing?

For perception of AI, we asked both the U.S. and South Korean participants two questions – in which culture becomes a between-subjects factor and perception type becomes a within-subjects factor. To examine the interaction between culture and perception type, we conducted a 2 (culture: U.S. vs. South Korea) x 2 (perception type: threat vs. blessing) mixed-model analysis of variance (ANOVA).

The ANOVA did not yield a significant main effect of culture, $F(1, 94) = 2.04$. $p = 0.16$. However, the results indicated a marginally significant main effect of perception type, $F(1, 94) = 3.18$, $p = 0.08$, $\eta^2 = .03$, suggesting that the degree of perceiving AI as a blessing (M = 4.55, SD = 1.56) was higher than the degree of perceiving AI as a threat (M = 4.03, SD = 1.63) in the general public. For *Perception of Threat*, a one-sample t test

was not significantly different from 4, the neutral point on a seven-point Likert scale, $t(97) = .18$, p = ns. However, for *Perception of Blessing*, we found a statistically significant difference from 4, $t(97) = 3.50$, $p < .001$, 95% CI = [0.24, 0.86]. Thus, we could only conclude general public perceive AI to be a blessing. Lastly, the Culture x Perception Type interaction was not significant, $F(1,94) = .89$, p = ns.

Beliefs in What AI Can Replace: Intuition or Logic?

Concerning beliefs on what AI can replace, we also asked both U.S. and South Korean participants two questions. We can see that culture is a between-subjects factor, and belief type is a within-subjects factor. To examine the interaction between culture and belief type, we performed a 2 (culture: U.S. vs. South Korea) x 2 (belief type: AI can replace intuitive jobs vs. logical jobs) mixed-model ANOVA.

We did not find a significant main effect of culture, $F(1, 94) = 0.09$, p = ns, nor a main effect of belief type, $F(1, 94) = 1.30$, p = ns. A one-sample t test showed that there are statistically significant differences, with a value of 4, in both *Beliefs in AI Replacing Intuitive Jobs*, $t(97) = -3.25$, $p = .002$, and *Beliefs in AI Replacing Logical Jobs*, $t(97) = 7.80$, $p < .001$, indicating that the general public does not think AI can replace work that requires intuition ($M = 3.43$, $SD = 1.74$), but they do think AI can replace work that requires logic ($M = 5.24$, $SD = 1.58$). We did not find the significant Culture x Belief Type interaction, $F(1, 94) = 0.69$, p = ns.

Correlations Between Main Variables

We expected that participants would perceive more of a threat from AI if they have a higher degree of belief that AI can replace intuitive workers. To examine our hypothesis, a simple correlation analysis was conducted after controlling for one's familiarity with AI technology and gender (see Table 1). However, we found no significant correlation between *Perception of Threat* and *Belief in AI Replacing Intuitive Jobs* (r = .13, p = ns) and no significant correlation between *Perception of Threat* and *Belief in AI Replacing Logical Jobs* (r = .11, p = ns). Whether the sample population believed that AI could replace intuitive or logical jobs did not affect their perception of AI as a threat.

Although there was no significant correlation between *Perception of Blessing* and *Belief in AI Replacing Intuitive Jobs* (r = .04, p = ns), we instead found a significant and positive correlation between *Perception of Blessing* and *Belief in AI Replacing Logical Jobs* (r = .28, p = .006). The more the participants believed that AI could replace logical works, the more likely they considered AI as a blessing, partially supporting our original hypothesis.

Even when we divided the data for cultural comparison between U.S. and South Korean participants, there was no significant correlation between *Perception of Threat* and either *Belief in AI Replacing Intuitive Jobs* or *Belief in AI Replacing Logical Jobs* (*ps* = ns). We found a significant and positive correlation between *Perception of Blessing* and *Belief in AI Replacing Logical Jobs* only in the U.S. sample (r = .34, p < .05). U.S.

participants who think AI could replace logical jobs were more likely to consider AI to be a blessing.

Discussion

In Study 1, we found a wide range of individual perceptions regarding AI in both U.S. and South Korea, specifically whether participants perceived AI as a threat or a blessing and whether they believed AI could replace intuitive and logical jobs. People in general perceived AI to be more of a blessing than a threat. Although the main effect of culture was not significant, this perceptual gap between *Perception of Blessing* and *Perception of Threat* was more evident in the United States. One noticeable difference between cultures was found in a simple comparison, with the degree of *Perception of Blessing* higher in U.S. participants (M = 4.82, SD = 1.55) than in South Korean participants (M = 4.27, SD = 1.56), $t(47) = 5.84$, $p < .001$, $d = 0.84$, 95% CI = [0.03, 0.62], whereas both countries do not differ in *Perception of Threat* toward AI, $t < 1$. We speculated that the unexpected human loss to AI in Lee Se-dol's Go match with Google's AlphaGo in March 2016 might have led to a weaker reception of AI as a blessing in South Korea.

Consistent with our prediction, we found a positive correlation: the more people believe AI can replace logical jobs, the more likely they are to view AI as a blessing. This can be explained by findings in Khan (1998) and Ray, Mondada, and Seigwart (2008) that indicate people want robots to perform mundane and routine tasks that do not require deep thinking

processes. Computers, as an aid to process data efficiently and accurately, are a good example.

However, another main research hypothesis – an expected correlation between threat perception and beliefs about AI replacing intuitive jobs – was not present. We speculated that the questions in Study 1 were too broad and out of context. For instance, when we asked simple questions such as "To what extent do you think AI can replace jobs that require intuition?" without providing specific context, ease of recall and types of jobs that came to mind would have varied widely among participants. Furthermore, recalling intuitive work might be also psychologically more demanding than remembering logical work.

Study 2

To remedy the lack of specificity in Study 1, we picked 17 real jobs that fall into three respective categories for Study 2: jobs requiring creativity and intuition, such as painter, novelist, and photographer; jobs that epitomize logic, calculation, or accuracy, such as physician, scientist, or stock analyst; and jobs that fall somewhere between the two extremes, such as sports team captain and sport human resource (HR) headhunter. We believe Study 2 is the very first study that directly asks people, using specific jobs, what their feelings would be if artificial intelligence (AI) achieved supremacy in some of these areas. We predicted that participants would expect humans to dominate in areas of creativity and intuition, and would feel threatened by AI dominance in these areas. Conversely, we

predicted that participants would expect humans to be less competent than AI in calculation and logic tasks, and would not feel threatened by AI dominance in these areas. We did not expect particular cultural differences in the results.

Method

Participants

A total of 116 participants responded to a 20-minute online survey for monetary compensation. We recruited 55 U.S. participants (30 males, 25 females) ranging from 19 to 65 years old (M_{age} = 33.73, SD_{age} = 10.39) via Amazon's Mechanical Turk service. For cultural comparison, 61 South Korean undergraduate students (35 males, 26 females, M_{age} = 22.61, SD_{age} = 1.19) from Seoul National University were recruited online as well. The basic demography included SES, college major, and current career.

Measures

Participants answered three seven-point Likert questions about every 17 job that we picked as a within design. Since we believe that these three main variables are correlated and, therefore, might produce an order effect, the presentation order of the questions was randomized for each participant.

Job type. We asked U.S. 60 pilot-study participants to write down five jobs that would fall into the three study categories in the pretest: intuitive jobs, logical jobs, and jobs somewhere between the two endpoints. We picked 17 jobs that were mentioned most often in each category. For

intuitive jobs, we included six jobs: architect, disk jockey (DJ), music composer, novelist, painter, and photographer. For logical jobs, we also included six jobs: court judge, mortgage lender, physician (cancer diagnosis), scientist (natural science), stock analyst, and strategic consultant. Finally, for the in-between category, we picked five jobs: airplane pilot, criminal profiler, HR headhunter, sports team captain, and sports team head coach.

Intuition-logic balance. The first question asked for each job was: "For the following fields, what do you think will matter more?" Participants rated each job on a seven-point Likert scale (from 1 = *intuition/creativity/experience/inspiration will absolutely matter more* to 7 = *logic/information/calculation/accuracy will absolutely matter more*, counterbalanced) (M = 4.21, SD = 0.53, M_{US} = 4.19, SD_{US} = .60, M_{KOR} = 4.23, SD_{KOR} = 0.47). Even though we included many concepts in one axis, we would use "intuition" as a representative concept of the *intuition/creativity/experience/inspiration* axis, and "logic" as a representative concept of the *logic/information/calculation/accuracy* axis.

Dominance prediction. The second question for each job was: "Imagine great experts and virtuosos in the following fields competing with AI. Which would perform better?" A seven-point Likert scale was used (from 1 = *AI would perform absolutely better* to 7 = *humans would perform absolutely better*, counterbalanced) (M = 4.68, SD = 1.03, M_{US} = 4.61, SD_{US} = 1.01, M_{KOR} = 4.75, SD_{KOR} = 1.06).

Threat perception. The third question for each job was: "Imagine

artificial intelligence (AI) would perform better than great experts and virtuosos in the following fields. How do you feel about it?" A seven-point Likert scale was used (from 1 = *AI would absolutely be a threat* to 7 = *AI would absolutely be a blessing*, counterbalanced) (M = 3.93, SD = 1.12, M_{US} = 4.01, SD_{US} = 1.01, M_{KOR} = 3.87, SD_{KOR} = 1.21).

Results

We asked U.S. and South Korean participants three questions for each of 17 jobs. Our design allows us to consider culture as a between-participants factor and job type as a within-participants factor. Thus, we conducted a 2 (culture: U.S. vs. South Korea) x 17 (job type) mixed-model ANOVA on intuition-logic balance, dominance prediction, and threat perception.

Intuition-Logic Balance: Does Intuition or Logic Matter?

Mauchly's test indicated that the assumption of sphericity was violated, $\chi^2(135) = 765.44$, $p < .001$. Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = 0.40$). The ANOVA did not yield a significant main effect of culture on the intuition-logic balance, $F(1, 113) = 0.24$, p = ns, indicating that U.S. and South Korean participants shared a similar degree of intuition-logic balance on each of 17 jobs. A main effect of the job type was statistically significant, $F(6.42, 725.08) = 13.38$, $p < .001$, $\eta^2 = .11$, in which some jobs are thought to be more intuition-laden than others, whereas some are thought to be more logic-laden than others. Thus, we conducted a simple one-sample t test on

each job, with a value of 4 (neutral point on a seven-point Likert scale). We found that people think intuition is more crucial than logic for five jobs: music composer, painter, photographer, novelist, and DJ (*ps* < .001). There are nine jobs in which participants perceived logic to be more critical than intuition: stock analyst, physician, scientist, flight pilot, mortgage lender, strategic consultant, court judge, criminal profiler, and HR headhunter (*ps* < .001) (see Table 2 and Figure 1). Finally, the ANOVA did not yield a significant Culture x Job Type interaction on the intuition-logic balance, $F(6.42, 725.08) = 4.23$, p = ns. In fact, a simple comparison revealed that among 17 jobs, mortgage lender was the only one with significant cultural difference, $t(54) = -4.36$, $p < .001$, $d = 0.59$, 95% CI = [-0.61, -0.23]: South Korean participants ($M = 5.80$, $SD = 1.28$) thought that logic is more crucial in mortgage lending than U.S. participants ($M = 5.38$, $SD = 1.73$).

Dominance Prediction: AI or Human?

Mauchly's test indicated that the assumption of sphericity was violated, $\chi^2(135) = 531.66$, $p < .001$. Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = 0.56$). Consistent with our expectation, the ANOVA did not yield a significant main effect of culture on dominance prediction, $F(1, 111) = 0.54$, p = ns. In both U.S. and South Korean participants, their dominance prediction – whether AI will be better or humans will be better – for each job did not vary much. However, we found a significant main effect of job type, $F(8.99, 997.59) = 2.07$, $p = .03$, $\eta^2 = .02$, indicating that participants expected AI to

outperform humans in some jobs, whereas humans will be better than AI at other jobs. A simple one-sample *t* test on each job, with a value of 4, revealed that the following 12 jobs are ones in which participants expect humans to win against AI: novelist, music composer, painter, photographer, sports-team head coach, court judge, sports team captain, HR headhunter, DJ, criminal profiler, architect, and scientist (*ps* < .001). In fact, people thought AI definitely would overwhelm humans in only two jobs: strategic consultant and stock analyst ($p < .001$) (see Table 2 and Figure 2). We also did not find a significant Culture x Job Type interaction on dominance prediction, $F(8.99, 997.59) = 0.37$, p = ns.

Threat Perception: Threat or Blessing?

The assumption of sphericity was violated, $\chi^2(135) = 630.99$, $p < .001$. Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = 0.49$). The results from ANOVA did not show a significant main effect of culture on threat perception, $F(1, 112) = 0.48$, p = ns, indicating that the degree of threat perception if AI defeats humans in each of 17 jobs was similar for U.S. and South Korean participants. Although ANOVA also did not yield a significant main effect of job type, $F(7.82, 876.16) = 1.60$, $p = .12$, a simple one-sample *t* test on each job, with a value of 4, revealed that humans would feel threatened if AI dominates the following seven jobs: novelist, court judge, music composer, painter, sports team captain, sports team head coach, and photographer (*ps* < .001). Humans would consider AI a blessing, even if AI dominated the

following six jobs: stock analyst, strategic consultant, DJ, mortgage lender, physician, and architect (*ps* < .001) (see Table 2 and Figure 3). We did not find significant Culture x Job Type interaction on threat perception, $F(7.82, 876.16) = .51$, p = ns.

Overall Correlations Between Three Variables

We originally hypothesized that participants would expect humans to dominate in areas of creativity and intuition, and would feel threatened by AI dominance in those areas. We also predicted that participants would expect humans to be less adept than AI in areas involving calculation and logic, but would not feel threatened if AI eventually dominates humans in these realms. To examine these relationships, we conducted a simple correlation analysis. There was a significant and negative correlation between intuition-logic balance and dominance prediction in both U.S. (r = - .34, p < .001) and South Korean participants (r = - .33, p < .001; Overall, r = - .33, p < .001). We also found a significant and positive correlation between intuition-logic balance and threat perception in U.S. (r = .17, p < .001) and South Korea (r = .16, p < .001; Overall, r = .16, p < .001). Consistent with our prediction, we found that for jobs in which participants think intuition is the key to success, they expect humans to perform better than AI, and that if AI were to dominate such areas, people would perceive AI to be a threat to humanity.

Correlations Between Three Variables for Each Job

We expected that overall correlational relationships that we found

between three main variables might be different from individual correlations for each job. First, we found an identical significant and negative correlation between intuition-logic balance and dominance prediction for the following nine jobs: music composer, painter, sports team captain, novelist, strategic consultant, DJ, scientist, mortgage lender, and photographer (*ps* < .1). However, we only found three jobs in which people would perceive AI as a threat if they believe intuition is particularly crucial in those areas: strategic consultant, scientist, and physician (*ps* < .1) (See Table 3a,3b,3c, and 3d for detailed correlations for each job and cultural differences).

Discussion

As predicted, we found in Study 2 that individual perceptions of AI as a threat were based on subjective evaluations of job characteristics: whether one perceives AI as able to replace intuition-driven work such as painting or composing music, or logic-driven work such as analyzing data or crafting strategies. At the job level of analysis, when looking at each job, we found inconsistent correlational relationships between the three variables. However, when we aggregated the data to examine it at the individual level, as individuals think the certain area requires human intuition, they are more likely to expect human supremacy and perceive a threat from AI dominance. However, Studies 1 and 2 were solely correlational studies, from which we cannot conclude any causal relationships between our factors of interest.

Study 3

In Study 3, we sought to further develop the causal relationship

between the perceived characteristics of each job and respondents' predictions of AI performance. We hypothesized that if we reframed the core characteristics of each job, shifting the emphasis from logic to intuition (the logic-intuition frame), people would expect humans to beat AI – even in those areas where logic is key, such as math and science.

Method

Participants

We recruited total 60 U.S. participants (34 male, 26 female), ranging from age 21 to 69 years (M_{age} = 38.12, SD_{age} = 12.06), via Mechanical Turk by Amazon. The participants were mostly identified as White Americans (81.7%). Participants responded to a 30-minute online survey for monetary compensation. The basic demography included SES, college major, and current career.

Measures

Logic-intuition frame. Participants were given a fabricated *New York Times* news article about a math conundrum contest. In the scenario, IBM had a newly invented artificial intelligence, UniMath, which competes with the promising math genius, George Witten, the holder of 10 international math competitions. There were two scenario frame conditions for the study: a logic-ignited frame and an intuition-ignited frame. In the logic-ignited frame condition (see Appendix A), participants read that former contest-winning mathematicians all agree that: "Logical thinking, accurate, and prompt calculation based on an objective database of a series

of solved math problems is the key to a win." In the intuition-ignited frame condition (see Appendix B), that part was substituted with "Intuitive thinking with a sense of creativity, based on subjective experiences, is the key to a win." Everything else in the two scenarios was identical.

Dominance prediction. At the end of the fabricated scenario, *The New York Times* polls the readers to determine what outcome the people expect before the contest begins. The participants had to answer, "Who do you think will win the math contest? AI or human?" on a seven-point Likert scale (from 1 = *AI* to 7 = *human*, counterbalanced) (M = 4.15, SD = 2.11).

Results

To examine the main effect of the logic-intuition frame (logic-ignited frame vs. intuition-ignited condition) on the dominance prediction, we conducted a univariate one-way ANOVA. As seen in Figure 4, we found a significant main effect of the logic-intuition frame with a medium effect size, $F(1,57) = 4.97$, $p < .05$, $\eta^2 = .08$. People were more likely to expect that humans would win the math competition when the scenario was manipulated such that winning a math competition requires one's intuition (M = 4.74, SD = 2.02), than when participants were told that winning the math conundrum contest, in fact, is a matter of one's logic skills (M = 3.52, SD = 2.05). For each frame condition, an additional one-sample t test was conducted to determine whether a statistically significant difference existed between the dominance prediction and a value of 4, the neutral score in the seven-point Likert scale. We only found a marginally significant difference,

with a value of 4, in intuition-ignited frame condition, $t(30) = 2.05$, $p = .05$, indicating that only those who think math was a game of intuition expected humans to win. We could not conclude that those in logic-ignited frame conditions expected AI to win, as there was no statistically significant difference between winning prediction and the value of 4, $t(28) = -1.27$, $p =$ ns.

Discussion

From Study 3, we found that respondents used a logic-intuition frame to make sense of job characteristics and requirements. As a default, humans win in intuition and AI win in logic. However, even in math, an area quintessentially identified with logic, participants are more likely to expect humans to win when they were simply told that math is, in fact, a game of intuition. Thus, we concluded that by simply reframing our descriptions of jobs, we could manipulate participants' subjective cognition and their predictions of competition between humans and AI. In short, we could easily make participants switch responses based on the logic-intuition frame. Following from evaluations of human versus AI performance in jobs, our next interest was whether we could similarly alter individuals' threat perceptions of AI by manipulating their logic-intuition frame.

Study 4

According to the findings from Studies 1 and 2, people are less likely to feel threatened if an AI wins against a human in a logic or computation contest, but do feel threatened by AI that dominate in creative

jobs. However, Study 3 demonstrated that this basic division could be shifted by manipulating the scenario and altering one's logic-intuition frame, thus influencing predictions of AI performance given particular job characteristics. In Study 4, as a supplementary extension, we again manipulated individuals' logic-intuition frame to measure the manipulation's effect on perceptions of the threat posed to humankind by developing AI. We expected that people would feel more of a threat to humanity if they were simply told that AI had won against humans in a highly intuitive way, even in logic-driven areas, such as math. Conversely, we expected that people would feel less threatened when told that AI had won using straight logic, even in creative areas, such as art. Thus we hoped to assert the importance of an intuition-logic frame, regardless of the area of work.

Method

Participants

We recruited total 124 U.S. participants (60 male, 64 female), ranging from 20 to 70 years of age (M_{age} = 37.73, SD_{age} = 13.02), via Mechanical Turk by Amazon. The participants were mostly identified as white Americans (91.7%). Participants responded to a 30-minute online survey for monetary compensation. Two of the 124 participants were excluded from the final analysis because their completion times were considered outliers.

Measures

We designed Study 4 as a 2 (task type: math vs. art) x 2 (frame type: logic-ignited vs. intuition-ignited) factorial design.

Task type. Unlike Study 3, which only focused on math scenario, we also added art scenarios with two frame conditions to see if the effect might be because of particular tasks used in scenarios for Study 4. The reason we chose the math scenario was that we believed math is the representative area where logic is the key to success. On the other hand, art represents an area in which human intuition is crucial.

Logic-intuition frame. Participants were given a slightly modified version of the scenario in Study 3, a fabricated *New York Times* article about a math conundrum contest. In that scenario, IBM's newly invented UniMath won the math contest against the human math prodigy, George Witten. As with Study 3, there were two frame conditions. In addition to the identical manipulation in Study 3, another sentence was added to the end of the scenario. In the logic-ignited frame condition, the participants read George Witten's remarks: "I am impressed by how quickly and accurately UniMath can calculate. The way it solved the problem epitomized the perfect reasoning. I have never seen such a logical way of solving math puzzles." In the intuition-ignited frame condition, that part was replaced with "I am impressed by how intuitively and wittily UniMath can think. The way it solved the problem epitomized perfect creativeness. I have never seen such an intuitive way of solving math puzzles." Everything else in the two scenarios was identical. We used the same format for art scenarios. Instead,

AI's name "UniMath" was replaced with "UniPaint" in art scenarios.

Threat perception. Following the scenarios, the participants responded to "Do you think developing AI would be a threat to humankind?" on a seven-point Likert scale (from 1 = *not at all* to 7 = *very much*, counterbalanced) (M = 3.66, SD = 1.83).

Results

A 2 (task type: math vs. art) x 2 (frame type: logic-ignited vs. intuition-ignited) between-subjects ANOVA was performed to check the main effects of task type and the logic-intuition frame on threat perception toward AI. The ANOVA did not yield a significant main effect of the task type, $F(1,117) = 0.40$, p = ns, $\eta^2 = .003$. However, as seen in Figure 5, we found a significant main effect of the logic-intuition frame, $F(1,117) = 9.93$, $p < .01$, with a small effect size, $\eta^2 = .08$. Regardless of task type, people given an intuition-ignited frame condition (M = 4.02 SD = 1.68) estimated that AI is more likely to be a threat to humanity than those given the logic-ignited condition (M = 3.05, SD = 1.68). Even when examining the art and math scenarios separately, we found significant differences in threat perception between frame type in both math, $F(1,59) = 4.97$, $p = .03$, $\eta^2 = .08$, and art scenarios, $F(1,57) = 4.81$, $p = .03$, $\eta^2 = .08$. In a math-scenario condition, participants who were ignited that AI defeated human intuition perceived more of a threat (M = 3.88, SD = 1.62) than those who were told that AI defeated human logic (M = 2.97, SD = 1.54). Also in an art-scenario condition, participants who were told that AI won an intuition game

perceived more of a threat (M = 4.16, SD = 1.68) than those who were ignited that AI had won a logic game (M = 3.14, SD = 1.83). We found no significant Task Type x Logic-intuition Frame interaction on threat perception, $F(1,117) = 0.03$, p = ns.

We performed a simple t test, with a value of 4, on threat perception in our four respective scenarios. A t test yielded significant differences in threat perception, with a value of 4 in a Math x Logic-ignited scenario, $t(29) = -3.67$, $p < .001$, $d = 1.36$, 95% CI = [- 1.61, - 0.46], and Art x Logic-ignited scenario, $t(28) = -2.54$, $p = .02$, $d = 0.96$, 95% CI = [- 1.56, - 0.16]. The results indicate that participants who were told AI defeated human logic in that particular field do not perceive AI as a threat. However, we could not conclusively affirm that people in intuition-ignited conditions perceive AI as a threat, as we did not find any significant differences in threat perception, with a value of 4, in both the Math x Intuition-ignited scenario and Art x Intuition-ignited scenario ($ts < 1$). However, the findings once again confirm our hypothesis that when people were ignited that AI had won a competition in which intuition is important, they perceived more of a threat to humankind, regardless of the work realm.

Discussion

In Study 4, we found further evidence that simply altering one's logic-intuition frame can affect one's perception of the threat to humankind from AI. This conclusion is especially meaningful in that the manipulation was found to be effective, even in the most logic-driven area – mathematics

– and even in the most intuition-driven area – art. The one limitation, or possible criticism, is that the threat perception found in the intuition-ignited condition – though the main effect of logic-intuition frame was significant – was only slightly higher than 4 (M_{AVG} = 4.02. M_{ART} = 4.16, M_{MATH} = 3.88), the neutral point. Plus, differences between mean values and 4 were not statistically significant either, $t < 1$. Some may say that it is difficult to conclude that people fear AI and contend that fear of AI is low in general. However, the logic-intuition frame had a significant effect on splitting threat perception, in both the math and art scenarios, in that the difference between the two frame conditions was so evident, and so starkly hypothetical.

Study 5

Now that we have found that the logic-intuition frame operates as a main mechanism in shaping individuals' threat perception towards AI, in Study 5, we wanted to study the real-life behavioral implications. We have shown the cause and nature of respondents' fear of AI, and we know that public perception of threat from AI is a huge obstacle for new technology to be integrated into society. For AI technology to be accepted by the public, and for technology developers to use information on threat perception as leverage to diffuse their innovations successfully, we should study how individuals choose to act based on their threat perceptions. Thus, in Study 5, we asked participants how willing they were to engage in various AI-related activities or invest in AI products or services.

Method

Participants

Total 121 participants responded to a 20-minute online survey for monetary compensation. We recruited 60 U.S. participants (32 male, 28 female), ranging in age from 20 to 70 years (M_{age} = 37.73, SD_{age} = 13.02), via Mechanical Turk by Amazon. For a cultural comparison, 61 South Korean undergraduate students (25 male, 35 female, 1 missing, M_{age} = 22.25, SD_{age} = 1.43) at Seoul National University were recruited via an online community. The basic demography included SES, major, or current career.

Measures

Threat perception. The participants answered two questions about AI that were used in Study 1. First, we asked about *Perception of Threat*, "To what extent do you think the development of AI will be a threat to humankind?" on a seven-point Likert scale, (from 1 = *definitely not a threat* to 7 = *definitely a threat*, counterbalanced) (M = 4.03, SD = 1.59, M_{US} = 3.95, SD_{US} = 1.66, M_{KOR} = 4.11, SD_{KOR} = 1.52). Then, they rated their responses to the second question about *Perception of Blessing*, "To what extent do you think the development of AI will be a blessing to humankind?" on a seven-point Likert scale (from 1 = *definitely not a blessing* to 7 = *definitely a blessing*, counterbalanced) (M = 4.74, SD = 1.29, M_{US} = 4.88, SD_{US} = 1.39, M_{KOR} = 4.61, SD_{KOR} = 1.19).

Behavioral intention. After being given six scripts about AI-related activities, the participants were asked if they were willing to pay for, utilize, or engage in such activities. The six scripts included 1) robot cleaner, 2)

government's aggressive budget plan on AI development, 3) AI interviewer, 4) AI cancer diagnosis, 5) AI-composed music, and 6) AI legal service.

Robot cleaner. The participants were given a short script that stated, "AI has definitely been a hot buzzword in electronics in 2017. As a result, there are currently many electronic products with artificial intelligence technology on the market. Among them, AI cleaning robots have drawn a huge amount of attention." The participants rated their responses to the question, "To what extent would you be willing to buy AI-powered electronic products?" on a 7-point Likert scale (from 1 = *I will not buy at all* to 7 = *I will definitely buy*, counterbalanced) (M = 4.92, SD = 1.76, M_{US} = 5.02, SD_{US} = 1.69, M_{KOR} = 4.82, SD_{KOR} = 1.84).

Aggressive budget plan. This script explained that the government just disclosed that the budget for developing AI-related technology would be almost as twice that of the 2017 budget. The participants rated their responses to the question, "To what extent do you agree with [the] government's aggressive budget plan for developing AI?" on a 7-point Likert scale (from 1 = *I do not agree at all* to 7 = *I definitely agree*, counterbalanced) (M = 4.48, SD = 1.74, M_{US} = 4.48, SD_{US} = 1.90, M_{KOR} = 4.47, SD_{KOR} = 1.59).

Interviewer. The participants were given a script mentioning that Google just started an AI interviewer project to make a better selection of the right people for the company, and many other companies were applying such a system. They responded to the question, "To what extent would you

be willing to ask for an AI interviewer when applying to a company?" on a 7-point Likert scale (from 1 = *I will not choose AI at all* to 7 = *I will definitely choose AI*, counterbalanced) (M = 3.29, SD = 1.87, M_{US} = 3.33, SD_{US} = 1.98, M_{KOR} = 3.25, SD_{KOR} = 1.71).

Cancer diagnosis. This script stated that ever since Boston National Hospital successfully adopted AI in diagnosing cancers, a few other hospitals also started AI-powered diagnostic systems. The participants rated their responses to the question, "To what extent would you be willing to use an AI system for cancer diagnosis?" on a 7-point Likert scale (from 1 = *I will not use [it] at all* to 7 = *I will definitely use [it]*, counterbalanced) (M = 4.97, SD = 1.75, M_{US} = 5.03, SD_{US} = 1.80, M_{KOR} = 4.90, SD_{KOR} = 1.70).

AI-composed music. According to this script, experts in the music industry said that Sony Music would be using AI composer Izael for some of its music. The participants rated their responses to the question, "To what extent would you be willing to listen to music composed by AI?" on a 7-point Likert scale (from 1 = *I will not listen at all* to 7 = *I will definitely listen*, counterbalanced) (M = 4.67, SD = 1.72, M_{US} = 4.60, SD_{US} = 1.72, M_{KOR} = 4.73, SD_{KOR} = 1.74).

Legal service. Following Latham & Watkins' adventurous decision to use an AI-based legal advising service, many other law firms displayed a positive stance toward adopting AI attorneys. The participants rated their responses to the question "To what extent would you be willing to get legal advice from AI?" on a 7-point Likert scale (from 1 = *I will not buy at all* to

7 = *I will definitely buy*, counterbalanced) (M = 3.60, SD = 1.76, M_{US} = 3.70, SD_{US} = 1.74, M_{KOR} = 3.50, SD_{KOR} = 1.78).

Overall intention. Each rating from the six activities was averaged to obtain a composite score that showed the individuals' overall intention of engaging in AI-related activities (M = 4.32, SD = 1.18, M_{US} = 4.36, SD_{US} = 1.20, M_{KOR} = 4.28, SD_{KOR} = 1.16; Cronbach's α = 0.75).

Covariates. In order to control individuals' familiarity with AI technology, we asked, "To what extent do you think you are familiar with current AI technology?" Participants rated on a 7-point Likert scale (from 1 = *I am not familiar at all* to 7 = *I am really familiar*, counterbalanced) (M = 3.84, SD = 1.39, M_{US} = 3.83, SD_{US} = 1.45, M_{KOR} = 3.85, SD_{KOR} = 1.34). Gender was also controlled in the main analysis.

Results

Threat Perception: Threat or Blessing?

We asked two respective questions to both the U.S. and South Korean participants regarding threat perception. We can consider culture as a between-subjects factor and perception type as a within-subjects factor. To examine the interaction between culture and perception type, we conducted a 2 (culture: U.S. vs. South Korea) x 2 (perception type: threat vs. blessing) mixed-model ANOVA.

Consistent with our findings from Study 1, the ANOVA did not yield a significant main effect of culture, $F(1, 116) = .16$. p = ns. Moreover, we did not find a significant main effect of perception type, $F(1, 116) = .24$,

p = ns. People held similar degrees of *Perception of Threat* and *Perception of Blessing* in both the U.S. and South Korea (see Table 4). For *Perception of Threat*, a one-sample t test was not significantly different from 4, the neutral point on a seven-point Likert scale, $t(121) = .23$, p = ns. However, for *Perception of Blessing*, we found a statistically significant difference from 4, $t(121) = 6.32$, $p < .001$, 95% CI = [0.51, 0.98]. Consistent with our finding from Study 1, we could only conclude that the general public perceives AI to be a blessing. The Culture x Perception Type interaction was not significant, $F(1,116) = .80$, p = ns.

Behavioral Intention on AI-related Activities: Yes or No?

We asked both the U.S. and South Korean participants a single behavioral intention question for each of the six AI-related activities. Thus, our design allowed us to consider culture as a between-subjects factor and AI-related activities as a within-subjects factor. We conducted a 2 (culture: U.S. vs. South Korea) x 6 (activity type) mixed-model ANOVA on behavioral intention.

Mauchly's test indicated that the assumption of sphericity was violated, $\chi^2(14) = 34.11$, $p = .002$. Thus, degrees of freedom were corrected using the Huynh-Feldt estimates of sphericity ($\varepsilon = 0.95$). As expected, the ANOVA did not yield a significant main effect of culture on behavioral intention, $F(1, 116) = .03$, p = ns, indicating that both cultures share similar degrees of behavioral intention on the six AI-related activities. However, there was a marginally significant main effect of activity type, $F(4.76,$

552.64), $p = .08$, demonstrating that people definitely want to utilize some AI-related activities and definitely do not want to use some. We conducted a one-sample *t* test on each activity to examine whether there were statistically significant differences between the mean value of each activity and 4, which was the neutral point on the seven-point Likert scale. As seen in Table 5, people were open to using the following four activities: cancer diagnosis, robot cleaner, AI-composed music, and aggressive budget plan, $ps < .01$. However, they were very reluctant to utilizing AI-powered interviewers and legal services, $ps < .01$. Lastly, the ANOVA did not yield a significant Culture x Activity Type interaction on behavioral intention, $F(4.76, 552.64) = .20$, p = ns.

Overall Correlations between Threat Perception and Behavioral Intention

To examine our hypothesis, i.e., the more people perceive AI to be a threat, the less likely they are to engage in AI-related activities, we performed a simple correlational analysis after controlling for individuals' familiarity with AI and gender. As the simple correlational analysis found a significant and negative correlation between *Perception of Threat* and *Perception of Blessing* ($r = -.55$, $p < .001$), it appeared sensible to obtain a composite score to measure individuals' threat perception. We labeled this composite value the *Perception of Threat-Blessing* (the average between *Perception of Threat* and reversed *Perception of Blessing*). If a respondent scores high on this value, it means that he or she perceives AI as more of a

threat than a blessing. A one-sample *t* test was significantly different from 4, $t(120) = -3.07$, $p = .003$, 95% CI = [-0.58, -0.12]. Ordinary people perceive AI to be more of a blessing than a threat ($M = 3.64$, $SD = 1.27$).

As we hypothesized, there was a significant and negative correlation between the *Perception of Threat-Blessing* and each of the AI-related activities, thereby yielding a significantly negative correlation with the overall intention of engaging in AI-related activities, with the composite score ($r = -.61$, $p < .001$). As seen in Table 6, individuals feeling threatened by AI are less likely to buy AI-powered electronics, agree with the government's aggressive budgetary plan for developing AI, ask for an AI interviewer when applying for a job, ask an AI doctor about a cancer diagnosis, listen to AI-composed music, and seek advice from an AI attorney. Identical patterns were found in the U.S. and South Korean samples, except for the intention of using an AI interviewer. In the U.S. population, there was no significant correlation between threat perception and the intention of using an AI interviewer ($r = - .15$, $p =$ ns). However, there was a marginally significant and negative correlation between them in South Korean participants ($r = -.25$, $p = .06$). In South Korea, the more people feel threatened by AI, the less likely they are to use an AI interviewer for their job interviews.

Discussion

In Study 5, we analyzed respondents' varying inclinations for or against AI-related activities, such as purchasing AI-powered cleaning robots,

listening to AI-generated music, letting AI conduct job interviews, utilizing AI-powered legal services, receiving AI cancer diagnoses, or responding to the government's budget plans for AI development. We found a significant and negative correlation between the threat perception of AI and the overall intention to engage with AI services. Consistent with our prediction, as people perceived greater threat from AI, they were less likely to engage in AI-related activities than those who perceived AI as a blessing. Study 5 is especially meaningful in the sense that we have briefly shown how individuals' perception of AI can have real-life behavioral implications. Thus, the mere perceptions of AI that ordinary people hold will play a crucial role in whether AI would be successfully diffused in society or not.

Study 6

In Study 6, we wanted to revisit Study 3 and 4, by applying a logic-intuition frame to six AI-related scenarios used in Study 5. We expected that if we tell participants that AI is being developed and applied in areas defined by logic and accurate, fast calculation (logic-ignited frame), they are more likely to engage in AI-related activities; conversely, they would be less likely to engage if told that AI is being developed in areas of creative and intuitive work (intuition-ignited frame). We expected Individuals' threat perception of AI had a mediating effect on effect of logic-intuition frame, and thus shaped their willingness to engage with AI in their daily lives.

Method

Participants

We recruited total 110 U.S. participants (42 males, 68 females), ranging from 20 to 70 years old (M_{age} = 38.27, SD_{age} = 13.52), via Mechanical Turk by Amazon. Participants responded to a 20-minute online survey for monetary compensation. The basic demography included: SES, major, or current career.

Procedures

The procedure was almost identical to Study 5, except for the logic-intuition frame manipulation in the very beginning of the survey.

Logic-intuition frame. Participants were randomly assigned to two frame conditions. In the logic-ignited frame condition, they were given a short script that says, "AI technology is now being applied in the areas where logical thinking and accurate and fast calculation are very important." In the intuition-ignited frame, participants read the description that AI technology is now being applied in the areas where creative thinking and intuition are very important.

Threat perception. Participants answered two seven-point Likert questions about AI that were used in Studies 1 and 5. We asked about *Perception of Threat*, "To what extent do you think the development of AI will be a threat to humankind?" on a seven-point Likert scale (from 1 = *definitely not a threat* to 7 = *definitely a threat,* counterbalanced) (M = 4.03, SD = 1.59). Then the participants rated their responses to the question about *Perception of Blessing*: "To what extent do you think the development of AI will be a blessing to humankind?" on a seven-point Likert scale (from 1 =

definitely not a blessing to 7 = *definitely a blessing*, counterbalanced) (*M* = 4.74, *SD* = 1.29).

Behavioral intention. Participants were given exactly the same six scripts from Study 5. For overall intention, the ratings from each script were averaged to yield composite scores for overall intention of engaging in AI-related activities, *M* = 4.22, *SD* = 1.14, Cronbach's α = .70.

Covariates. We asked, "To what extent do you think you are familiar with current AI technology?" on a seven-point Likert scale (from 1 = *I am not familiar at all* to 7 = *I am really familiar,* counterbalanced) (*M* = 3.84, *SD* = 1.39). Familiarity and gender were controlled in the final analysis

Results

Threat Perception: Threat or Blessing?

We asked two respective questions to both logic-ignited condition participants and intuition-ignited condition participants. We can consider the logic-intuition frame as a between-subjects factor and perception type as a within-subjects factor. To examine the interaction between logic-intuition frame and perception type on threat perception, we conducted a 2 (frame: logic-ignited vs. intuition-ignited) x 2 (perception type: threat vs. blessing) mixed-model ANOVA.

The ANOVA did not yield the main effect of logic-intuition frame on threat perception, $F(1, 106) = .15$, p = ns. We did find a significant main effect of perception type on threat perception, $F(1, 106) = 4.85$, $p = .03$,

indicating that the degree of perceiving AI to be a blessing (M = 4.74, SD = 1.54) is higher than the degree of perceiving AI to be a threat (M = 3.56, SD = 1.61), regardless of frame effect. Also, a significant Logic-intuition Frame x Perception Type was revealed, $F(1, 106) = 4.30$, $p < .05$, with a small effect size, $\eta^2 = .04$. A simple comparison result showed a statistically significant difference of *Perception of Threat* between logic-ignited condition and intuition-ignited condition, $t(54) = -8.70$, $p < .001$, $d = 0.39$, 95% CI = [-0.76, -0.48]. Consistent with our previous findings, intuition-ignited condition participants perceived more of a threat (M = 3.87, SD = 1.62) than logic-ignited condition participants (M = 3.25, SD = 1.54). We also found a marginally significant difference of *Perception of Blessing* between logic-ignited participants and intuition-ignited participants, $t(54) = 1.98$, $p = .05$, $d = 0.34$, 95% CI = [-0.00, 1.06]. Also consistent with our prediction, intuition-ignited condition participants perceived less of a blessing (M = 4.47, SD = 1.71) than logic-ignited condition participants (M = 5.00, SD = 1.32).

Behavioral Intention on AI-related Activities: Yes or No?

We asked participants a single behavioral intention question for each of the 6 AI-related activities in both logic-ignited condition and intuition-ignited condition participant groups. Thus, our design allows us to consider the logic-intuition frame as a between-subjects factor and AI-related activities as a within-subjects factor. We conducted a 2 (frame: logic-ignited vs. intuition-ignited) x 6 (activity type) mixed-model ANOVA on

behavioral intention.

Mauchly's test indicated that the assumption of sphericity was violated, $\chi^2(14) = 25.12$, $p = .03$. Thus, degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = 0.99$). The ANOVA yielded a significant main effect of logic-intuition frame on behavioral intention, $F(1, 106) = 5.94$, $p = .02$, $\eta^2 = .05$, indicating that intuition-ignited condition participants were more reluctant to engage in AI-related activities ($M = 3.96$, $SD = 1.29$) than logic-ignited condition participants ($M = 4.49$, $SD = .91$). Simple comparison results show that this main logic-intuition frame effect was only evident for robot cleaner, cancer diagnosis, and AI-composed music ($ps < .01$). There were no statistically significant differences in aggressive budget plan, interviewer, and legal services (ps = ns; see Table 7). We found a significant main effect of activity type, $F(4.96, 525{,}75) = 2.75$, $p = .02$, $\eta^2 = .03$, demonstrating that there are some AI-related activities to which people are particularly open and others to which people are particularly reluctant. A one-sample t test with a value of 4 revealed that participants are open to engaging in cancer diagnosis, robot cleaner, and aggressive budget plan, $ps < .001$. However, people are reluctant to engage in AI-powered interviewer and legal service, ps = ns. Moreover, the ANOVA did not yield a significant Logic-intuition Frame x Activity Type interaction, $F(4.96, 525{,}75) = .61$, p = ns.

Threat Perception as a Mediator on Behavioral Intention

We have demonstrated that there is a significant main effect of logic-

intuition frame on intention toward engaging in AI-related activities and threat perception toward AI. In Studies 3 and 4, we showed that the logic-intuition frame is a key mechanism behind one's threat perception of AI. In Study 5, we demonstrated that high threat perception toward AI in an individual leads to passive intentions toward AI-related activities, which in turn leads to further inquiries about the relationships between an individual's logic-intuition frame, threat perception, and behavioral intentions.

We speculated that the mental process of perceiving a threat, measured on the threat and blessing axes, mediates the effect of the logic-intuition frame on the intention to engage in AI-related activities. *Perception of Threat-blessing* composite score (M = 3.40, SD = 1.35) was calculated and included in the main analysis as a result of averaging *Perception of Threat* and reversed *Perception of Blessing*. For overall behavioral intention, the ratings from each activity were averaged to yield composite scores for overall intention of engaging in AI-related activities (M = 4.22, SD = 1.14).

To check our hypothesis, we used a regression plug-in by Hayes (2012) in SPSS. The results from the regression analysis indicate that the logic-intuition frame effect was a significant predictor of one's *Perception of Threat-blessing*, b = .52, $t(108) = 2.04$, $p < .05$. Also, *Perception of Threat-blessing* was a significant predictor of one's behavioral intention to engage in AI-related activities, b = -.45, $t(107) = -6.65$, $p < .001$. The type of logic-intuition frame was no longer a significant predictor of behavioral intention

to engage in AI-related activities after controlling for our mediator of interest, *Perception of Threat-blessing*, b = -.30, $t(107)$ = -1.61, p = ns, consistent with full mediation. Approximately 33% of the variance in the intention to engage was accounted for by the predictors (R^2 = .33). The indirect effect of our regression model was significant, b = -.53, $t(108)$ = -2.49, $p < .05$ (see Figure 6). Thus, we can now say that when individuals perceive that AI is involved in intuitive tasks, they feel much more of a threat, which leads to less intention to engage in AI-related activities. In addition, when individuals perceive that AI is involved in logical tasks, they feel that AI is less of a threat, which leads to a more uninhibited attitude to engage in AI-related activities.

Discussion

In Study 6, we replicated our main findings from Study 4 in that participants who were told that AI dominates human intuition were more likely to perceive AI to be a threat than those who were told that AI outperforms logic. In addition, we demonstrated that the logic-intuition frame can also shift individuals' behavioral intentions toward AI-related activities, making relatively passive attitudes toward AI into more active attitudes and vice versa.

General Discussion and Future Studies

Our six studies provided consistent evidence that the logic-intuitive frame acts as a key cognitive mechanism in formulating individuals' perception of threat from artificial intelligence. In Study 1, we found a wide

disparity in whether respondents perceived AI as a threat or a blessing, an uncertainty well reflected in wider society, even among AI experts. However, we found strong correlations among characteristics of jobs (measured on a logic-intuition balance), respondents' predictions of human versus AI performance in those jobs, and threat perception in Study 2. If AI outperforms humans in work where intuition is key, where humans are thus expected to win, individuals perceive AI as a potential threat to humanity. Conversely, AI are considered less of a threat if they outperform humans in contests of logic or calculation, in which their success is more expected.

To supplement these correlational studies, and discern the causal relationship between the logic-intuition frame and threat perception, we experimented with frame manipulation in Studies 3 and 4. The results demonstrated that even in the most intuitive area, art, and the most logical area, math, the threat perception of individuals depended on how we framed each job in our questions, shifting our emphasis within the logic-intuition spectrum. In Study 5, we found that perception of AI as a threat can have several behavioral implications, such as opposition to the government's intensive investment in AI development. Nevertheless, respondents' low inclinations to engage with AI-related services could be swayed positively, if we simply reframed the work done by the AI as exclusively logical (Study 6). Throughout our studies, there were very few significant differences between two cultures: U.S. and South Korea. As Raub (1981) suggested, we

found a distinct gender effect for some variables; however, because our main interest was not gender, it was controlled in main statistical analysis.

Our findings offer several implications for both academia and public life. Our studies are among the first to demonstrate the specific reasons why people may feel threatened by technological innovations, especially artificial intelligence. Because they have seen technophobia as a status to overcome, much prior research on technophobia has focused on demographical and contextual factors, on which segments of society would be most apprehensive of technology (Rosen, Sears, and Weil, 1993). Even in the studies whose findings included AI (Nomura et al., 2006), surprisingly few delved into the exact nature of the perceived AI threat.

Secondly, we identify a need for researchers to differentiate artificial intelligence from other computers, keeping in mind that the logic-intuition frame is a key component in shaping people's perception of an AI threat. In fact, the majority of technophobia literature still focuses on general computer technology and refers to AI and computers interchangeably. Even in studies in Human-Robot Interaction (HRI), the presumed goal is often to give robots the most anthropomorphic appearances or motions. Our findings, however, suggest that public apprehension stems not primarily from robots lacking human appearances, but from fears of AI infringing upon human uniqueness.

Finally, we presented reasonable empirical and experimental evidence that humans consider intuition to be one of our unique human

traits (Haslam, 2006), a concept that resonates in the fields of philosophy and sociology. This also further raises our intellectual curiosity about what intuition really means and how ordinary people define intuition (Pacini & Epstein, 1999). Some may think intuition is a mysterious instinct, like a hunch, but others may contend that intuition is also the result of astute calculation based on experience or information. Overall, our findings have expanded our understanding of the reasons behind the perceived threat of new technology, the potential of AI as a subject for further academic attention, and the capabilities that are seen as distinguishing AI from humans.

We strongly believe that both potential AI providers and consumers can benefit from applying our findings in real life. As seen in nuclear power facilities and genetic-recombination technology, public acceptance of new technology is crucial to its effective proliferation and implementation, regardless of its stability or potential contribution to humanity. Following our findings that the logic-intuition frame operates as a fundamental mechanism in individuals' fear of AI, technology providers can pursue unobtrusive marketing strategies that do not threaten the essence of human beings. These may include changing wording or nuances in AI-related ads and downplaying AI's ability to accomplish creative or intuitive tasks. Considering the consistent results from Studies 5 and 6, indicating that people were least likely to utilize AI interviewer or legal services – the services that are actually happening in real life – these tactics would be

especially helpful in particular areas. At least at this moment, to avoid threatening potential customers, marketing AI-related products as mere machines that operate on logic would be a smart way to lower customer roadblocks.

Consumers, on the other hand, may take our findings as an indicator of judging whether they unnecessarily over-reacted to harmless AI-related products. Humans have thoroughly developed the area of artificial narrow intelligence (ANI). The smartphones in our palm, Amazon's auto recommendation program, and Google's search and translation engines are everyday examples of ANI. However, we are not yet anywhere close to artificial general intelligence (AGI) – a computer that is as smart as a human – or artificial superintelligence (ASI), an intellect that would be much smarter than the best human brains in practically every field, including scientific creativity, general wisdom and social skills (Goertzel, Pennachin, Geisweiller, 2014). In fact, AlphaGO was an example of weak AI and that was enough to threaten people because it superficially attacked the area of intuition. Possessing an unnecessary paranoia about a technology that is far from completion yet would definitely not help AI develop.

However, the current study entails some observable limitations. First, all of the studies relied heavily upon the online questionnaire. Considering that perceptions of AI will be affected by exposure to other types of information technology, it may have skewed the results that we collected data from those who are already familiar enough with computers to respond

to our surveys. To allow an even greater freedom to manipulate the study scenarios, research in person or in lab settings would be desirable. Expanding the framing scenarios we used, we could attempt to find subtler, novel cues to trigger respondents' logic-intuition frames, such as making them listen to ambient versus classical music, or presenting them with abstract versus realist paintings created by AI. Second, our sample sizes in each study were too small. Since replicability (Swiątkowski, 2017) is a necessity in Social Science, further studies with a greater number of participants are advised. Even though we found no cultural differences in our studies – unlike previous studies in technophobia literature (Marcoulides and Wang, 1990) – we cannot confidently conclude that there will be no cultural differences due to our limited pool of participants.

Another potential objection we foresee is that our study questions sometimes oversimplified psychological concepts. For instance, in Study 2, participants rated each job on a seven-point Likert scale (1 = *intuition/creativity/experience/inspiration will absolutely matter more*, while 7 = *logic/information/calculation/ accuracy will absolutely matter more*, counterbalanced). Considering that intuition, creativity, experience, and inspiration are all conceptually independent, putting them on the same extreme end would affect the mental process of participants. Moreover, a process that is not logical is not necessarily intuitive. We revised the wording and composition of the questions as we conducted the follow-up studies, and are open to developing them further in order to reflect a real

mental process of an individual participant. However, even with such simple questions, we consistently found congruent results in our studies.

Also, we failed to completely differentiate threat sources, as we used *threat* as an umbrella term. In addition to exposing humans' perceived existential threat from AI potentially infringing on human intuition, actual threats might come from job insecurity – i.e., technological unemployment – or the idea that people perceive a threat when they fail to satisfy the need to reduce uncertainty (Esses, Medianu, and Lawson, 2013). However, we only have shown that people's threat perceptions of AI can be affected by the belief that AI is infringing upon human intuition, and we failed to exclude other possibilities. This surely calls for an extra study that differentiates and excludes out various, possible threat sources.

Finally, throughout our present studies, we used inconsistent questions on threat and blessing perceptions. For Studies 1, 5, and 6, we used two unipolar questions that separated *Perception of Threat* and *Perception of Blessing*. Participants had to answer on a seven-point Likert scale for each of the threat-perception and blessing-perception questions. However, for Studies 2, 3, and 4, we asked one bipolar question that posits threat and blessing at the extreme axes. We believe asking two unipolar questions about blessing and threat more accurately represents the actual mental processes involved in human perceptions of AI. Modest correlations between *Perception of Threat* and *Perception of Blessing* were found in studies that used two unipolar questions to demonstrate the need to use two

separate questions to measure such perceptions. When using one bipolar question, the concepts of threat and blessing might have been intertwined in participants' minds, thereby making regression to mean more likely. For instance, participants can simply choose 4 because they think AI can be both a threat and a blessing at the same time. However, we should note that even when using one bipolar question, we yielded consistent results just like when we used two unipolar questions.

The limitations of our study thus suggest several interesting directions of future studies, expanding the research we have started into the contents of the perceived threat of AI. As we hypothesized that the term artificial intelligence should be differentiated from robots, does artificial intelligence triggers people to anthropomorphize machines? What are some everyday tasks that ordinary people would feel comfortable replacing with AI? What are some jobs that people expect to soon be filled by AI? Would happy people want AI in their lives? Surveying society with these questions will be a good indicator of public acceptance of AI and the possible areas in which AI technology might be useful. Considering public reactions to recent accidents involving self-driving cars, responsibility for unexpected accidents caused by AI would also be an interesting area to expand our studies to. Who is culpable for mishaps in the self-learning ability of an AI – the AI or its developers?

However, the first, most important task to obtain watertight understanding of AI is to encourage researchers to conduct vast studies

across different genders, social classes, generations, and cultures – all segments of society. Researchers must simply be cautious that as AI technology advances with accelerating momentum, the realization of the need to understand the technology may come too late.

Conclusion

"By far, the greatest danger of Artificial Intelligence is that people conclude too early that they understand it." – Eliezer Yudkowsky, AI theorist

As Kurzweil (2005) said, technology accelerates with unfathomable speeds. Beyond simple computing technology, humans are trying to build artificial intelligence that mimics humanity in many aspects. However, there are ambivalences towards the uncharted area of AI: excitement and threat. In order for AI technology to be usefully implemented in ordinary life, we must examine how people perceive AI and where the individual differences in threat perception originate from. As previous studies have failed to dive deeply into the sources of that threat, we proposed a few studies and found promising results. We hope our findings can trigger many other researchers in social science to study matters related to artificial intelligence, one of the newest and most quickly-developing technologies.

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Appendix A

The Logic-ignited Frame Scenario

The New York Times

Gilium's Problems Contest:

AI puts Human Logic on the Test

By **J. BENNER** MARCH 10, 2016

TORONTO, Canada – Gilium's problems solving contest will be held on March 20th in Toronto, Canada.

Gilium's problems are a list of twenty-three problems in mathematics recently published by German mathematician David Gilium. It drew worldwide attention as the problems are regarded as invincible to solve and beyond human calculation.

In recent years, some initially unsolvable math puzzles were cracked through these contests. Yang's problems solving contest winner was awarded about US $1M prize.

Former contest-winning mathematicians all agree: "Logical thinking, accurate and prompt calculation based on an objective database of a series of solved math problems is the key to a win."

IBM newly developed an artificial intelligence (AI) UniMath, which will compete with the promising math genius George Witten, the holder of 10 international math competition titles. The NY Times is polling readers with the following questions to figure out what outcome people expect before the contest begins:

Appendix B

The Intuition-ignited Frame Scenario

The New York Times

Gilium's Problems Contest:

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By J. BENNER MARCH 10, 2016

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In recent years, some initially unsolvable math puzzles were cracked through these contests. Yang's problems solving contest winner was awarded about US $1M prize.

Former contest-winning mathematicians all agree: "Intuitive thinking with a sense of creativity, based on subjective experiences, is the key to a win."

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Table 1.

Partial Correlations Between Threat Perceptions and Beliefs in What AI Can Replace

Total (N = 98)

Variables	1	2	3	4
1. Perception of Threat	-			
2. Perception of Blessing*	**-.30****	-		
4. Beliefs in AI Replacing Intuitive Jobs*	.13	.04	-	
5. Beliefs in AI Replacing Logical Jobs*	.11	**.28****	**.19***	-

United States (N = 46)

Variables	1	2	3	4
1. Perception of Threat	-			
2. Perception of Blessing*	**-.29***	-		
4. Beliefs in AI Replacing Intuitive Jobs*	.17	.20	-	
5. Beliefs in AI Replacing Logical Jobs*	.14	**.34***	.16	-

South Korea (N = 44)

Variables	1	2	3	4
1. Perception of Threat	-			
2. Perception of Blessing*	**-.30****	-		
4. Beliefs in AI Replacing Intuitive Jobs*	.08	-.12	-	
5. Beliefs in AI Replacing Logical Jobs*	.08	.21	.22	-

Note. Familiarity with AI and gender are controlled. *p<.1, **p<.01

Table 2.

Means and Standard Deviations of Three Main Variables on 17 Jobs

	Three Variables on Each Job					
	Logic-intuition Balance		Dominance Prediction		Threat Perception	
Jobs	*M*	*SD*	*M*	*SD*	*M*	*SD*
Music Composer	1.90	1.37	5.75	1.62	3.33	1.88
Novelist	2.01	1.41	5.90	1.60	3.10	1.91
Painter	2.03	1.42	5.57	1.86	3.46	2.01
Photographer	2.23	1.43	5.41	1.73	3.57	1.95
DJ	2.42	1.61	4.65	1.83	4.51	1.73
Architect	3.73	1.77	4.56	1.82	4.30	1.75
Sports team Head coach	3.85	1.51	5.37	1.62	3.55	1.79
Sports team Captain	4.06	1.60	5.25	1.65	3.55	1.66
HR Headhunter	4.54	1.40	4.68	1.58	3.94	1.73
Criminal Profiler	4.95	1.78	4.57	2.04	3.76	2.13
Court Judge	5.07	1.96	5.32	1.93	3.12	2.00
Strategic Consultant	5.62	1.47	3.69	1.94	4.61	1.86
Mortgage Lender	5.66	1.52	3.78	1.92	4.42	1.89
Flight Pilot	5.67	1.38	3.99	2.11	4.30	2.07
Scientist	5.84	1.44	4.38	2.77	4.11	1.81
Physician (Cancer Diagnosis)	5.93	1.41	3.93	2.14	4.36	2.03
Stock Analyst	6.11	1.18	2.83	1.93	4.88	1.97
Total	4.21	.53	4.68	1.03	3.93	1.12

Note. Logic-intuition Balance: 1 = *intuition/creativity/experience/inspiration matters,* 7 = *logic/information/calculation/accuracy matters.* Dominance Prediction: 1 = *AI would perform absolutely better,*7 = *Human would perform absolutely better.* Threat Perception: 1 = *AI would absolutely be a threat,* 7 = *AI would absolutely be a blessing*

Table 3a.

Correlations Between Three Main Variables for 17 Jobs (Study 2)

Architect (N = 112)				United States (N = 52)				South Korea (N = 57)			
Variables	1	2	3	Variables	1	2	3	Variables	1	2	3
1. Logic-intuition balance	-			1. Logic-intuition balance	-			1. Logic-intuition balance	-		
2. Dominance prediction	.08	-		2. Dominance prediction	.02	-		2. Dominance prediction	.13	-	
3. Threat perception	.01	-.31**	-	3. Threat perception	.16	-.35**	-	3. Threat perception	-.11	-.27**	-
Court Judge (N = 112)				United States (N = 52)				South Korea (N = 57)			
Variables	1	2	3	Variables	1	2	3	Variables	1	2	3
1. Logic-intuition balance	-			1. Logic-intuition balance	-			1. Logic-intuition balance	-		
2. Dominance prediction	-.10	-		2. Dominance prediction	.11	-		2. Dominance prediction	-.09	-	
3. Threat perception	-.01	-.47**	-	3. Threat perception	-.06	-.52**	-	3. Threat perception	.04	-.42**	-
Criminal Profiler (N = 112)				United States (N = 52)				South Korea (N = 57)			
Variables	1	2	3	Variables	1	2	3	Variables	1	2	3
1. Logic-intuition balance	-			1. Logic-intuition balance	-			1. Logic-intuition balance	-		
2. Dominance prediction	-.03	-		2. Dominance prediction	.09	-		2. Dominance prediction	-.17	-	
3. Threat perception	-.13	-.42**	-	3. Threat perception	-.24*	-.47**	-	3. Threat perception	-.01	-.38**	-
Flight Pilot (N = 112)				United States (N = 52)				South Korea (N = 57)			
Variables	1	2	3	Variables	1	2	3	Variables	1	2	3
1. Logic-intuition balance	-			1. Logic-intuition balance	-			1. Logic-intuition balance	-		
2. Dominance prediction	-.04	-		2. Dominance prediction	-.04	-		2. Dominance prediction	-.06	-	
3. Threat perception	.15	-.50**	-	3. Threat perception	.18	-.57**	-	3. Threat perception	.12	-.46**	-
Mortgage Lender (N = 112)				United States (N = 52)				South Korea (N = 57)			
Variables	1	2	3	Variables	1	2	3	Variables	1	2	3
1. Logic-intuition balance	-			1. Logic-intuition balance	-			1. Logic-intuition balance	-		
2. Dominance prediction	-.16*	-		2. Dominance prediction	-.25*	-		2. Dominance prediction	-.08	-	
3. Threat perception	.09	-.29**	-	3. Threat perception	.12	-.40**	-	3. Threat perception	.07	-.20	-

Note. Familiarity with AI and gender are controlled. *p<.1, **p<.01

Table 3b.

Correlations Between Three Main Variables for 17 Jobs (Study 2)

Music Composer (N = 112)				United States (N = 52)				South Korea (N = 57)			
Variables	1	2	3	Variables	1	2	3	Variables	1	2	3
1. Logic-intuition balance	-			1. Logic-intuition balance	-			1. Logic-intuition balance	-		
2. Dominance prediction	-.36**	-		2. Dominance prediction	-.42**	-		2. Dominance prediction	-.31*	-	
3. Threat perception	.03	-.22*	-	3. Threat perception	.13	-.20	-	3. Threat perception	-.06	-.24*	-
Sports Team Headcoach (N = 112)				United States (N = 52)				South Korea (N = 57)			
Variables	1	2	3	Variables	1	2	3	Variables	1	2	3
1. Logic-intuition balance	-			1. Logic-intuition balance	-			1. Logic-intuition balance	-		
2. Dominance prediction	-.09*	-		2. Dominance prediction	-.16*	-		2. Dominance prediction	-.16*	-	
3. Threat perception	.12	-.29**	-	3. Threat perception	.09	-.29**	-	3. Threat perception	.09	-.29**	-
Novelist (N = 112)				United States (N = 52)				South Korea (N = 57)			
Variables	1	2	3	Variables	1	2	3	Variables	1	2	3
1. Logic-intuition balance	-			1. Logic-intuition balance	-			1. Logic-intuition balance	-		
2. Dominance prediction	-.26*	-		2. Dominance prediction	-.26*	-		2. Dominance prediction	-.27*	-	
3. Threat perception	.09	-.15	-	3. Threat perception	.090	-.09	-	3. Threat perception	.09	-.19	-
Painter (N = 112)				United States (N = 52)				South Korea (N = 57)			
Variables	1	2	3	Variables	1	2	3	Variables	1	2	3
1. Logic-intuition balance	-			1. Logic-intuition balance	-			1. Logic-intuition balance	-		
2. Dominance prediction	-.31**	-		2. Dominance prediction	-.30*	-		2. Dominance prediction	-.34**	-	
3. Threat perception	.14	-.37**	-	3. Threat perception	.21	-.36**	-	3. Threat perception	.07	-.40**	-
Photographer (N = 112)				United States (N = 52)				South Korea (N = 57)			
Variables	1	2	3	Variables	1	2	3	Variables	1	2	3
1. Logic-intuition balance	-			1. Logic-intuition balance	-			1. Logic-intuition balance	-		
2. Dominance prediction	-.16*	-		2. Dominance prediction	-.24*	-		2. Dominance prediction	-.07*	-	
3. Threat perception	.10	-.32**	-	3. Threat perception	.25*	-.23	-	3. Threat perception	-.08	-.39**	-

Note. Familiarity with AI and gender are controlled. *p<.1, **p<.01

Table 3c.

Correlations Between Three Main Variables for 17 Jobs (Study 2)

Physician (N = 112)				United States (N = 52)				South Korea (N = 57)			
Variables	1	2	3	Variables	1	2	3	Variables	1	2	3
1. Logic-intuition balance	-			1. Logic-intuition balance	-			1. Logic-intuition balance	-		
2. Dominance prediction	-.10	-		2. Dominance prediction	-.12	-		2. Dominance prediction	-.08	-	
3. Threat perception	.16	-.48**	-	3. Threat perception	.09	-.45**	-	3. Threat perception	.30*	-.52**	-
Scientist (N = 112)				United States (N = 52)				South Korea (N = 57)			
Variables	1	2	3	Variables	1	2	3	Variables	1	2	3
1. Logic-intuition balance	-			1. Logic-intuition balance	-			1. Logic-intuition balance	-		
2. Dominance prediction	-.16*	-		2. Dominance prediction	-.12	-		2. Dominance prediction	-.25*	-	
3. Threat perception	.17	-.53**	-	3. Threat perception	.12	-.48**	-	3. Threat perception	.29*	-.57**	-
Stock Analyst (N = 112)				United States (N = 52)				South Korea (N = 57)			
Variables	1	2	3	Variables	1	2	3	Variables	1	2	3
1. Logic-intuition balance	-			1. Logic-intuition balance	-			1. Logic-intuition balance	-		
2. Dominance prediction	-.14	-		2. Dominance prediction	-.26*	-		2. Dominance prediction	-.08	-	
3. Threat perception	.11	-.38**	-	3. Threat perception	.12	-.45**	-	3. Threat perception	.14	-.32*	-
Strategic Consultant (N = 112)				United States (N = 52)				South Korea (N = 57)			
Variables	1	2	3	Variables	1	2	3	Variables	1	2	3
1. Logic-intuition balance	-			1. Logic-intuition balance	-			1. Logic-intuition balance	-		
2. Dominance prediction	-.26*	-		2. Dominance prediction	-.23*	-		2. Dominance prediction	-.29*	-	
3. Threat perception	.19*	-.34**	-	3. Threat perception	.22	-.23	-	3. Threat perception	.17	-.43**	-
DJ (N = 112)				United States (N = 52)				South Korea (N = 57)			
Variables	1	2	3	Variables	1	2	3	Variables	1	2	3
1. Logic-intuition balance	-			1. Logic-intuition balance	-			1. Logic-intuition balance	-		
2. Dominance prediction	-.21*	-		2. Dominance prediction	-.21*	-		2. Dominance prediction	-.26*	-	
3. Threat perception	-.03	-.39**	-	3. Threat perception	-.09	-.40**	-	3. Threat perception	.03	-.38**	-

Note. Familiarity with AI and gender are controlled. *p<.1, **p<.01

Table 3d.

Correlations Between Three Main Variables for 17 Jobs (Study 2)

HR Headhunter (N = 112)				United States (N = 52)				South Korea (N = 56)			
Variables	1	2	3	Variables	1	2	3	Variables	1	2	3
1. Logic-intuition balance	-			1. Logic-intuition balance	-			1. Logic-intuition balance	-		
2. Dominance prediction	-.10*	-		2. Dominance prediction	-.20	-		2. Dominance prediction	-.01	-	
3. Threat perception	.08	-.35**	-	3. Threat perception	.15	-.38**	-	3. Threat perception	.01	-.34*	-

Sports Team Captain (N = 112)				United States (N = 52)				South Korea (N = 56)			
Variables	1	2	3	Variables	1	2	3	Variables	1	2	3
1. Logic-intuition balance	-			1. Logic-intuition balance	-			1. Logic-intuition balance	-		
2. Dominance prediction	-.26*	-		2. Dominance prediction	-.29*	-		2. Dominance prediction	-.23*	-	
3. Threat perception	.15	-.45**	-	3. Threat perception	.12	-.43**	-	3. Threat perception	.17	-.46**	-

Note. Familiarity with AI and gender are controlled. *p<.1, **p<.01

Table 4.

Means and Standard Deviations of Threat Perception by Cultures (Study 5)

	U.S. (N = 60)		South Korea (N = 61)		Total (N = 121)	
Threat Perception	*M*	*SD*	*M*	*SD*	*M*	*SD*
1. Perception of Threat	3.95	1.66	4.11	1.52	4.03	1.59
2. Perception of Blessing	4.88	1.39	4.61	1.19	4.73	1.30
3. Perception of Threat-blessing*	3.53	1.41	3.75	1.12	3.64	1.27

Note. *3 is a composite score of 1 and reverse-coded 2. There were no significant differences by cultures.

Table 5.

Means and Standard Deviations of Behavioral Intentions by Cultures (Study 5)

	Total (N = 121)		United States (N = 60)		South Korea (N = 61)	
Behavioral Intentions	*M*	*SD*	*M*	*SD*	*M*	*SD*
1. Robot cleaner	4.93	1.76	5.02	1.69	4.82	1.84
2. Aggressive budget plan	4.48	1.74	4.48	1.90	4.47	1.59
3. Interviewer	3.29	1.87	3.33	1.98	3.25	1.71
4. Cancer diagnosis	4.97	1.75	5.03	1.80	4.90	1.70
5. AI-composed music	4.67	1.72	4.60	1.72	4.73	1.74
6. Legal service	3.60	1.76	3.70	1.74	3.50	1.78
7. Overall intention	4.32	1.18	4.36	1.20	4.28	1.16

Note. There were no significant differences by cultures.

Table 6.

Correlations Between Threat Perception and Behavioral Intentions (Study 5)

Total (N = 116)

Variables	1	2	3	4	5	6	7	8
1. Perception of Threat-Blessing	-							
2. Robot cleaner	**-.47****	-						
3. Aggressive budget plan	**-.55****	.39**	-					
4. Interviewer	**-.21***	.19*	.30**	-				
5. Cancer diagnosis	**-.43***	.37**	.40**	.18*	-			
6. AI-composed music	**-.41****	.45**	.49**	.13	.31**	-		
7. Legal service	**-.39****	.29**	.47**	.36**	.41**	.22*	-	
8. Intention (Composite)	**-.61****	.68**	.76**	.56**	.67**	.65**	.69**	-

United States (N = 56)

Variables	1	2	3	4	5	6	7	8
1. Perception of Threat-Blessing	-							
2. Robot cleaner	**-.40****	-						
3. Aggressive budget plan	**-.52****	.24*	-					
4. Interviewer	-.15	.14	.32**	-				
5. Cancer diagnosis	**-.42***	.27*	.37**	.19	-			
6. AI-composed music	**-.28***	.32*	.34**	.09	.30*	-		
7. Legal service	**-.46****	.16	.59**	.40**	.47**	.16	-	
8. Intention (Composite)	**-.57****	.55**	.74**	.59**	.67**	.56**	.72**	-

South Korea (N = 56)

Variables	1	2	3	4	5	6	7	8
1. Perception of Threat-Blessing	-							
2. Robot cleaner	**-.54****	-						
3. Aggressive budget plan	**-.57****	.54**	-					
4. Interviewer	**-.25**	.23*	.26*	-				
5. Cancer diagnosis	**-.43***	.44**	.41*	.17	-			
6. AI-composed music	**-.54****	.56**	.62**	.15	.30*	-		
7. Legal service	**-.30***	.37*	.34*	.32*	.32*	.26*	-	
8. Intention (Composite)	**-.64****	.78**	.77**	.52**	.65**	.71**	.64**	-

Note. Familiarity with AI and gender are controlled. *p<.05, **p<.01

Table 7.

Means and Standard Deviations of Behavioral Intentions by Logic-intuition Frame (Study 6)

	Logic Ignited (N = 55)		Intuition Ignited (N = 55)		Total (N = 110)	
Behavioral Intentions	*M*	*SD*	*M*	*SD*	*M*	*SD*
1. Robot cleaner**	5.09	1.72	4.25	2.08	4.67	1.95
2. Aggressive budget plan	4.73	1.53	4.16	2.01	4.45	1.80
3. Interviewer	3.47	1.89	2.96	1.92	3.22	1.92
4. Cancer diagnosis*	5.40	1.20	4.84	1.78	5.12	1.54
5. AI-composed music*	4.49	1.68	3.95	2.00	4.22	1.85
6. Legal service	3.75	1.60	3.58	1.99	3.66	1.80
7. Overall intention**	4.49	.91	3.96	1.29	4.22	1.14

Note. *Significant difference between logic-ignited and intuition-ignited conditions.

*p<.1, **p<.05

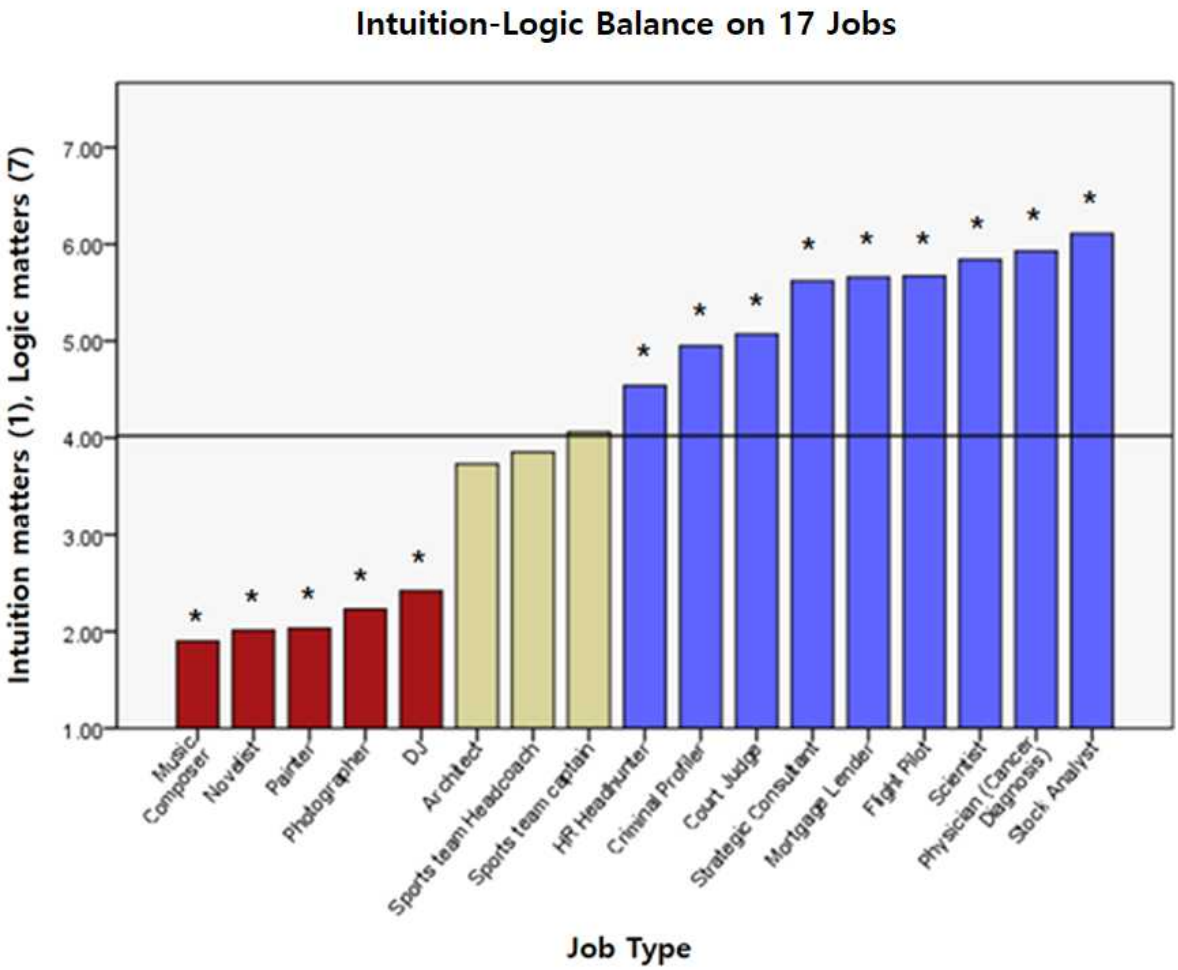

Figure 1. Mean Values for Intuition-Logic Balance on 17 Jobs

*Note *Significant difference with value of 4 in a simple t-test.

Intuition-Logic balance: 1 = intuition/creativity/experience/inspiration matters

7 = logic/information/calculation/accuracy matters

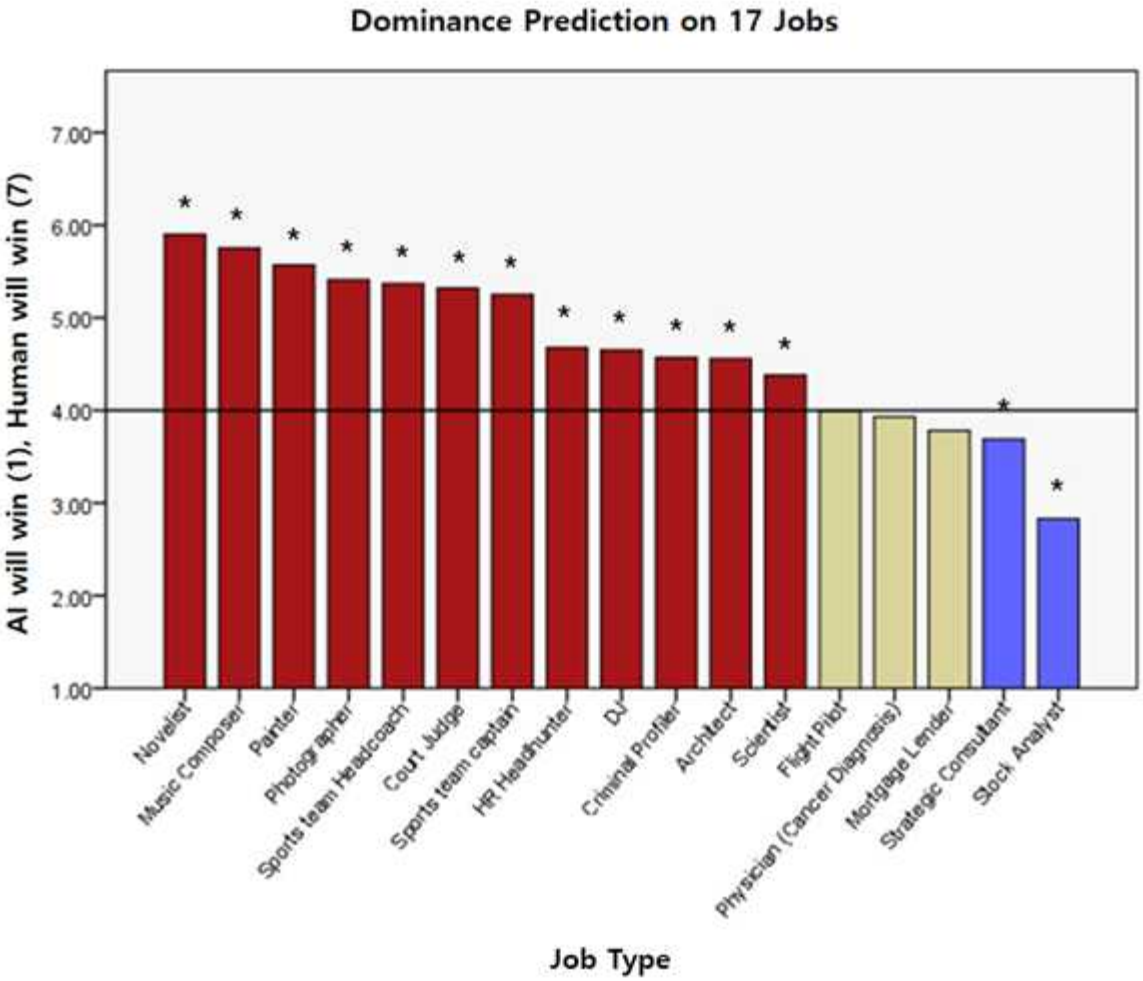

Figure 2. Mean Values for Dominance Prediction on 17 Jobs

*Note *Significant difference with value of 4 in a simple t-test.

Dominance Prediction: 1 = AI would perform absolutely better

7 = Human would perform absolutely better

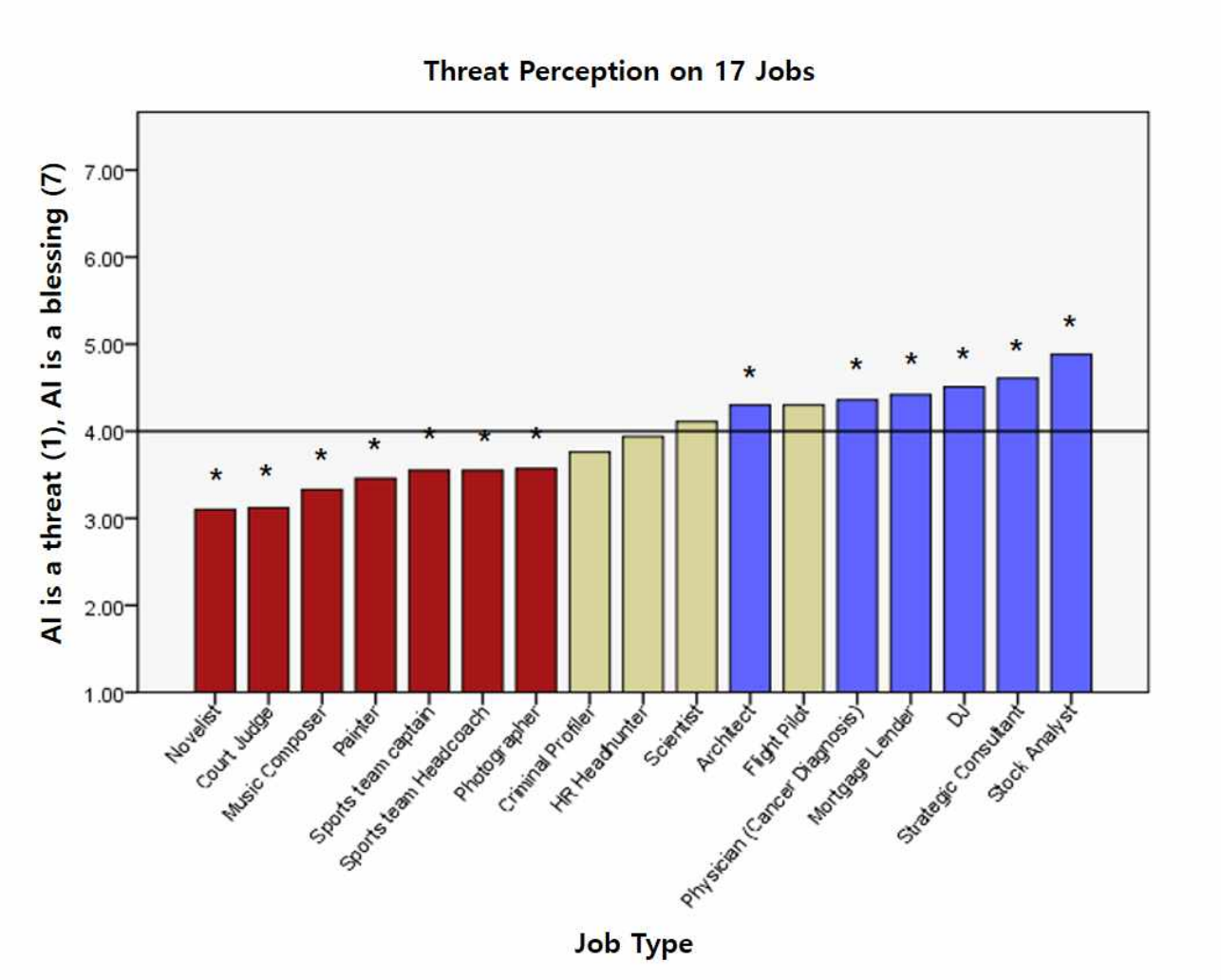

Figure 3. Mean Values for Threat Perception on 17 Jobs

*Note *Significant difference with value of 4 in a simple t-test.

Threat perception: 1 = AI would absolutely be a threat

7 = AI would absolutely be a blessing

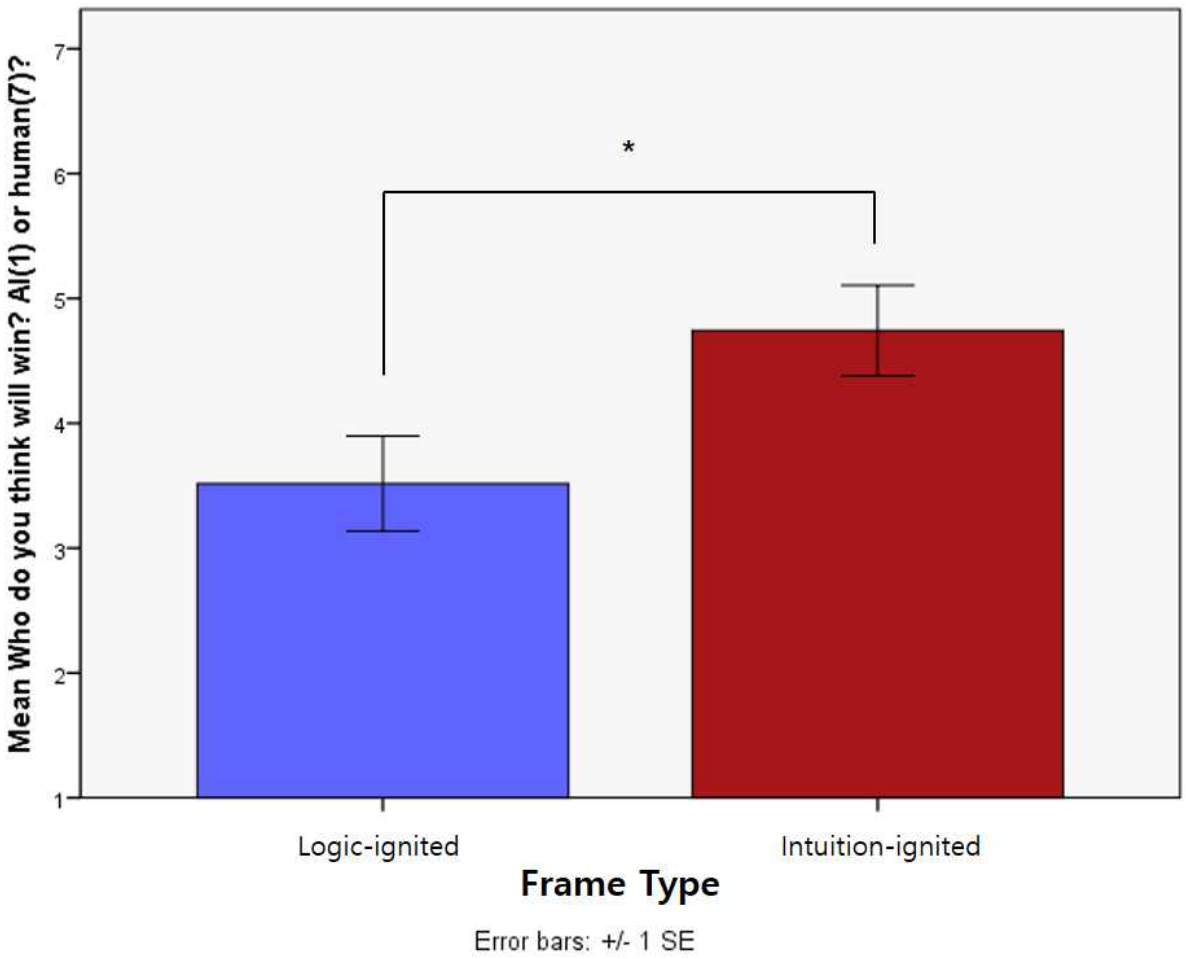

Figure 4. Effects of Logic-Intuition Frame on Dominance Prediction

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

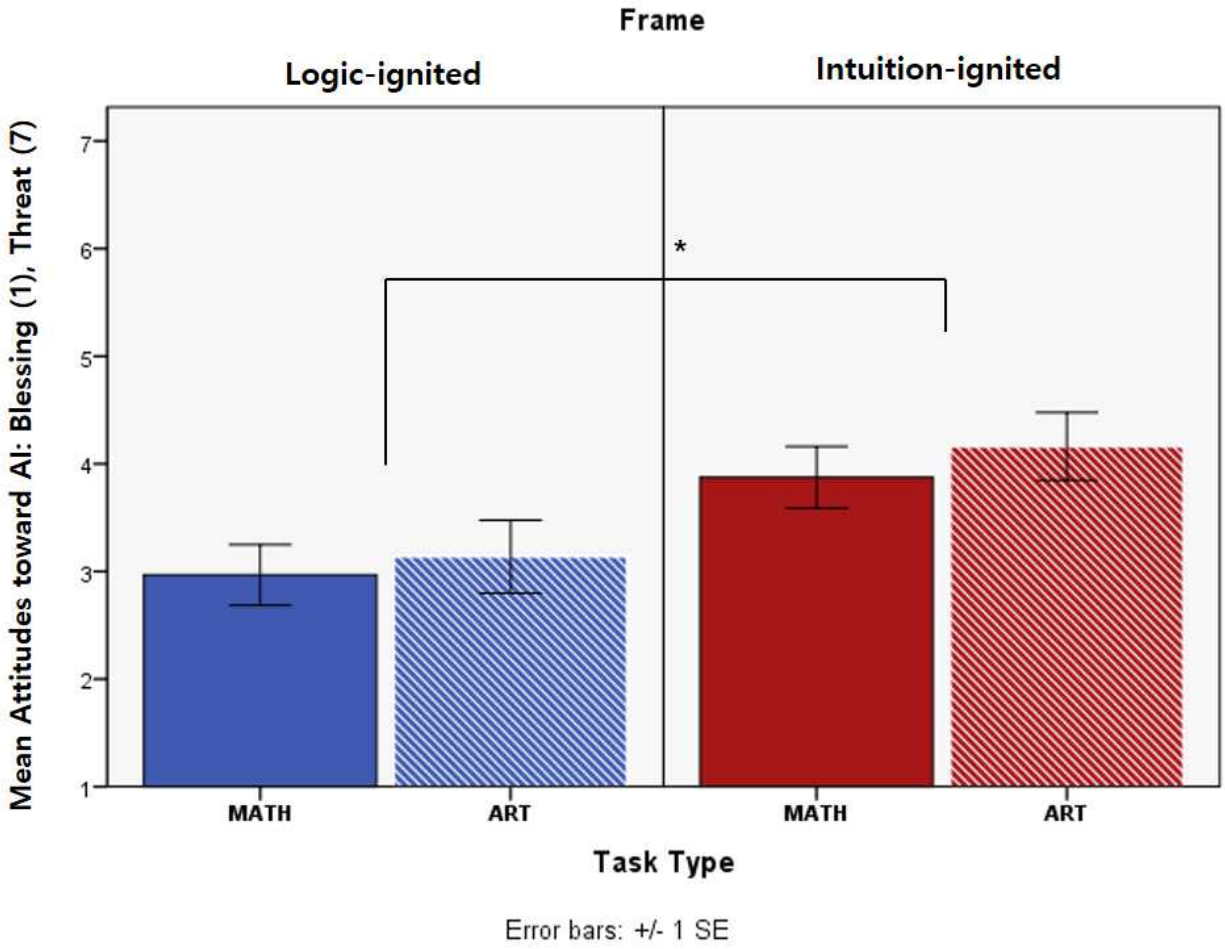

Figure 5. Effects of Logic-Intuition Frame on Threat Perception in ART/MATH Scenarios
*Note *p<.05, **p<.01

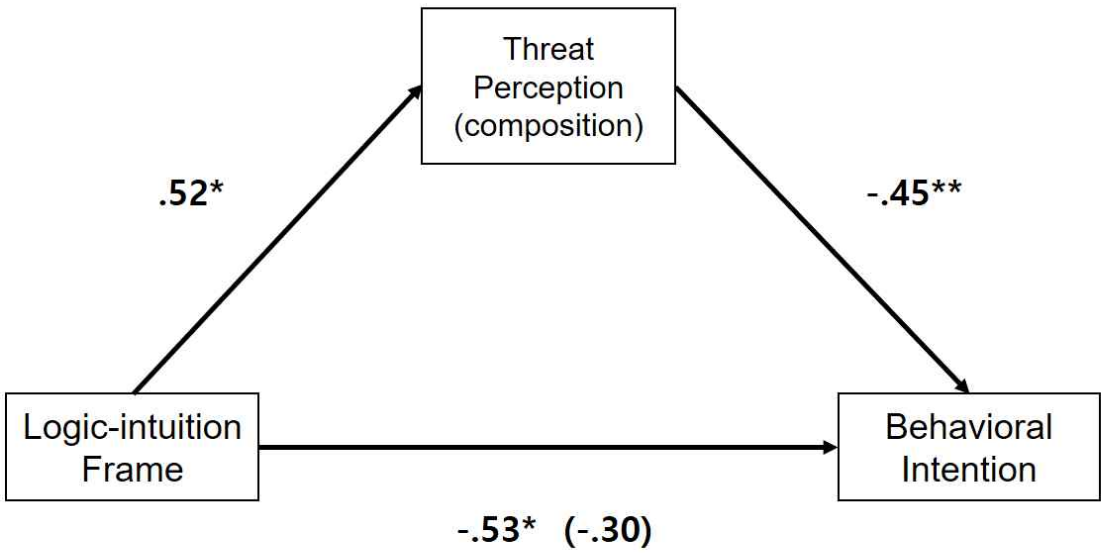

Figure 6. Perception of Threat-Blessing as a Mediator between Logic-intuition Frame effect and Intention of Engaging in AI-related Activities

Abstract in Korean

인공지능을 바라보는 인간의 시선: 축복인가 위협인가?

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인공지능이 가져 올 변화에 대한 정확한 예측이 현재로선 쉽지 않지만, 대중 매체나 영화 그리고 소설에서 그려내는 미래의 모습은 긍정적이지 않다. 인공지능에 대한 제품들과 서비스들에 대한 대중의 신뢰와 사회적 합의가 결여되면, 아무리 뛰어난 제품이라 할지라도 수용성이 떨어질 수밖에 없다. 따라서 인공지능에 대한 사회적 논의 과정에는 기술적, 법적, 윤리적, 경제적 논의 뿐만 아니라, 심리학적 논의가 매우 중요하다고 할 수 있다. 본 연구는 인공지능에 대한 사람들의 불안의 내용을 실험적으로 살펴보는 것을 목표로 한다. 여섯 개의 연구를 통하여 연구자들은 첫째, 인공지능을 축복 또는 위협으로 인식하는 것에는 개인차가 있으며, 둘째, 이 개인차는 인공지능이 대체하고 있는 분야 또는 인공지능의 메커니즘이 논리에 관련된 것인지, 직관에 관련된 것인지에 대한 개인의 Logic-Intuition Frame에 의해 영향을 받고, 셋째, 이러한 인공지능에 대한 인식의 개인차는 인공지능 관련 제품에 대한 구매 의도와 같은 개개인의 실제 삶 행동에 영향을 미치고 있음을 밝혔다. 즉 인공지능이 인간만의 고유한 영역이라고 여겨졌던 직관과 창의성의 영역에 도전한다고 여겨지는 것이 인류에게 위협으로 느껴지는 것이다. 인공지능이 제공할 수 있는 다양한 혜택을 부작용 없이 충분히 누리기 위해서는 기술적 안정성과 함께 심리적 수용성의 문제를 심도 있게 고민해야 할 것이다.