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The Impact of Self-Quantification on Consumers' Participation in Green Consumption Activities and Behavioral Decision-Making

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Abstract: Looking at the contradiction between the prevalence of self-quantification and unclear applicable boundaries, the objective of this study is to examine the internal mechanism of how self-quantification influences consumers' participation and behavioral decision-making in green consumption activities. Based on the goal setting theory, a series of research hypotheses were proposed. Four experiments were designed and performed in different situations with different subjects. Through the analysis of variance and bootstrap testing, the experimental data were analyzed and processed. The results show that, under specific goals, consumers with low self-quantification participate more in promotional activities and less in defensive activities. In promotional green consumption activities, self-quantification enables consumers with (without) goal requirements to reduce (enhance) their participation performance, and choose high-intensity promotional activity categories less (more) with better (worse) participation experience. In defensive green consumption activities, self-quantification enables consumers with (without) goal limitations to enhance (reduce) participation performance and choose high-intensity defensive categories more (less) with better (worse) participation experience. The conclusions can provide enlightenment for enterprises to guide consumers to participate in green consumption activities.

Keywords: self-quantification; green consumption; activity participation; behavioral decision-making

1. Introduction

In the face of a deteriorating ecological environment, consumers' awareness of environmental protection and sustainable development is increasing. More consumers are willing to participate in green consumption activities [1]. However, there is still a gap between consumers' expectations and their actual green consumption behaviors [2]. Green consumption is not an activity based on simple moral judgment, but is often mixed with personal interests. Although many enterprises actively guide consumers to participate in green consumption, unfamiliarity with emerging green products and green activities makes consumers hesitate to participate, or stop participating after a short-term trial, resulting in a lack of green consumption [3]. In the digital era, from monitoring electricity consumption to tracking carbon emissions, with increasingly diversified and decentralized quantitative data collection and utilization through technical tools, consumers' green consumption activities are becoming more data-oriented [4]. In this context, many enterprises try to apply self-quantification to drive consumers to actively participate in green consumption activities [5].

Self-quantification refers to the process by which consumers track data related to their participation in activities or behavioral status, thereby forming self-knowledge and reflection to mediate their

behavior [6]. From weighing themselves to recording household expenses, consumers have always had the habit of quantifying themselves, and the development of technology has made it possible to track and measure various personal behaviors in real time [6]. Especially when the technical tools permit and the activities involve specific participation outcomes, consumers will be more motivated to quantify themselves [4]. The literature in the field of sports and health generally indicates that self-quantification will increase consumers' participation outcome in sports and health activities. By acquiring tracking data, consumers can be aware of the effectiveness of their specific behaviors, so as to carry out self-control, make adjustments, and optimize decision-making [4,5].

With the development of self-tracking and promotion of technology by enterprises, more consumers are participating in self-quantification activities [7]. In the early days, consumers used smart bracelets and other technical tools to track their walking steps, calorie consumption, etc., and self-quantification was mostly used in the field of health care [8]. In recent years, with the development of smart shopping carts, carbon emission monitoring, and other technologies, self-quantification has been gradually applied to the field of green consumption. For example, many consumers buy smart sports shoes equipped with sensors to record their green footprint, cars are equipped with real-time monitoring technology to measure carbon emissions [9], online platforms such as Ant Forest feed back users' daily green energy values by tracking their green travel and online payments of water, electricity, and gas, etc., so as to guide green consumption behavior [4]. Enterprises generally believe that self-quantification can effectively stimulate consumers' participation in green consumption activities, thus actively apply or even blindly promote self-quantification to seize the market [10].

However, although self-quantification is more widely used in the field of green consumption, it does not seem to be achieving the expected benefits. According to an industry report, more than half of consumers reduce or even stop participating in self-quantification activities after a few months [11]. Many enterprises apply self-quantification to guide green consumption and try to drive consumers to track their green behaviors through gamification design such as scores and rankings. However, the unclear understanding of the influencing mechanism and effect boundary of self-quantification has led to poor positive effects [12,13]. Blind self-quantification even leads to the illusion that consumer behaviors are in control, which leads to adverse consequences such as consuming more energy or choosing high-energy products [14].

Focusing on the phenomenon, it has not been fully explored how self-quantification will affect consumers' participation and behavioral decision-making in green consumption activities. Most scholars believe that self-quantification will enhance the performance of consumers' energy-saving activities and the choice of high-intensity energy-saving products [10], but some scholars question whether it will affect consumers' participation given different types and goal settings [14]. In terms of green consumption, existing research suggests that it includes both promotional and defensive sides. Consumers can track positive outcomes (e.g., green footprint) in promotional activities (e.g., green travel) or negative outcomes (e.g., carbon emissions) in defensive activities (e.g., energy consumption) [15,16]. According to the goal setting situation, consumers can participate in self-tracking activities with or without a goal [12]. How self-quantification influences consumers' participation performance, behavioral choice, and participation experience in different types of green consumption activities under different goal settings needs to be further explored.

Therefore, focusing on the field of green consumption, from the consumer perspective, this research explores the influencing mechanism of self-quantification on consumers' participation in green consumption activities and behavioral decision-making. Specifically, based on the different types of green consumption activities and goal setting situations, we analyze the differential impacts of self-quantification on participation performance, behavioral decision-making (such as the selection of specific activity categories), and participation experience, and the internal mechanisms behind different types of activities and goal settings. In the past, consumers' behavioral decision-making mostly relied on previous experience. Self-quantification enables consumers to form self-knowledge based on quantitative data to make accurate behavioral decisions. Consumers' behavioral decisions are

shifting from experience-driven to data-driven. The discussion of relevant issues not only explains the differential effects and effect boundary of self-quantification in green consumption, but also provides a theoretical basis for clarifying the decision-making and behavioral choice of consumers driven by quantitative data. It provides a new perspective for understanding the model of data-driven behavioral decision-making, and it can provide enlightenment for enterprises to decide whether and under what conditions to apply self-quantification in guiding consumers to participate in green consumption activities, and a scientific basis to design green consumption activities and promote green products.

2. Theoretical Background

2.1. Self-Quantification

Self-quantification refers to the process by which consumers track their own behavioral state by relevant technical tools and form their own knowledge based on quantitative data, so as to make adjustments in order to optimize their behavioral performance [4]. According to the existing research, consumers have different motivations to participate in self-quantification, such as behavioral optimization and self-improvement, self-control and self-regulation, knowledge exploration, and self-enjoyment [6]. Self-quantification is a phased process involving activity selection and goal setting, collecting data with technical tools, interpreting or reflecting data, and optimizing the participation based on that reflection [17]. In terms of participation performance, the industry generally believes that self-quantification can effectively promote consumers' participation performance [10], but some scholars have pointed out that self-quantification may cause the illusion of control and bring adverse consequences, and its positive effect is not absolute [9,13]. In terms of participation experience, most existing studies believe that self-quantification will bring procedural and mechanized participation perception and lead to negative participation experience, but the universality of this result remains to be confirmed [12,18]. The two types of self-quantification, consolidating positive behavioral patterns and changing negative behavioral patterns by tracking behavioral states, can also be considered in terms of promotion and defense [19]. However, most studies discuss the effects of self-quantification in promotion-oriented activities such as step measurement and rarely focus on the effects in defense-oriented activities such as monitoring electricity consumption [4], and the differences under different goal settings are unclear [12]. Relevant research has not fully tested the consequences of self-quantification such as its influence on participation performance, and lacks a procedural understanding of how self-quantification affects consumers' specific behavioral preferences and decision-making [13]. Under different conditions, the influence of self-quantification on consumers' participation in activities and even behavioral decision-making and its internal mechanism need to be further explored [20].

2.2. Green Consumption

Green consumption refers to consumers considering the impact of their consumption behavior on the environment, minimizing the negative impacts and maximizing the long-term benefits [21]. Referring to the dichotomy of promotion and defense of general behavior [22], to some extent, green consumption is a process of minimizing the negative impact of consumption and protecting the environment during consumption [15,23,24]. With the promotion and multi-domain application of tracking technology, consumers are increasingly tracking their own green consumption activities, obtaining self-knowledge through quantitative data [25], thereby regulating their behavioral preferences and decisions [10], for example, adjusting one's green consumption and travel behavior through real-time tracking feedback of carbon emissions and carbon footprint [9]. The academic community also recognizes the phenomenon of self-quantification in green consumption and increasingly advocates guiding consumers' green behavior through self-quantification. However, it is not clear whether there are differences in the effects of self-quantification under different situations and what the influencing mechanism is [5]. Some scholars track energy consumption behavior by observing carbon footprint and

energy consumption values, and subjectively suppose that self-quantification will encourage consumers to reduce their energy consumption [9]. In terms of self-quantification, there are not only activities to reduce the adverse impacts on the environment (defensive activities such as tracking electricity consumption to alter one's behavior), but also activities to enhance environmental performance (promotional activities such as tracking emission reduction to alter one's behavior). However, the existing research mostly considers a single situation, and there are few comprehensive analyses in different contexts and a lack of data validation [16]. Relevant research lacks an accurate understanding of the consequential influence of self-quantification in green consumption, neglecting its influence on the participation process such as behavioral decision-making and experience.

3. Research Hypotheses

Goal setting theory is often used to test how consumers set goals in the process of participating in activities and how those goals will affect their performance and behavioral decision-making [26]. According to traditional goal setting theory, consumers with goal requirements or goal limitations will pay attention to their performance in the process of participating in activities, and mentally track their progress to estimate their performance, so as to adjust their efforts [27]. However, individual participation performance and behavioral decision-making do not result from goal setting alone. Environmental cues such as performance feedback and differences in goal orientation in different activities also affect individual goal pursuit motivation and participation behavior under goal setting [4,26]. Individuals who set goals for promotional activities will activate their goal orientation and pursue positive participation outcomes. Individuals who set goals in defensive activities will activate their avoidance goal orientation and avoid negative participation outcomes [16]. Based on goal setting theory and the two types of green consumption activities, we analyze the influence of self-quantification on consumers' activity participation performance, behavioral decision-making, and participation experience in different situations (see Figure 1 for the research framework).

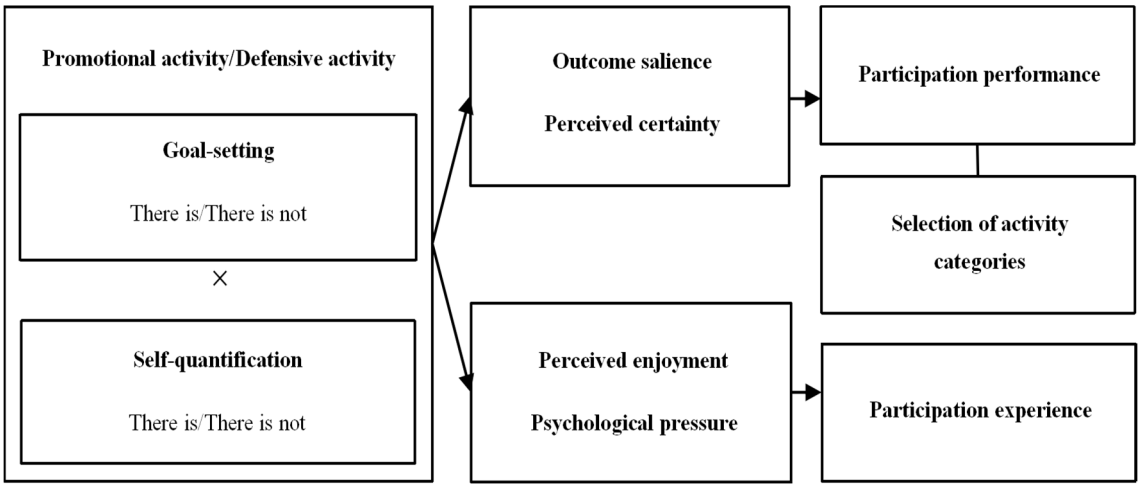


Figure 1. Research framework.

3.1. Self-Quantification and Participation Performance of Green Consumption Activities

By providing data feedback to consumers on the progress of their participation in activities, self-quantification can highlight their participation outcomes [28], which will make them tend to pay attention to their behavioral outcomes in the process of participating [12]. For example, measuring the mileage of a ride will draw someone's attention to the mileage they have already covered. When participating in promotional activities without specific goals, consumers who pay attention to the highlighted participation outcomes in quantitative data feedback will be motivated and tend to maximize their behavioral progress, so as to enhance their performance [12,28]. However, under a

specific goal requirement (pursuing a goal requires promoting behaviors such as riding at least five kilometers per day), consumers who participate in promotional green consumption activities will instinctively track their participation outcomes in their minds [12], which are often at a high level of salience [29]. Therefore, the effect of outcome salience on such consumers is limited. When quantitative data feedback is provided to consumers, they can compare their performance with their goals and have greater certainty. The perceived certainty will drive them to adjust their effort level [30]. The theory of dynamic self-regulation points out that when consumers know the progress of their goals and are more certain that they will achieve the goals through quantitative data feedback, they will slack off and reduce their effort [31]. When quantitative data feedback shows that the progress of participation has reached the final goal requirement, the degree of effort will decrease rapidly [32].

With the salience of participation outcomes caused by self-quantification in defensive green consumption activities, attention to participation outcomes will make consumers more cautious in their follow-up behavior [29]. Unlike the goal requirement in promotional activities requiring individuals to achieve specific positive results, the goal limitation in defensive activities means that individuals should avoid reaching specific negative results, and the activity participation outcome is constrained by the upper bound [16]. Research in the field of green consumption shows that for the same activity, the level of energy consumption of consumers who have no goal limitation (pursuing the goal requires behavioral restriction, such as using at most five kilowatts per day) and receive tracking data is lower, and self-quantification has a significant negative impact on their defensive activity participation performance [10]. Without goal limitation, the salience of outcomes brought by self-quantification will stimulate consumers to reduce their participation in defensive activities [33]. However, when consumers with goal limitations participate in defensive green consumption activities, they tend to mentally track and highlight the outcomes [12]. The effect of outcome salience caused by self-quantification on such consumers is limited. Under goal limitations, consumers will feel the loss when their participation performance in defensive activities exceeds the goal, and they will value these losses more than the opportunity cost brought by participating in such activities [34]. In order to minimize the risk of over-participation and experiencing loss, uncertainty about the progress of self-made goals makes such consumers tend to participate in activities less [35]. However, self-quantification will reduce the uncertainty of participation outcomes in defensive activities, thus ensuring that consumers can participate in these activities more without exceeding the goal [36]. The reduction of perceived uncertainty will also stimulate consumers with goal limitations to participate in defensive green consumption activities more.

Hypothesis 1a. *Self-quantification will enhance the participation performance of consumers without goal requirements in promotional activities.*

Hypothesis 1b. *Self-quantification will reduce the participation performance of consumers with goal requirements in promotional activities.*

Hypothesis 1c. *Self-quantification will reduce the participation performance of consumers without goal limitations in defensive activities.*

Hypothesis 1d. *Self-quantification will enhance the participation performance of consumers with goal limitations in defensive activities.*

3.2. Self-Quantification and Category Selection of Green Consumption Activities

In general, consumers' daily self-quantification activities often include a variety of categories [12]. For example, consumption involves the selection of promotional product categories with different degrees of environmental protection, such as clothing made entirely or partly from natural fibers and travel by bus or bike. It also involves the selection of defensive product categories with different

degrees of environmental damage, such as a private car with a displacement of 2.0 or 3.0 and the use of 1.5 or 2.0 HP air-conditioners. Under different circumstances, consumers will choose different activity categories according to the quantitative data feedback in the process of pursuing participation performance [37].

In terms of consumption without goal requirements, some scholars believe that self-quantification can not only help consumers accurately know the participation state of their promotional activities, but also reduce their marginal behaviors, allowing them to do more useful things [37]. Self-quantification not only enhances consumers' participation performance in promotional green consumption activities through outcome salience, but also improves their choice of healthier and greener activities [33]. For example, through real-time tracking of green footprint by relevant tools, consumers can increase their participation performance in environmental protection activities by paying attention to the highlighted green footprint, and at the same time, they will also choose more walking and riding and less public transportation when conditions permit [9]. Consumers with goal requirements, in the process of self-quantification, will have the illusion that their participation is in control since they know their goal progress. Their sense of pressure and caution in promotional activity participation will be reduced, and they will be over-optimistic [38]. Therefore, on the premise of meeting the goal requirements, consumers may choose more relaxed and convenient, even opportunistic ways to participate in activities, and more relatively relaxed and convenient activity categories [38,39].

With regard to consumption without goal limitations, after receiving tracking feedback data, in order to reduce participation in defensive activities, consumers will adjust their selection of activity categories. Taking electricity consumption as an example, when consumers have no specific limitations, real-time tracking of their own electricity consumption will reduce their electricity wastage, and by monitoring their consumption, they will be more inclined to choose appliances with low electricity wastage over appliances with large electricity wastage [33]. Participating in self-quantification will reduce the choice of marginal behavior of consumers without goal limitations and enhance their relatively healthier and greener behavioral choices [40]. When limited by specific goals, consumers often establish security boundaries in the process of participating in activities to minimize the risk of exceeding the goals. However, the acquisition of quantitative data ensures that consumers with goal limitations can maximize their interests, and the perceived controllable space of activity participation from self-quantification is understood as a "windfall." When receiving quantitative data, consumers may spend this windfall more easily and frivolously within the goal limitation, choosing categories of non-beneficial activities more [41]. The windfall effect seems to justify the choice of categories of non-beneficial activities by consumers with goal limitation [42].

Hypothesis 2a. *Self-quantification will enhance the selection of high-intensity promotional categories by consumers without goal requirements.*

Hypothesis 2b. *Self-quantification will reduce the selection of high-intensity promotional categories by consumers with goal requirements.*

Hypothesis 2c. *Self-quantification will reduce the selection of high-intensity defensive categories by consumers without goal limitations.*

Hypothesis 2d. *Self-quantification will enhance the selection of high-intensity defensive categories by consumers with goal limitations.*

3.3. Self-Quantification and Participation Experience of Green Consumption Activities

In the process of participating in promotional green consumption activities, consumers are often driven by interest, enjoyment, and other internal motivations. However, according to the theory of external incentives, if external incentives are provided, they will "crowd out" internal motivation, and

there is also an external incentive effect of quantitative data feedback. Consumers will attribute their behavior to external incentives rather than internal motivation, and the transfer of such attribution will reduce their enjoyment in participation [12]. In the absence of goal requirements, self-quantification emphasizes the outcomes of participating in activities, highlights external benefits, and forms external incentive effects by tracking consumers' promotional green behaviors, such as kilometers of riding. It makes consumers pay too much attention to their performance rather than enjoying the activity itself, and they gradually feel that participation becomes mechanical, destroying the experience (i.e., of enjoying the activity and feeling satisfied) [43–45]. However, for consumers who have a specific goal requirement to participate in promotional green consumption activities, self-quantification enables them to learn their progress through quantitative data in the pursuit of goals, obtain certainty about their participation and achievements, and reduce their cognitive pressure [46]. Moreover, knowing their progress brings consumers a gamification experience, even enhancing their sense of enjoyment in activities and improving the participation experience [12].

In the process of participating in defensive green consumption activities, consumers with specific goal limitations tend to mentally track their performance, thus feeling psychological pressure [12]. Self-quantification and quantitative data feedback on the outcomes of defensive activities such as wasting electricity eliminate the need for psychological tracking of such consumers, thus reducing their psychological pressure and improving their experience [47]. Without goal limitations, self-quantification will stimulate consumers to reduce their participation in defensive green consumption activities. These consumers may need to give up some categories such as high energy consumption and high carbon emission, which will make them feel pressure, and their abandonment will be regarded as a loss, triggering negative emotions [36]. This will have a negative impact on the participation experience of consumers without goal limitations [48].

Hypothesis 3a. *Self-quantification will lead to a worse experience participating in promotional activities by consumers without goal requirements.*

Hypothesis 3b. *Self-quantification will lead to a better experience participating in promotional activities by consumers with goal requirements.*

Hypothesis 3c. *Self-quantification will lead to a worse experience participating in defensive activities by consumers without goal limitations.*

Hypothesis 3d. *Self-quantification will lead to a better experience participating in defensive activities by consumers with goal limitations.*

4. Experiment

4.1. Experimental Design of Promotional Activities

We invited subjects to participate in a carbon emission reduction activity and provided them with various types of projects to choose from, including high-intensity and low-intensity activities (as depicted in Table 1, low-intensity activities include using an electric fan less for 5 h, and high-intensity activities include using an air-conditioner less for 5 h). The subjects answered several questions after participating in the activity. In all, 100 students at a university in Jiangxi Province from 87 cities were recruited as subjects (average age 19.03 years; 47.00% male). The experiment was designed as 2 (goal setting: yes/no) × 2 (self-quantification: yes/no). The subjects were randomly and averagely assigned to 4 groups.

Table 1. List of emission reduction activities.

Low-Intensity Project	Carbon Emission Reduction Value	High-Intensity Project	Carbon Emission Reduction Value
Use mobile phone less for 5 h	0.02 kg CO_2	Use computer less for 5 h	0.26 kg CO_2
Use electric fan less for 5 h	0.2 kg CO_2	Use air-conditioner less for 5 h	3.1 kg CO_2
Travel by bus for 5 km	0.5 kg CO_2	Travel by bike for 5 km	1.0 kg CO_2
Recycle a shopping bag 5 times	0.05 kg CO_2	Recycle a plastic bottle 5 times	0.2 kg CO_2
Use table lamp less for 5 h	0.04 kg CO_2	Use ceiling lamp less for 5 h	0.12 kg CO_2
Raise a green plant for 5 days	2.5 kg CO_2	Raise a pot of green plants for 5 days	5.5 kg CO_2
Use 2 pairs of disposable chopsticks less	0.02 kg CO_2	Use 2 disposable lunch boxes less	1.7 kg CO_2

Data source: Online carbon tracking and emission calculator, China.

Before participating in the activity, subjects used a computer in the laboratory for nonrepetitive and free selection (up to 7 items; incomplete selection was allowed) from a list of 7 pairs of emission reduction projects through an interface. Each pair in the list included 2 categories, high-intensity and low-intensity projects, to choose from (see Table 1 for details). According to the list of categories, CO_2 could be reduced by 11.88 kg (3.33 kg) if 7 high-intensity (low-intensity) projects were fully selected, so the target emission reduction of subjects with goal requirements was set as 7.61 kg CO_2 (average value if both projects were fully selected). The subjects were told to complete the selected projects within 1 week, and only after verification could they obtain the rewards. If the final emission reduction of subjects with goal requirements was less than 7.61 kg CO_2, they needed to do 10 extra exercises in advanced mathematical operation, but this did not affect the rewards. In addition, 20 graduate students invited to conduct a pretest were all wrong in estimating the total emission reduction of their chosen projects and uncertain about the estimated emission reduction. The list of emission reduction activities was confirmed with these graduate students.

We designed 2 self-quantification situations. For one, in the process of selecting an activity category, each time a subject clicked to select a project, the pop-up window displayed the emission reduction value, which dynamically accumulated as the number of categories selected increased. The pop-up window showed "You will reduce XX kg CO_2 emission in this emission reduction activity." We asked the subjects to pay attention to the information of the pop-up window for each item they chose. For participants classified as low self-quantification, for each item chosen, the pop-up window displayed its name, and we asked them to pay attention to the pop-up information every time they chose a project.

According to the selected activity categories, we learned the final emission reduction for each subject through computer records, as well as the number of high- and low-intensity projects in all selected categories. Based on the experimental situation and the measurement method of perceived certainty of Ülkümen (2008) [48], the subjects were asked to write down their estimated emission reduction value after completing the selected projects, and report their degree of confidence in having no deviation between their written value and the actual value (1 = very unconfident, 5 = very confident). Based on Etkin's (2016) measurement method of outcome salience [12], the subjects reported the extent to which they felt emission reduction was highlighted during the selection of activity categories ("During the selection of activity categories, your overall emission reduction is always highlighted (in mind)": 1 = totally disagree, 5 = totally agree). According to Etkin's (2016) measurement method of perceived enjoyment [12], we asked the subjects to report their perceived enjoyment in the process of activity participation at the end ("The degree of enjoyment you feel in the process of activity participation": 1 = very low, 5 = very high). Based on the measurement method of Menon and Kahn (2002) for participation experience [45], the subjects reported their experience of participating in emission reduction activities ("You are satisfied with this emission reduction experience"; "You enjoy participating in this emission reduction activity"; "You are generally satisfied in the process of emission reduction": 1 = totally disagree, 5 = totally agree).

In addition, considering that relevant factors might interfere with the subjects' selection of activity categories and participation performance [18], they reported their environmental protection awareness ("It is beneficial to environmental protection to participate in emission reduction activities"), their initial preference for the activity ("How much did you like emission reduction activities before participating in this activity"), perceived importance ("It's very important for you to participate in this activity"), and perceived difficulty ("It's very difficult for you to participate in this activity") by 5-point Likert scales. We stressed that there was no right or wrong answer to the test items or questions involved in this experiment, and the subjects only needed to answer truthfully and independently.

4.2. Experimental Results of Promotional Activities

4.2.1. Activity Participation Performance

There was no significant difference between male and female participants in each group in their understanding of goal setting and self-quantification, so the data of both were integrated for data processing and statistical analysis. All subjects recognized that all categories of activities in Table 1 are carbon emission reduction activities and participating in these activities can improve environmental protection. Analysis of variance (ANOVA) shows that, for subjects without goal requirements, the emission reduction of those using self-quantification is higher ($F(1, 48) = 15.20$, $p < 0.001$), thus H1a is supported. Consistent with hypothesis H1b, the emission reduction of subjects with goal requirements is lower with self-quantification ($F(1, 48) = 45.80$, $p < 0.001$), and meets (but does not substantially exceed) the goal requirement (close to 7.61 kg CO_2). In addition, there are no significant differences in environmental awareness ($F(1, 98) = 0.76$, $p > 0.05$), initial preference ($F(1, 98) = 1.50$, $p > 0.05$), perceived importance ($F(1, 98) = 0.34$, $p > 0.05$), or perceived difficulty ($F(1, 98) = 0.16$, $p > 0.05$). Therefore, the effect of these factors on performance is excluded (see Figure 2 for details).

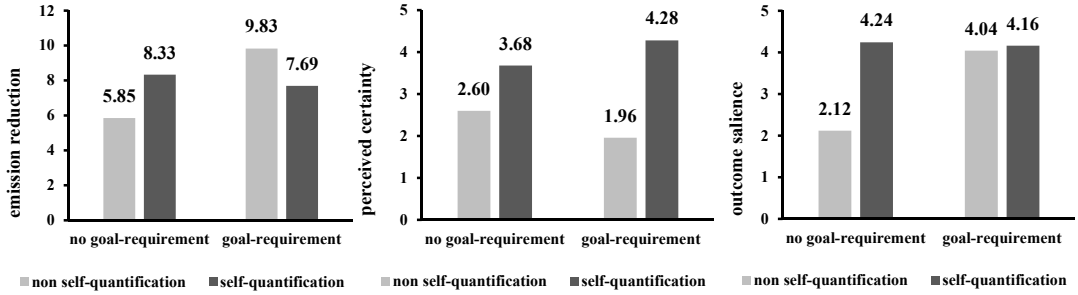


Figure 2. Influence of self-quantification on (**a**) participation performance, (**b**) perceived certainty, and (**c**) outcome salience in promotional green activities.

4.2.2. Perceived Certainty and Outcome Salience

Consistent with expectations, self-quantification enhanced subjects' perceived certainty, but the extent of enhancement of those with goal requirements ($F(1, 48) = 161.47$, $p < 0.001$) is relatively higher compared to those without goal-requirements ($F(1, 48) = 32.64$, $p < 0.001$). In addition, self-quantification significantly enhances the outcome salience of subjects without goal requirements ($F(1, 48) = 62.42$, $p < 0.001$), but does not affect that of subjects with goal requirements ($F(1, 48) = 0.24$, $p > 0.05$). Through regression analysis, the estimated deviation (C: actual participation performance—estimated participation performance) of the subjects is taken as the control variable. The results show that the activity participation performance of subjects with goal requirements decreases with increased perceived certainty ($\beta = -0.97$, $t(48) = -10.68$, $p < 0.001$), but that of subjects without goal requirements is not affected by perceived certainty ($\beta = 0.77$, $t(48) = 1.86$, $p > 0.05$). The participation performance of subjects with goal requirements is not affected by outcome salience ($\beta = 0.15$, $t(48) = 0.59$, $p > 0.05$),

but that of subjects without goal requirement increases with increased outcome salience (β = 1.58, t (48) = 12.97, $p < 0.01$) (see Figure 2 for details).

4.2.3. Mediating Effect of Perceived Certainty and Outcome Salience

Referring to the analysis procedure of Zhao et al. (2010) [49], and using the bootstrap test method recommended by Preacher et al. (2007) to test the mediating effect of perceived certainty and outcome salience [50], we selected model 8, set the sample size to 5000, and used nonparametric percentile sampling of bias correction to test the mediating effect. The results of bootstrap analysis confirm that the influence of self-quantification on the participation performance of subjects with goal requirements is mediated by perceived certainty, and the indirect effect of self-quantification is significant (mean bootstrap estimate = −2.65, SE = 0.53; 95% CI = −3.68, −1.57, excluding 0). For subjects without goal requirements, the indirect effect of self-quantification is not significant (mean bootstrap estimate = −0.28, SE = 0.58; 95% CI = −1.39, 0.92, including 0), and perceived certainty does not play a mediating role; however, the effect of self-quantification is mediated by outcome salience. The indirect effect of self-quantification is significant (mean bootstrap estimate = 4.49, SE = 0.66; 95% CI = 3.22, 5.83, excluding 0). For subjects with goal requirements, the indirect effect of self-quantification is not significant (mean bootstrap estimate = 0.03, SE = 0.08; 95% CI = −0.06, 0.31, including 0), and outcome salience does not play a mediating role.

4.2.4. Selection of Activity Categories

For subjects without goal requirements and with self-quantification, the proportion of high-intensity emission reduction categories selected increases from 44.72% to 64.20% (F (1, 48) = 19.17, $p < 0.001$), supporting H2a. For subjects with goal requirements and self-quantification, the proportion of high-intensity emission reduction categories selected decreases from 87.68% to 60.68% (f (1, 48) = 82.27, $p < 0.001$), supporting H2b (see Figure 3 for details).

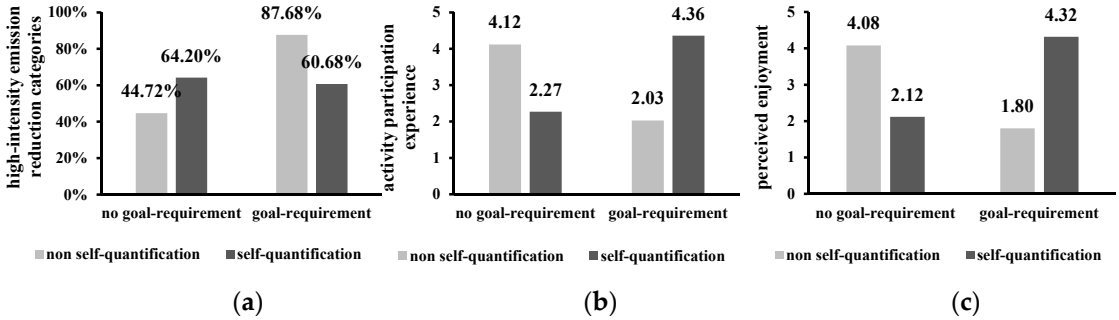


Figure 3. Influence of self-quantification on (**a**) selection of high-intensity emission reduction categories, (**b**) participation experience, and (**c**) perceived enjoyment in promotional green activities.

4.2.5. Activity Participation Experience

Cronbach's α value of activity participation experience is 0.96. Participants without goal requirements have worse participation experience with self-quantification (F (1, 48) = 81.45, $p < 0.001$), supporting H3a. Consistent with H3b, participants with goal requirements and self-quantification have better participation experience (F (1, 48) = 145.72, $p < 0.001$). Subjects without goal requirements and with self-quantification report lower perceived enjoyment (F (1, 48) = 87.05, $p < 0.001$) when participating in promotional activities. Subjects with goal requirements and self-quantification report higher perceived enjoyment (F (1, 48) = 149.77, $p < 0.001$) when participating in promotional activities. Analysis confirms that the mediating effect of perceived enjoyment is 4.08 and the confidence interval is (3.52, 4.69), excluding 0, showing that perceived enjoyment plays a mediating role in the influence of goal setting and self-quantification on consumers' participation experience (see Figure 3 for details).

After study 1, in order to test the robustness of the research results, we conducted study 2 to expand the participant groups from young students to other ages and invited subjects to participate in self-quantification activities in the real environment, so as to further verify the research hypotheses.

4.3. Additional Experiment of Promotional Activities

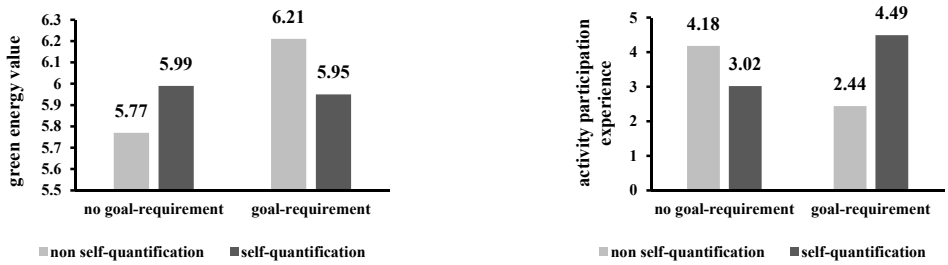
We invited 60 teachers of different majors at a university in Jiangxi Province to participate in some green consumption activities (average age 34.72 years; 46.67% male). They were asked to do these in their own everyday lives. The experiment was designed as 2 (goal setting: yes/no) × 2 (self-quantification: yes/no). Subjects were randomly and averagely assigned to 4 groups. All subjects were asked to participate in a series of green consumption activities freely and without repeating (as depicted in Table 2, activities include doing office work online and traveling by bus). Every activity was recorded on Alipay (an app with many functions, including payment, social networking, appointments, etc.). Subjects with self-quantification, after recording an activity, entered the Ant Forest interface (an interactive platform where carbon emission reduction is calculated as virtual "green energy") to obtain and view certain green energy values (for example, 52 g energy value can be obtained by recording a subway trip, and the value accumulates with additional activities), and the final energy value is fed back to researchers at the end. Other subjects were told that their activities would be converted into corresponding green energy values, but they only needed to record the activities and enter Ant Forest at the end to view and feed back the final values to researchers. They were asked not to view the energy value obtained while participating in each activity in real time. Subjects with goal requirements were told that the final green energy value could not be lower than 370 g (average value obtained by participating in all activities), otherwise they had to spend an extra half-hour watching a video about environmental protection. Subjects without goal requirements participated in activities freely. Subjects were told that the rewards had nothing to do with the number of activities they participated in and the green energy value, and they needed to strictly abide by the researchers' rules. After submitting the final energy value, subjects also reported their participation experience.

Table 2. List of green consumption activities.

Item	Green Energy Value	Item	Green Energy Value
Travel by bus	80 g	Travel by subway	52 g
Travel by shared bike	54 g	Do office work online	51 g
Make online payment	5 g	Decline cutlery for takeout	16 g
Shop without plastic bag	21 g	Use paperless reading	150 g
Use electronic invoice	5 g	Use scan code to order	7 g
Recycle carton	37 g	Top up life service online	262 g

Data source: Ant Forest platform of Alipay.

Natural logarithm (LN) transformation of green energy value was carried out to stabilize the non-normal distribution of data. The experimental results show that the green energy value of subjects without goal requirements is higher ($F(1, 28) = 6.00$, $p < 0.05$) and their participation experience is worse ($F(1, 28) = 199.24$, $p < 0.001$) with self-quantification. For subjects with goal requirements, the green energy value is lower ($F(1, 28) = 22.31$, $p < 0.001$) with self-quantification, but reaches (but basically does not exceed) the goal requirement (close to 370 g). In addition, they have better participation experience with self-quantification ($F(1, 28) = 167.84$, $p < 0.001$) (see Figure 4 for details). These findings provide further support for H1a, H1b, H3a, and H3b.



(**a**) (**b**)

Figure 4. Influence of self-quantification on (**a**) green energy value and (**b**) participation experience in green consumption activities.

After testing the impact of self-quantification on promotional activities, we continued to test whether there were differences in the impact on activity participation and behavioral decision-making with different goals set in defensive activities.

4.4. Experimental Design of Defensive Activities

We invited the subjects to participate in a food procurement activity, and provided them with a variety of foods to choose from, including high and low carbon emission foods (as depicted in Table 3, low carbon emission foods include 500 g chicken, and high carbon emission foods include 500 g pork). Subjects answered several questions after shopping. In all, 100 students at a university in Tianjin City from 82 cities were recruited as subjects (average age 19.86 years; 44.00% male; without special dietary beliefs). The experiment was designed as 2 (goal setting: yes/no) × 2 (self-quantification: yes/no). The subjects were randomly and averagely assigned to 4 groups.

Table 3. List of food categories.

High-Intensity Food	Carbon Emission Value	Low-Intensity Food	Carbon Emission Value
500 g mutton	19.6 kg CO_2	500 g beef	13.5 kg CO_2
500 g pork	6.1 kg CO_2	500 g chicken	1.9 kg CO_2
500 g egg	2.4 kg CO_2	500 g tofu	1.0 kg CO_2
500 mL beverage	2.1 kg CO_2	500 mL yogurt	1.1 kg CO_2
500 g nuts	1.3 kg CO_2	500 g fruit	0.6 kg CO_2
500 g mushrooms	1.5 kg CO_2	500 g vegetable	0.5 kg CO_2
500 g shrimp or crab	4.7 kg CO_2	500 g fish	1.8 kg CO_2

Data source: Online carbon tracking and emission calculator, China.

Before participating in the activity, subjects used a computer in the laboratory to make a nonrepetitive and free selection (up to 7 items; incomplete selection was allowed) from a list of 7 pairs of foods through the interface. Each pair included 2 categories of high and low carbon emission foods to choose from (see Table 3 for details). According to the list of categories, 37.70 kg (20.40 kg) CO_2 could be emitted if 7 high (low) carbon emission food items were fully selected. The maximum carbon emission of subjects with goal limitations was set as 25.55 kg CO_2 (average value of both items fully selected). Subjects were told that they would get the foods they chose as the reward, and according to the principle of saving, they were allowed to not choose all categories. For subjects with goal limitations, if the final carbon emission of the selected foods was higher than 25.55 kg CO_2, only the one with the lowest carbon emission could be obtained as the reward. This means that excessive carbon emission would lead to lower experimental rewards, so they were aware of the goal limitation when participating in the activity. In addition, 20 graduate students invited to conduct a pretest were all wrong in estimating the total carbon emission value of their chosen foods and uncertain about the estimated carbon emission value. The list of foods was confirmed with these graduate students.

We designed 2 self-quantification situations. For one, in the process of selecting a food category, each time subjects using self-quantification clicked to select a food, the pop-up window displayed the carbon emission, which dynamically accumulated as the number of foods selected increased. The pop-up window showed "Your carbon emission in this shopping activity is XX kg CO_2." We asked the subjects to pay attention to the information prompted by the pop-up window for each food they chose. For subjects classified as low self-quantification, for each chosen food, the pop-up window displayed its name. We asked the subjects to pay attention to the information prompted by the pop-up window.

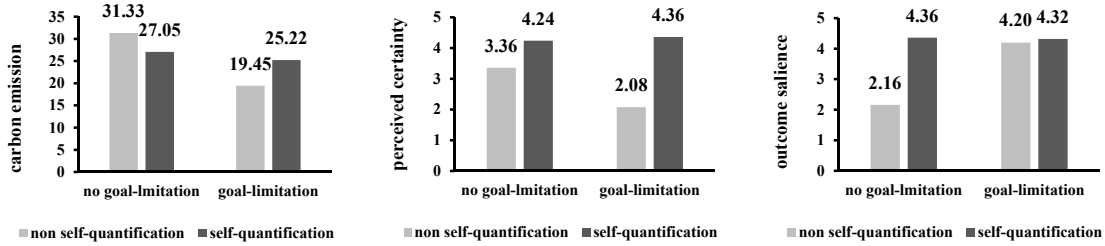
According to the food categories selected by the subjects, we learned their final carbon emissions through computer records, as well as the proportion of high and low carbon emission foods in all selected categories. Combining the experimental situation with the measurement method of perceived certainty of Ülkümen (2008) [48], we asked the subjects to write down their estimated carbon emissions after selecting the food categories, and report their degree of confidence in having no deviation between the written and actual carbon emissions (1 = very unconfident, 5 = very confident). Based on Etkin's (2016) measurement method of outcome salience [12], the subjects reported the extent to which they felt carbon emission was highlighted in the selection process ("In the process of selecting food categories, your overall carbon emissions are always highlighted (in mind)": 1 = totally disagree, 5 = totally agree). Combining the experimental situation with the measurement method of Van Ittersum et al. (2010) for psychological pressure [27], we asked the subjects to report their psychological pressure in the process of participating at the end ("The degree of pressure you feel in the process of activity participation": 1 = very low, 5 = very high). Based on the measurement method of Menon and Kahn (2002) for participation experience [45], the subjects reported their experience with the process of selecting foods ("You are satisfied with the food selection experience"; "You enjoy the food selection activity"; "You are generally satisfied with the food selection process": 1 = totally disagree, 5 = totally agree).

In addition, considering that relevant factors might interfere with their choice of food categories and participation performance [18], we had the subjects report their awareness of environmental protection ("Choosing high carbon emission food is not conducive to environmental protection"), initial preference for activities ("How much did you like high carbon emission food before participating in this activity"), perceived importance ("It's very important for you to participate in this activity"), and perceived difficulty ("It's very difficult for you to participate in this activity") by 5-point Likert scales. We stressed that there was no right or wrong answer to the test items or questions involved in this experiment, and the subjects only needed to answer truthfully and independently.

4.5. Experimental Results of Defensive Activities

4.5.1. Activity Participation Performance

There was no significant difference between male and female participants in each group in their understanding of goal setting and self-quantification, so the data of both were integrated for data processing and statistical analysis. All subjects admitted that food intake will bring carbon emissions, and participating in activities that produce carbon emissions will cause a certain degree of environmental damage. Analysis of variance (ANOVA) shows that, for subjects without goal limitations, the carbon emission of those with self-quantification is lower ($F(1, 48) = 35.07$, $p < 0.001$), supporting H1c. Consistent with hypothesis H1d, the carbon emission of subjects with goal limitations and self-quantification is higher ($F(1, 48) = 38.74$, $p < 0.001$), but does not exceed the goal limitation (close to 25.55 kg CO_2). In addition, there are no significant differences in environmental awareness ($F(1, 98) = 0.02$, $p < 0.05$), initial preference ($F(1, 98) = 0.19$, $p > 0.05$), perceived importance ($F(1, 98) = 0.77$, $p > 0.05$), or perceived difficulty ($F(1, 98) = 0.25$, $p > 0.05$). Therefore, the effect of these factors on performance is excluded (see Figure 5 for details).



(**a**) (**b**) (**c**)

Figure 5. Influence of self-quantification on (**a**) participation performance, (**b**) perceived certainty, and (**c**) outcome salience in defensive green activities.

4.5.2. Perceived Certainty and Outcome Salience

Consistent with expectations, self-quantification enhances subjects' perceived certainty, but the extent of enhancement of subjects with goal limitations ($F(1, 48) = 105.37$, $p < 0.001$) is significantly higher compared to those without goal limitations ($F(1, 48) = 17.65$, $p < 0.001$). In addition, self-quantification significantly enhances the outcome salience of subjects without goal limitations ($F(1, 48) = 99.73$, $p < 0.001$), but does not affect that of subjects with goal limitations ($F(1, 48) = 0.56$, $p > 0.05$). Through regression analysis, the estimated deviation (C: Actual participation performance—estimated participation performance) of subjects is taken as the control variable. The results show that participation performance of subjects with goal limitations increases with increased perceived certainty ($\beta = 2.64$, $t(48) = 10.72$, $p < 0.001$), but the performance of subjects without goal limitations is not affected by perceived certainty ($\beta = -0.73$, $t(48) = -1.33$, $p > 0.05$). The performance of subjects with goal limitations is not affected by outcome salience ($\beta = 1.35$, $t(48) = 1.23$, $p > 0.05$), but that of subjects without goal limitations decreases with increased outcome salience ($\beta = -2.23$, $t(48) = -14.70$, $p < 0.001$) (see Figure 5 for details).

4.5.3. Mediating Effect of Perceived Certainty and Outcome Salience

We referred to the analysis of Zhao et al. (2010) [49] and used the bootstrap method recommended by Preacher et al. (2007) to test the mediating effect of perceived certainty and outcome salience [50]. We selected model 8, set the sample size to 5000, and used the nonparametric percentile sampling method of bias correction to test the mediating effect. The results of bootstrap analysis confirm that the influence of self-quantification on the participation performance of subjects with goal limitations is mediated by perceived certainty, and the indirect effect of self-quantification is significant (mean bootstrap estimate = 6.55, SE = 1.49; 95% CI = 4.02, 9.87, excluding 0). For subjects without goal limitations, the indirect effect of self-quantification is not significant (mean bootstrap estimate = 0.69, SE = 0.46; 95% CI = −0.07, 1.79, including 0), and perceived certainty does not play a mediating role. However, the effect of self-quantification on the performance of subjects without goal limitations is mediated by outcome salience. The indirect effect of self-quantification is significant (mean bootstrap estimate = −6.18, SE = 0.98; 95% CI = −8.42, −4.50, excluding 0). For subjects with goal limitations, the indirect effect of self-quantification is not significant (mean bootstrap estimate = 0.09, SE = 0.21; 95% CI = −0.10, 0.91, including 0), and outcome salience does not play a mediating role.

4.5.4. Selection of Activity Categories

For subjects without goal limitations, the proportion using self-quantification who selected high-intensity carbon emission categories decreased from 72.40% to 43.96% ($F(1, 48) = 78.39$, $p < 0.001$), supporting H2c. For subjects with goal limitations, the proportion using self-quantification who selected high-intensity carbon emission categories increased from 34.48% to 65.36% ($F(1, 48) = 64.84$, $p < 0.001$), supporting H2d (see Figure 6 for details).

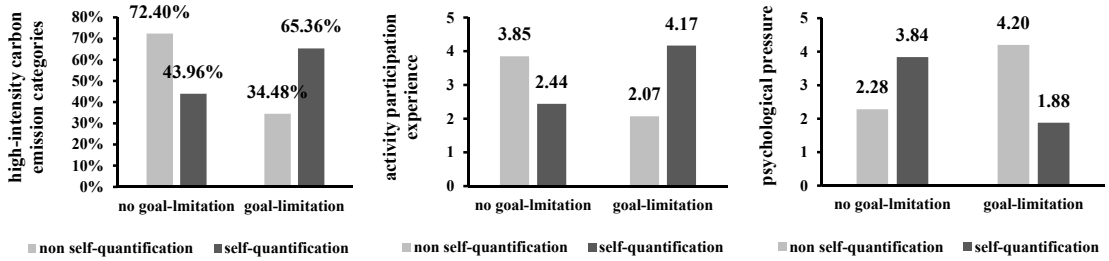


Figure 6. Influence of self-quantification on (**a**) selection of high-intensity carbon emission categories, (**b**) participation experience, and (**c**) psychological pressure in defensive green activities.

4.5.5. Activity Participation Experience

Cronbach's α value of activity participation experience is 0.95. Participants without goal-limitations had worse participation experience with self-quantification ($F(1, 48) = 47.39$, $p < 0.001$), supporting H3c. Consistent with H3d, participants with goal-limitations and self-quantification had a better participation experience ($F(1, 48) = 155.38$, $p < 0.001$). Subjects without goal-limitations and with self-quantification reported higher psychological pressure ($F(1, 48) = 42.45$, $p < 0.001$) when participating in defensive activities. Subjects with goal limitations and self-quantification reported lower psychological pressure ($F(1, 48) = 142.64$, $p < 0.001$) when participating in defensive activities. Analysis results confirm that the mediating effect of psychological pressure is 3.22 and the confidence interval is (2.72, 3.71), excluding 0. This shows that psychological pressure plays a mediating role in the influence of goal setting and self-quantification on consumers' participation experience (see Figure 6 for details).

After study 3, in order to test the robustness of the research results, we conducted study 4 to expand the participant groups from young students to other ages and invited subjects to participate in self-quantification activities in the real environment, so as to further verify the research hypotheses.

4.6. Additional Experiment of Defensive Activities

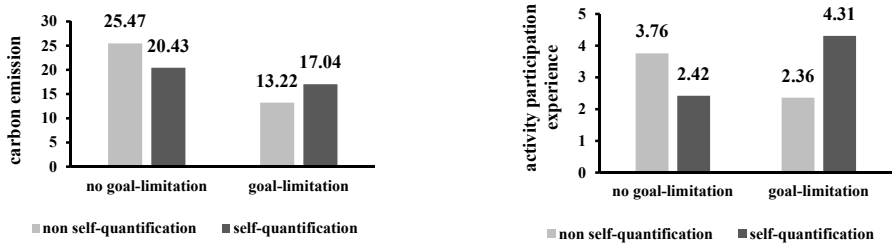
In cooperation with a local supermarket in Jiangxi Province, a supermarket guide invited 60 customers without special dietary beliefs (average age 35.58 years; 36.67% male) to simulate a discount shopping trip. The experiment was designed as 2 (goal setting: yes/no) × 2 (self-quantification: yes/no). The subjects were randomly and averagely assigned to 4 groups. All subjects were told that the supermarket was running a 70% discount promotion for some fresh foods. The 60 lucky customers could freely purchase specified weights of foods at a discount according to the list (as depicted in Table 4, foods included 500 g pork and 500 g tomatoes). They were told that different foods had different levels of carbon emissions and environmental impact (e.g., meat has higher carbon emission), and they should choose rationally. For subjects using self-quantification, the foods on the list were marked with the corresponding carbon emissions. The subjects were asked to record and sum the carbon emissions with their mobile phones for the foods they chose, and inform the guide of the final value after purchase. Other subjects got a list displaying only the names of foods, and final carbon emissions were calculated through shopping receipts. Subjects with goal limitations were told that the total carbon emissions of purchased promotional foods could not be higher than 17.10 kg CO_2 (average carbon emissions of all promotional foods), otherwise they had to pay the original price. Subjects without goal limitations chose food freely. Participants also reported their experience after participating in the promotion activity.

Table 4. List of discounted fresh food.

Item	Carbon Emission	Item	Carbon Emission
500 g pork	6.1 kg CO_2	500 g beef	13.5 kg CO_2
500 g chicken	1.9 kg CO_2	500 g potatoes	1.4 kg CO_2
500 g peanuts	1.3 kg CO_2	500 g shrimp	4.7 kg CO_2
500 g mushrooms	1.5 kg CO_2	500 g oranges	0.6 kg CO_2
500 g tomatoes	0.6 kg CO_2	500 g broccoli	1.0 kg CO_2
500 g lentils	0.5 kg CO_2	500 g tofu	1.0 kg CO_2

Data source: Online carbon tracking and emission calculator, China.

The experimental results show that for subjects without goal limitations and with self-quantification, carbon emission is lower ($F(1,28) = 13.82$, $p < 0.01$) and the participation experience is worse ($F(1,28) = 84.28$, $p < 0.001$). For subjects with goal limitations and self-quantification, carbon emission is higher ($F(1, 28) = 20.74$, $p < 0.001$) but does not exceed the goal limitation (close to 17.10 kg CO_2). In addition, they have better participation experience ($F(1, 28) = 129.38$, $p < 0.001$) (see Figure 7 for details). These findings provide further support for H1c, H1d, H3c, and H3d.



(**a**) (**b**)

Figure 7. Influence of self-quantification on (**a**) carbon emissions and (**b**) participation experience in discount shopping trip.

5. Results

Research Conclusion

The results of four experiments focusing on how self-quantification affects the participation performance, activity category selection, and participation experience of consumers with or without goals in green consumption activities show the following:

- In terms of promotional activities, self-quantification reduces the participation performance of consumers with goal requirements on the premise of meeting their goals, and the perceived certainty obtained by self-quantification plays a mediating role. This kind of consumer will also choose high-intensity promotional categories less and have a better participation experience.
- Self-quantification will enhance the participation performance of consumers without goal requirements in the process of receiving quantitative data feedback, and the outcome salience obtained through self-quantification plays a mediating role. This kind of consumer will also choose high-intensity promotional categories more and have a worse participation experience.
- In terms of defensive activities, self-quantification enhances the participation performance of consumers with goal limitations on the premise of not violating their goal limitation, and the perceived certainty obtained through self-quantification plays a mediating role. This kind of consumer will also choose high-intensity defensive categories more and have a better participation experience.
- Self-quantification will reduce the participation performance of consumers without goal limitations in the process of receiving quantitative data feedback, and the outcome salience obtained through

self-quantification plays a mediating role. This kind of consumer will also choose high-intensity defensive categories less and have a worse participation experience.

6. Discussion

6.1. Theoretical Contribution

In contrast to qualitative methods, such as descriptive analysis and interviews used in previous research, this research is based on goal setting theory and uses experimental research to discuss and test the relevant issues. While clearly explaining the influencing mechanism of self-quantification in consumers' activity participation and behavioral decision-making in green consumption activities, goal setting theory is also enriched. The in-depth analysis of the influence and effect boundary of self-quantification brings a new perspective to understanding the existing goal setting theory.

According to the traditional goal setting theory, consumers with goals will pursue the maximization of utility when participating in activities. Psychological implications brought by goal requirements will stimulate consumers to enhance their efforts and participate in promotional activities or participate in defensive activities to the maximum extent without exceeding the goal limitations [26,51,52]. The psychological implication brought by goal requirements motivates consumers to participate in promotional activities, and the pursuit of maximum utility stimulates consumers with goal limitations to participate in defensive activities to the maximum extent. However, this research finds that consumers with goal requirements will participate in promotional activities more so that they will not fail to meet the goal requirements, and consumers with goal limitations will participate in defensive activities less to avoid breaking the goal limitations. It shows that when the progress toward goals is missing and consumers perceive uncertainty, loss aversion determines their behavioral decision-making to a greater extent than the pursuit of gain. Compared with the gain of meeting the goal requirement, the loss brought by failing to meet it will be more concerning, so consumers will work harder to participate in promotional activities so they do not fail to meet goal requirements. Compared with the gain of participating in defensive activities to the maximum extent under goal limitations, the loss suffered by breaking them will be more valued by consumers, and to minimize the risk of loss and participate in defensive activities far below the goal-limitation. The quantitative data feedback obtained by self-quantification will enhance the perceived certainty of consumers with goals, stimulating them to participate less in promotional activities under the premise of achieving goal requirements, and to participate more in defensive activities within the goal limitations.

The research results provide a theoretical basis for more accurate understanding and prediction of consumers' goal setting behavior in green consumption activities by making it clear that the perceived certainty brought by self-quantification provides more justification for consumers with goals to opportunistically participate in promotional activities and frivolously participate in defensive activities, and the outcome salience brought by self-quantification provides more stimulation for consumers without goals to actively participate in promotional activities and prudently participate in defensive activities. This study explains the decision-making change process of self-quantification guiding consumers' selection of activity categories. The relevant conclusions provide a theoretical basis for understanding the rules of behavioral decision-making in green consumption activities.

6.2. Managerial Implications

Self-quantification entails a new business model, and the market expects to optimize consumption and behavior in green activities by implementing it. Consumers are eager to learn the effectiveness and significance of their behavioral decision-making through self-quantification [8]. This study can provide enlightenment for enterprises to timely and appropriately drive consumers to participate in self-quantification, as well as scientifically design green consumption activities and promote relevant products. Specifically, enterprises should consider the following points when applying self-quantification in green consumption activities:

First, consumers' participation in green consumption activities is often a complex process that integrates self-quantification and goal setting, and the activities themselves are divided into two sides of promotion and defense. Therefore, before considering the application of self-quantification technology, enterprises should first clarify the types of activities, which is the premise of predicting the effectiveness of self-quantification and accurately using the technology. According to the utility orientation and possible influence of the activities that consumers participate in, enterprises should make clear whether they are promotional or defensive activities.

Second, referring to the research results, when enterprises provide self-quantification conditions for consumers who participate in promotional activities, such as tree planting, cycling, etc., and choose reusable products and other green consumption, in order to promote participation in such activities, they should try their best to weaken consumers' goal awareness and avoid setting specific goals for consumers. In addition, in promoting promotional products, enterprises should try to create self-quantification conditions for consumers without goals and recommend high-intensity promotional products to them, and regard such consumers as the main audience for high-intensity promotional products.

Third, referring to the research results, when enterprises provide self-quantification conditions for consumers who participate in defensive activities, such as consuming water and electricity and purchasing polluting products and other items, in order to reduce participation in such activities, they should try their best to weaken consumers' goal awareness and avoid setting specific goals for consumers. In addition, in promoting low energy consumption and low pollution products, enterprises should try to create self-quantification conditions for consumers without goals and recommend low-intensity defensive products to them, and regard such consumers as the main audience for low-intensity defensive products.

Fourth, although self-quantification can reduce the participation performance of consumers with goal requirements in promotional activities, their performance level can reach the goal requirement. Therefore, if enterprises advocate moderate participation in promotional green consumption, managers can raise consumers' awareness of goals and, on this basis, create self-quantification conditions for them. Although self-quantification can make consumers with goal limitations enhance their participation performance in defensive activities, their performance level will not break the goal limitation. So, if enterprises want to improve participation performance in such activities and enhance product revenue, but not against a particular limitation due to excessive participation in defensive activities so as to avoid negative consequences, managers can raise consumers' awareness of goals and, on this basis, create self-quantification conditions for them.

Fifth, while self-quantification brings positive effects, it will also reduce (enhance) the participation performance of consumers with goals in promotional (defensive) activities, and destroy the participation experience of consumers without goals. Therefore, while applying self-quantification technology, enterprises can consider other operation strategies such as advertising, customer loyalty plans, etc., and integrate gamification design into self-quantification activities, so as to reduce the negative effects to a certain extent and improve the participation experience of consumers without goals.

6.3. Research Limitations and Future Research Directions

First, the results of experimental tests confirm the relevant theories constructed in this research, but we only intercept the self-quantification phenomenon at a certain point in time for discussion. Since self-quantification is a long-term process, an analysis of its effects in short-term experiments may contain bias. In the future, we can try to use the method of in-depth experimentation to track the process of consumers' activity participation under the influence of self-quantification for a long period of time so as to get more accurate results.

Second, this study did not collect data from consumers in countries outside China to verify the research hypotheses, which may limit the universality of the research results to a certain extent. Results may vary across countries and sections of the population. The students randomly selected in our

experiments came from different cities in China, and their concepts of life and consumption are more or less different. Although data from subjects in different cities finally verified the research hypotheses, we should expand the survey sample to other countries and conduct comparative experiments to obtain more general research conclusions in the future.

Third, with the development of technology and online social platforms, it is inevitable for individuals with their own data to conduct self-comparison, share with others, and compare with standards. Self-quantification has increasingly shifted from an individual practice to a social practice [53]. Green consumption activities can occur not only in individual situations, but also in community situations. Consumers can quantify themselves not only in a private context in individual green consumption activities, but also in a public context in community activities [54]. The possible differential influence and the internal mechanism of self-quantification in public and private situations still lack in-depth discussion and verification.

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