Autonomous Choice Preference: Manifestations, Mechanisms, and Applications

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Abstract

Autonomous choice preference refers to the phenomenon where, when confronted with the option of choosing autonomously or delegating decisions to others, individuals consistently prefer autonomous choice, even when it entails costs. While this preference may be attributed to overconfidence, illusion of control, and ambiguity aversion, it more likely originates from autonomous choice itself bearing intrinsic value. Neural activity in the reward system (striatum, medial prefrontal cortex) constitutes its key neural substrate, which is also regulated by cognitive control systems. Future research should elucidate the mechanisms of action and modulatory factors of autonomous choice preference within social contexts, and investigate its balancing mechanisms across groups, thereby promoting individual well-being and collective welfare.

Full Text

Self-Choice Preference: Manifestation, Mechanism and Application

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Abstract: Self-choice preference refers to the phenomenon where, when faced with self-determined choice or delegating choice to others, people always prefer self-determined choice, even at a cost. The underlying reasons may include overconfidence, illusion of control, and ambiguity aversion, but it more likely stems from the intrinsic value embedded in self-determined choice itself. Neural activity in the reward system (striatum, medial prefrontal cortex) constitutes its key neural basis, while also being regulated by the cognitive control system. Future research should reveal the mechanisms and regulatory factors of self-choice preference in social contexts, and explore its balancing mechanisms among groups, in order to promote individual well-being and collective interests.

Keywords: Self-choice preference; Selection effect; Intrinsic value; Reward system

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Self-choice preference refers to the phenomenon where, when faced with self-determined choice or delegating choice to others, people always prefer self-determined choice, even at a cost. Specifically, this phenomenon manifests as willingness to pay for the right of self-determined choice, regarding this right as a reward, demonstrating greater motivation for self-determined choice, and showing preference for self-selected outcomes. In other words, people will pay more money or exert more effort to keep the right to choose firmly in their own hands, which makes them feel positive. While overconfidence, ambiguity aversion, and illusion of control are thought to underlie this preference, it is more likely that intrinsic values embedded in self-determined choice drive people to prefer choosing for themselves. This preference is mainly supported by the reward system (striatum, medial prefrontal cortex) and regulated by the cognitive control system. Self-choice preference is widely observed in decision-making, management, and education. Future research should further reveal its mechanisms and regulatory factors in social scenarios, and explore the balance mechanisms of self-choice preferences among different groups, in order to promote individual wellbeing and group interests.

Keywords: self-choice preference; selection effect; control premium; reward system

Consider these common scenarios: A mother lays out clothes for her kindergarten daughter, but the girl insists on wearing something else, even if her own choice is unsuitable. Adult children often scoff at blind dates arranged by their parents yet are willing to meet someone they found themselves, though knowing that person may not be a good match. A company hires a professional investment advisor at a high salary, but the boss still follows his own intuition when making decisions. Such examples are ubiquitous in our lives: when faced with autonomous choice versus delegating choice to others, we prefer autonomous choice, even when it comes at a cost. This widespread phenomenon has long attracted researchers' attention, who have examined its positive effects (Zuckerman, Porac, Lathin, Smith, & Deci, 1978). However, it was not until Leotti et al. (2010) published their article titled "Born to Choose"in the prestigious journal *Trends in Cognitive Science* that systematic research on this phenomenon began to flourish. This paper reviews relevant research from psychology, economics, and cognitive neuroscience to elaborate on the manifestations, mechanisms, neural basis, and practical applications of self-choice preference.

1.1 I Choose, I Pay

The most direct manifestation of self-choice preference is people' s willingness to pay for the right to choose. Fehr et al. (2013) had two participants complete an "authority game," serving as principal and agent respectively. The principal could either choose autonomously or delegate the choice to the agent, who could only choose when delegated. Results showed that principals consistently preferred autonomous choice, even when it harmed their monetary payoff. Bartling et al. (2014) replicated this finding, demonstrating that choice rights possess not only extrinsic value but also some form of intrinsic value. Owens et al. (2014) used a different paradigm to show that people will pay for autonomous choice rights: participants first estimated their own and a partner' s probability of correctly solving Mensa puzzles, then chose between "win $20 if I answer correctly" and "win $20 if my partner answers correctly." Despite estimating their own success probability at only 56.4%, participants chose to rely on themselves 64.9% of the time. The researchers concluded that people are willing to sacrifice 8% to 15% of their payoff to obtain autonomous choice rights, a phenomenon termed the "control premium." Recent research has shown that this willingness to pay for choice rights exists not only in gain frames but also in loss frames (Bobadilla-Suarez, Sunstein, & Sharot, 2017). These studies, grounded in economic logic, quantify the monetary value people are willing to sacrifice for self-determined choice rights, providing objective evidence for the existence of self-choice preference.

1.2 I Choose, I' m Happy

People are not only willing to pay for choice rights but also experience more positive emotions from autonomous choice. Leotti and Delgado (2011) had participants complete a binary choice task where cues indicated whether they would choose autonomously or be forced to accept the computer' s option. Results showed participants preferred conditions with autonomous choice, and merely anticipating autonomous choice activated the ventral striatum—a key brain region for reward and pleasure—suggesting that choice rights bring happy experiences. They later replicated this finding, showing it occurs only in gain frames, indicating that choice-induced reward experience may be modulated by context and individual traits (Leotti & Delgado, 2014). Fujiwara et al. (2013) had participants make two rounds of choices: first between Option A (fixed reward, e.g., 40 yen) and Option B (number of daily items, e.g., 3 items including scissors, calculator, and mirror). If choosing A, the reward was 40 yen; if choosing B, participants could autonomously select one item as reward. Results showed that the more daily items available, the larger the monetary amount participants matched to it, and autonomous choice activated the striatum, with activation levels correlating positively with matched monetary amounts. Aoki et al. (2014) similarly found that the more alternatives participants obtained, the stronger their positive emotions and the higher their striatal activation. These studies demonstrate that obtaining autonomous choice rights produces more positive

emotional experiences and activates the ventral striatum, the core region of the reward system (Murayama, Izuma, Aoki, & Matsumoto, 2016), suggesting that autonomous choice rights function as material rewards like money or food, eliciting pleasurable reward experiences and serving as a target of human pursuit.

1.3 I Choose, I Strive

Self-choice preference also manifests as higher motivation levels and greater willingness to exert effort when completing self-chosen tasks (Patall, Cooper, & Robinson, 2008). Zuckerman et al. (1978) had some participants solve self-chosen puzzles while others solved predetermined puzzles. After task completion, when left alone with additional puzzles, those who solved self-chosen puzzles voluntarily worked on more extra puzzles. Legault and Inzlicht (2013) found similar results using a Stroop task: participants performed better on self-chosen tasks (compared to no-choice tasks), and error feedback elicited larger error-related negativity (ERN), indicating stronger motivation when having choice rights. Additionally, having choice rights can improve memory performance (Monty & Perlmuter, 1975), enhance athletes' performance (Halperin, Chapman, Martin, Lewthwaite, & Wulf, 2017), and increase pain tolerance (Rose, Geers, Rasinski, & Fowler, 2012; Salomons, Johnstone, Backonja, & Davidson, 2004). Murayama et al. (2015) used a stopwatch task and also found that autonomous choice improved task efficiency. Moreover, when participants had choice rights, negative feedback did not reduce ventromedial prefrontal cortex (vmPFC) activation, suggesting that choice rights can counteract negative emotions elicited by negative feedback. In team cooperation, people exerted more effort and performed better in self-selected groups compared to randomly assigned groups (Chen & Gong, 2018). These findings reveal that people are more willing to invest time and energy in completing self-chosen tasks—similar to paying a "control premium" for choice rights—representing another external manifestation of self-choice preference.

1.4 I Choose, I Like

People also prefer outcomes resulting from their own choices. Brehm (1956) first had participants rate their liking for multiple items, then choose between two equally liked items, and finally rate all items again. Results showed increased liking for chosen items and decreased liking for rejected items—a phenomenon termed the "choice effect" that has been repeatedly replicated (Izuma et al., 2010; Qin et al., 2011; Sharot, De Martino, & Dolan, 2009; Sharot, Velasquez, & Dolan, 2010) and confirmed as robust by meta-analysis (Kenworthy, Miller, Collins, Read, & Earleywine, 2011). Recent research suggests the reward system, including the striatum (Izuma et al., 2010; Sharot et al., 2009), ventromedial prefrontal cortex (Izuma et al., 2015; Izuma et al., 2010; Qin et al., 2011), medial prefrontal cortex (mPFC), and posterior cingulate cortex/precuneus (PCC/Pcu) (Tompson, Chua, & Kitayama, 2016), may constitute the neural basis of the choice effect. People' s preference for self-chosen

outcomes also appears in roulette games, where they place larger bets on self-selected options (Fleming & Darley, 1990). This effect shares some similarity with the well-known endowment effect in behavioral economics, as both assign higher value to items associated with oneself. However, while the endowment effect emphasizes that "the item belongs to me" (Kahneman, Knetsch, & Thaler, 1991), the choice effect emphasizes that "it was merely chosen by me" (Dishon, Oldmeadow, & Kaufman, 2018). Recent research further indicates that in specific contexts, individuals with higher self-awareness levels are more likely to seek and discover meaning in choice.

In summary, people are willing to pay money for choice rights, exert more effort in self-chosen tasks, experience reward pleasure when obtaining choice rights, and value self-chosen outcomes more highly—all demonstrating strong self-choice preference. Leotti et al. (2010) claimed that people are "born to choose," suggesting that autonomous choice is human nature. Indeed, other primates such as capuchin monkeys also show self-choice preference (Perdue, Evans, Washburn, Rumbaugh, & Beran, 2014). However, self-choice preference is not necessarily rational, especially in today' s era of big data analytics and information science, where delegating to professional agents is often the more rational choice. So why do people still prefer autonomous choice?

2 Why Do We Prefer Self-Choice?

Autonomous choice often means failing to maximize extrinsic value and may even require sacrificing material interests. Researchers have proposed multiple explanations for this seemingly irrational behavior.

2.1 Overconfidence

One explanation is overconfidence—a cognitive bias where people' s confidence in their performance and judgment far exceeds their objective level (Camerer & Lovallo, 1999; Zhou Aibao & Zhao Xin, 2009). This account suggests that overconfidence leads individuals to believe their own choices will yield greater benefits than delegated choices, thus showing more self-choice (Hoelzl & Rustichini, 2005). Given the universality of overconfidence (Kahneman & Tversky, 1996; Moore & Healy, 2008), this explanation has some validity, and research has found that overconfidence can partially explain self-choice preference (Bobadilla-Suarez et al., 2017). However, the probability of individuals making autonomous choices remains significantly higher than their estimated probability of correctly completing tasks, indicating that overconfidence cannot fully explain self-choice preference (Bobadilla-Suarez et al., 2017; Owens, Grossman, & Fackler, 2014).

2.2 Illusion of Control

Illusion of control, a concept related to overconfidence, refers to a judgment bias where individuals unreasonably overestimate their control over environmental or event outcomes in uncontrollable situations (Langer, 1975; Chen Xueling, Xu

Fuming, Liu Tengfei, Jiang Duo, & Zhang Junwei, 2010). Some evidence supports this explanation: Fehr et al. (2013) argued that individuals refuse to delegate choice rights to maintain a sense of authority, while Bartling et al. (2014) suggested that sacrificing instrumental interests for autonomous choice represents paying a "control premium." Other studies have found that perceived control can promote various behavioral outcomes (Bhanji, Kim, & Delgado, 2016; Salomons et al., 2004). Based on this evidence, we can speculate that increasing control through autonomous choice may be one reason for self-choice preference. However, direct evidence is still lacking to show that autonomous choice increases individuals' sense of control, or that self-choice behavior decreases when autonomous choice does not enhance control.

2.3 Ambiguity Aversion

Ambiguity aversion refers to people' s preference for familiar over unfamiliar things and their avoidance of the unfamiliar (Fox & Tversky, 1995). When facing autonomous versus delegated choice, if individuals lack sufficient information to calculate the benefits of each option, they may perceive autonomous choice as less ambiguous than delegating choice, leading to more self-choice. Owens et al. (2014) manipulated the ambiguity of decision information and found that although self-choice preference varied with ambiguity level, the effect did not reach statistical significance. This suggests that while ambiguity aversion influences self-choice preference, it is not the most critical factor.

2.4 Intrinsic Value

The previous explanations can partially account for self-choice preference but cannot provide a complete explanation. Therefore, some researchers have taken a step back and proposed that people prefer autonomous choice simply because it possesses intrinsic value beyond extrinsic value (Bartling, Fehr, & Herz, 2014; Leotti & Delgado, 2011; Leotti et al., 2010). Strong evidence for this explanation includes the fact that autonomous choice rights themselves can elicit positive experiences and reward system activation (Aoki et al., 2014; Fujiwara et al., 2013; Leotti & Delgado, 2011, 2014), and that individuals are willing to sacrifice extrinsic value to obtain autonomous choice rights (Bartling et al., 2014; Bobadilla-Suarez et al., 2017; Owens et al., 2014). This account, attributing self-choice preference to the intrinsic value of choice itself, greatly enhances explanatory power. But this raises the question: what exactly is this intrinsic value?

One possibility is control. As previously discussed, control is a highly valued feeling that brings many benefits (Bhanji et al., 2016; Patall et al., 2008; Salomons et al., 2004), while loss of control can cause negative effects such as "learned helplessness" (Abramson, Seligman, & Teasdale, 1978). When choosing personally, individuals may experience an immediate sense of control—after all, the choice is their own, even if it requires sacrificing extrinsic value (Fehr, Herz, & Wilkening, 2013; Owens et al., 2014). If this sense of control exceeds realistic

levels, it becomes illusion of control, so this explanation partially encompasses the illusion of control hypothesis.

Another possibility is that autonomous choice is a "heuristic" developed during human evolution (Bobadilla-Suarez et al., 2017)—a "default option" when facing decisions. It is as if the brain has a preset: compared to others choosing for us, autonomous choices better match our preferences and satisfy our needs.[1] Therefore, we always execute this heuristic first (Gigerenzer & Gaissmaier, 2011), and merely executing this heuristic choice can activate the reward system (Leotti & Delgado, 2011), making individuals willing to sacrifice extrinsic value for it (Owens et al., 2014). Additionally, compared to delegated choice, autonomous choice may mean more opportunities for feedback-based learning, which also reinforces its value as a heuristic.

A third possibility is that autonomous choice better aligns with individuals' "intrinsic motivation." Deci and Ryan' s (2000) Self-Determination Theory posits that competence, autonomy, and relatedness are innate psychological needs—intrinsic motivations for individual behavior. Autonomous choice is an effective way to satisfy the needs for competence and autonomy. For instance, research reports that people perform better on self-chosen tasks, while external incentives, even rewards, can hinder intrinsic motivation and reduce performance (Deci, Koestner, & Ryan, 1999; Murayama, Matsumoto, Izuma, & Matsumoto, 2010). Therefore, autonomous choice rights and extrinsic material rewards may belong to the same category of human psychological needs and represent targets of human pursuit.

In summary, whether for gaining control, as a heuristic behavioral method, or for satisfying intrinsic motivation, autonomous choice represents value that meets internal needs, which may lead individuals to develop self-choice preference. However, like loss aversion and other phenomena, this preference, while having its rationality, still needs to be weighed against reason to help individuals maximize value.

3 The Neural Basis of Self-Choice Preference

Revealing the neural basis of self-choice preference can advance research in this field. In fact, cognitive neuroscience findings both confirm the existence of self-choice preference (Leotti & Delgado, 2011) and provide new perspectives for revealing its mechanisms. Some researchers have proposed "intrinsic motivation neuroscience" (Di Domenico & Ryan, 2017) and "autonomy neuroscience" (Murayama et al., 2016), emphasizing that exploring the neural basis of self-choice preference is important.

Autonomous choice rights represent a reward for individuals, satisfying preferences and serving as a target of pursuit. Several studies suggest that the reward system, including the striatum and ventromedial prefrontal cortex, constitutes an important neural basis for self-choice preference. For example, in Leotti and Delgado' s (2011, 2014) studies, merely informing participants that they had ob-

tained choice rights activated the ventral striatum. In choice effect studies, the degree to which items increased in liking after being chosen correlated positively with striatal activation (Sharot et al., 2009; Sharot, Shiner, & Dolan, 2010). Additionally, striatal activation strengthening memory is an important mechanism through which autonomous choice promotes memory effects (Murty, DuBrow, & Davachi, 2015). Aoki et al. (2014) found that striatal activation strength correlated positively with the number of items for which participants obtained choice rights, while ventromedial prefrontal activation correlated positively with the ratio of self-owned to other-owned alternative items. Murayama et al. (2015) found that choice rights could modulate ventromedial prefrontal activation in response to positive and negative feedback. Di Domenico (2017) suggested that self-choice preference is also related to the mesencephalic dopaminergic system, but current evidence is mainly based on analogies with intrinsic motivation (Bromberg-Martin, Matsumoto, & Hikosaka, 2010) and still lacks direct evidence from self-choice preference studies.

Other studies have found that choice-induced changes in item preference correlate with anterior cingulate cortex activation (Izuma et al., 2010; Kitayama, Chua, Tompson, & Han, 2013), and that dorsal anterior cingulate activation modulates the self-choice effect in Stroop tasks (Legault & Inzlicht, 2013). This may be because self-choice preference involves self-referential processing. Additionally, Di Domenico (2017) proposed that the intrinsic motivation system also involves salience detection and attention control networks. If self-choice preference is placed within the intrinsic motivation system, it should also involve brain regions such as the anterior insula and dorsolateral prefrontal cortex, though direct evidence is currently lacking.

In summary, based on existing evidence, the neural basis of self-choice preference mainly involves the striatum (completing automatic and primary evaluation of choice rights), medial prefrontal cortex and anterior cingulate cortex (incorporating contextual information and linking it to the self), while being regulated by attention control systems.

4 Applications and Future Directions

Studying self-choice preference as an independent phenomenon remains a new trend in psychology and economics. However, researchers have gradually recognized its importance, even giving rise to "autonomy neuroscience" and "intrinsic motivation neuroscience." The United Nations Sustainable Development Solutions Network' s *2018 World Happiness Report* identified "freedom to make life choices" as an important factor affecting national happiness. Across research in this field, investigators have described the manifestations of self-choice preference from psychological, economic, and neuroscientific perspectives and attempted to explain its mechanisms and neural basis. However, research on self-choice preference is still emerging, with many questions worth exploring in depth.

4.1 How Do Multiple "Causes" Work Together?

Although we can speculate about multiple mechanisms underlying self-choice preference based on existing research—including overconfidence, illusion of control, ambiguity aversion, and intrinsic value—no study has experimentally manipulated these mechanisms to explain self-choice preference. While the hypothesis that "self-choice preference carries some intrinsic value" explains the phenomenon well, how various possible causes work together remains unknown. Solving this problem could not only further reveal the mechanisms promoting self-choice preference but also help applied research find a balance between "self" and "agent."

For instance, economics research emphasizes the control brought by autonomous choice (Fehr et al., 2013; Rose et al., 2012), while psychology research emphasizes the psychological needs carried by autonomous choice (Deci & Ryan, 2000; Sharot, Velasquez, et al., 2010). The two perspectives overlap to some extent but also diverge. Revealing their interactive mechanisms through experimental manipulation could enhance understanding of this issue. Additionally, Self-Determination Theory proposes that competence, autonomy, and relatedness are intrinsic motivations (Deci & Ryan, 2000). The first two have been demonstrated in existing research, but the need for relatedness has been neglected, possibly because most studies ask participants to maximize their own extrinsic interests without considering social factors like relationships. However, if individuals know that delegating choice rights could satisfy others' self-choice preferences and thereby enhance mutual relationships, how would they decide? In fact, sociality is a key attribute of humanity, and self-choice preference should be considered in social contexts. Existing research has reported that self-choice preference is modulated by cultural factors (Iyengar & Lepper, 1999), suggesting that incorporating social factors may more deeply reveal the mechanisms of self-choice preference.

4.2 How to Balance Affect and Reason?

People prefer autonomous choice even when it does not increase extrinsic value and requires paying an additional "control premium" (Bartling et al., 2014; Bobadilla-Suarez et al., 2017; Fehr et al., 2013; Owens et al., 2014). Whether due to overconfidence or intrinsic value, this phenomenon—like temporal discounting and loss aversion—represents affective behavior dominated by subcortical structures. While evolutionarily rational, its irrational characteristics may be amplified in the information age. The intrinsic value carried by autonomous choice may dominate in the short term, but the sustainability of this dominance is questionable. Particularly today, with rapidly developing technology, professional agents and artificial intelligence based on big data can inevitably make better decisions based on extrinsic value. On one side is an evolutionarily developed "default setting" that gives individuals good psychological feelings; on the other is rational choice based on advanced technology that brings utilitarian benefits. How to care for internal needs while using rational cognitive control

systems to regulate this preference and nudge individuals toward optimal decisions is a question worth exploring.

If autonomous choice is an evolutionarily developed "default setting," then the artificial "default effect" seems to undermine this "default setting" to some extent. The default effect refers to the phenomenon where individuals tend to retain the default option without making changes when one exists (Huang Baozhen, Xu Fuming, Wang Lan, Ma Xiangyang, & Wu Xiuliang, 2011). Obviously, setting a default option hinders autonomy and freedom in decision-making to some degree, yet it effectively nudges behaviors like organ donation and insurance consumption (Thaler & Sunstein, 2008). So why would artificial default options make individuals give up their own choice? Future research could explore how to reconcile the contradiction between the default effect and self-choice preference and how they influence each other. Revealing the psychological processes involved when individuals weigh these two factors could not only advance research in this field but also have broad application prospects in commercial consumption, charitable donations, and other real-world issues.

Moreover, while autonomous choice is a reward and the pleasure from rewards increases with the number of alternatives (Aoki et al., 2014), reducing alternatives causes dissatisfaction (Mirosa, Loh, & Spence, 2016). However, choice entails cognitive costs, which humans generally dislike. How do we reconcile the preference for choice rights with the aversion to cognitive costs? Especially when increased alternatives cause information redundancy, how do people decide? Research has reported that people make more purchases when having 6 alternatives compared to 24-30 alternatives, suggesting that more options are not always better (Iyengar & Lepper, 2000). Therefore, providing opportunities for autonomous choice while keeping alternatives within an appropriate range may nudge individual decision-making.

4.3 Whose Self-Choice Preference Should Be Accommodated?

If everyone uses self-choice preference to satisfy internal needs and achieve control, whose preference should be accommodated in social interactions? For example, managers may refuse to delegate choice rights for a sense of authority (Fehr et al., 2013), while subordinates may obtain reward experiences from choice rights (Leotti & Delgado, 2011), exert more effort for their choices (Murayama et al., 2015), show more persistence (Rose et al., 2012), and thus achieve better performance (Legault & Inzlicht, 2013). So whose self-choice preference should take priority? Organizational activities are not zero-sum games[2]—managers and subordinates share common interests and have a cooperative relationship—so balance should be struck to care for each other' s psychological needs and handle both parties' self-choice preferences.

Furthermore, under China' s current education system, parents and teachers often design goals, methods, and processes for learners from the perspective of experienced authorities. While this approach may be rational, it often ne-

glects learners' self-choice preference. However, the fact is that autonomous choice can enhance students' intrinsic motivation (Cordova & Lepper, 1996; Ciampa, 2015), increase self-satisfaction (Lee & Reeve, 2013), and improve memory performance (Monty & Perlmuter, 1975). Research has also proposed that behavioral autonomous decision-making significantly positively predicts life satisfaction among rural left-behind and non-left-behind adolescents (Zhao Jingxin, Wang Qiujin, Yang Ping, & Liu Xia, 2017), suggesting that attending to adolescents' autonomous choice may be an effective way to enhance their wellbeing. Therefore, how to better use this inherent psychological characteristic of self-choice in education—particularly as assembly-line talent cultivation models gradually decline and the value of individual creativity and happiness becomes increasingly important—skillfully balancing the self-choice preferences of educators and learners has important value for educational reform.

Autonomous choice is an important means to achieve internal psychological needs (Deci & Ryan, 2000), yet we often find ourselves in social contexts when demanding autonomous choice. One person' s autonomous choice may hinder another' s. China' s current social contradiction is "the conflict between people' s growing needs for a better life and unbalanced, inadequate development." This means people will pay more attention to "soft needs" with subjective qualities such as sense of gain, happiness, and security, and "freedom in life choices" may be an important way to preserve these feelings. Therefore, in real life, we should examine all parties' self-choice preferences from a broader perspective, seek balance among them, and make choice agents aware of the irrational characteristics of self-choice preference while appropriately introducing cognitive regulation, which may promote individual happiness and enhance collective interests.

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[1] In most cases, this assumption is correct (Polman, 2010; Stone & Allgaier, 2008), and continuous reinforcement by liberalism and humanism may strengthen this belief.

[2] A zero-sum game refers to a situation where parties in strict competition have completely opposed interests—one party' s gain necessarily means another' s loss, and the sum of gains and losses always equals "zero," making cooperation impossible.

Note: Figure translations are in progress. See original paper for figures.