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## Idea support method to make people aware of the side effects of convenience

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### Abstract

This study aimed to establish methods for supporting ideas that raise awareness of the side effects of convenience. Often, when conceptualizing artifacts and mechanisms, emphasis is placed on “making things convenient.” However, there is a concern that this emphasis may inadvertently give rise to new problems. This phenomenon arises when an optimum is reached, leading to what we term the “side effect of convenience.” It is imperative to not only consider the intended convenience of new ideas but also to focus on potential side effects. Our objective was to devise a method that facilitates thinking about ideas from a broader perspective. The proposed method aimed to heighten awareness of these side effects during the ideation process by focusing on the variable actions associated with ideas. For instance, transitioning from a book to an e-book would change the action of “turning the page” to “swiping.” This presents these changes in action as sentences designed to induce awareness of potential side effects. To evaluate the effectiveness of our method, we conducted an experiment involving participant engagement and analyzed the impact of presenting these awareness-inducing sentences. Our findings revealed that such presentations prompt participants to consider alternatives and contemplate ideas from different angles.

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### 1. Introduction

In our modern lives, we often have access to convenient technologies such as personal computers and smartphones, which play essential roles in supporting various cognitive and physical functions. Additionally, various artifacts, such as automobiles and computers, contribute to the functioning of our world. These artifacts undergo continuous identification and improvement processes to enhance people’s lives. This cyclic improvement stems from the ongoing

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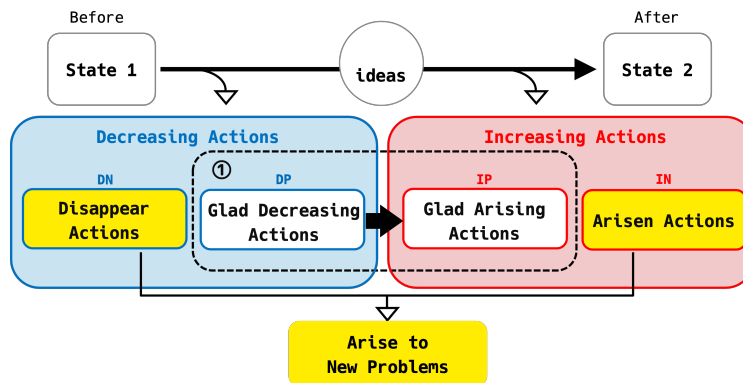


Fig. 1. Increase / decrease of actions by ideas

creation of human artifacts. However, when contemplating ideas related to artifacts and mechanisms, there tends to be an excessive focus on making things convenient. The primary emphasis is often placed on discussing “enhancing convenience,” which can lead to unexpected problems [1], particularly when aiming for optimization.

Consider the reported issue of “character amnesia” [2], where individuals can proficiently read characters but struggle to write them [3], particularly prevalent in countries with character-based languages, such as Chinese and Japanese. This phenomenon highlights the cognitive disuse atrophy [4] that arises as a side effect of such convenience, affecting various areas. These examples highlight the importance of considering the long-term consequences of convenience. While we often prioritize immediate convenience and efficiency in idea formulation, it is essential to evaluate the lasting influence that convenience may exert and integrate this consideration into our thinking process.

This study aims to address the challenges associated with introducing new ideas by shifting the focus to the side effects of innovation, rather than solely emphasizing the intended convenience. Our objective is to establish a method that supports idea generation from a broad perspective. To facilitate this, we introduce the concept of the “side effects of convenience” to guide our thinking process. However, this concept yields unexpected consequences, stemming from the realization of convenience through increased efficiency and functionality. Our goal is to identify and incorporate these side effects of convenience into the idea generation stage. Hence, we proposed an ideal support method for this purpose.

This method raises the following questions:

- Can we identify the influence of the side effects of convenience during the idea-generation stage?
- How can we incorporate this influence in the conception of the idea?

## 2. Variable actions by convenience

To understand the side effects of convenience, it is important to examine how convenience is established. When introducing new ideas, the goal is often to eliminate actions associated with inconvenience while introducing new actions that enhance convenience. For instance, using a broom requires time and effort, which is solved by introducing a vacuum cleaner. The vacuum cleaner introduces the idea of a vacuum mechanism (a mechanism in which a motor spins a fan at a high speed to suck air). This change eliminates the need for using a broom and a dustpan and introduces new actions related to the use of a vacuum cleaner. This change reduces human effort, ultimately making convenience possible.

In addition, the effects of convenience should be understood. The major effect is the reduction of time and effort required to achieve goals, resulting in greater convenience. However, there are also adverse effects that arise from these changes. Figure 1 illustrates the factors that may cause these problems. When brainstorming ideas, we intentionally eliminate actions associated with inconvenience (DP; Decrease Positive) and introduce actions necessary for convenience (IP; Increase Positive). In other words, it means changing from “glad decreasing actions” (DP) in decreasing

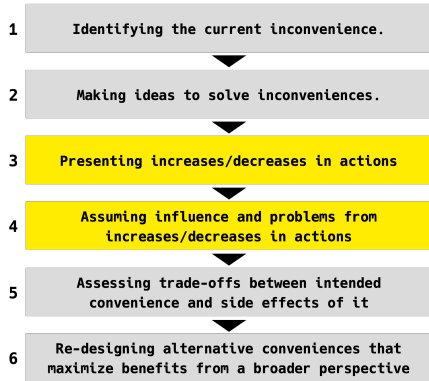


Fig. 2. Process for considering new conveniences

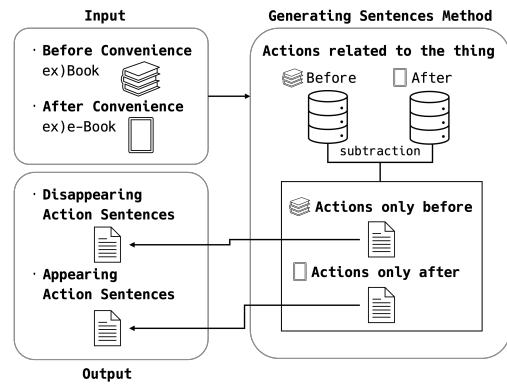


Fig. 3. Flow of Generating Sentences Method

Table 1. actions related to the things (e.g. books and e-books)

Prompts	Book	e-book
(i) A series of actions	Select from the bookshelf, Turn the page	Launch the application, Download e-books
(ii) Used simultaneously	Put a bookmark on, Take notes with a pen	Read while charging, Take notes with note-taking app
(iii) plaything	Topple dominoes, Build towers	Change font, Choose a book at random
(iv) Unconsciously	Smell the book, Read by pointing	Pinch, Adjust brightness
(v) Miss or accident	Skip page, Break page	Freeze, Power off
(vi) Relationship	Borrow and lend books, Gift books	Write a review, Share a recommendation link

actions (DA) to “glad arising actions” (IP) in increasing actions (IA). However, unintentional consequences, such as unintended disappearing actions (DN; Decrease Negative) or unintended emerging problems (IN; increase negative), can arise. For instance, the decreased use of the broom may lead to the loss of playful activity such as flying like a wizard. Similarly, while using a vacuum cleaner may increase convenience, the hassle of cleaning its filter emerges. The relational expressions are as follows:

$$DP, DN \in DA \tag{1}$$

$$IP, IN \in IA \tag{2}$$

Since the presence of DN and IN may lead to unforeseen problems, illustrating a side effect of convenience, the challenge lies in identifying these side effects during the idea-generation stage. Typically, when creating new conveniences, the focus is primarily on the intended actions–increases or decreases (DP, IP) (see Fig. 1–①). Unintended consequences, such as DN and IN, are often overlooked. This oversight may stem from confirmation bias [5], whereby idea thinkers may underestimate the problems arising from variable actions, leading them to overestimate the effect of intended convenience. We considered methods to identify the influence of side effects from the idea generation stage and integrated them into our ideas. It is desirable to consider ideas from a comprehensive viewpoint to eliminate bias and mitigate side effects when realizing convenience. It is necessary to consider the influence of unintentional increases/decreases (DN, IN) on idea formulation for new convenience. We aim to establish a method for identifying and incorporating these influences into our ideas.

### 3. Awareness of side effects method

In this section, we described the proposed idea support method. This methodology for idea generation diverges from solely pursuing immediate convenience by focusing on things before they become convenient. Subsequently, we reaffirmed the benefits brought about by pre-convenience. Finally, we attempted to exploit the benefits of idea generation, such as creating artifacts [6].

Table 2. generate the variable actions (e.g. books and e–books)

	Book	e-book
(i)	Fold the page corners, Turn the page	Adjust screen brightness, Use the voice reading function
(ii)	Read at night with reading lamps, Read with a book cover	Read on smartphone while outside, Listen to audiobooks with headphones
(iii)	Make dominoes, Stack books to make a tower	Games with e-book apps, Take and share screenshots
(iv)	Fold page corners, Lose the bookmark	Tap the screen to proceed to the next page, Unintentional text scaling
(v)	Tear out the pages, Spill the liquid	Failure to download e-book, Reading interrupted by dead battery
(vi)	Recommend a book to a friend, Lend and borrow books	Join online reading groups, Exchange reading feedback on social media

This methodology introduced inconveniences to previously convenient things. We approached the thinking of ideas from their inception, which is different from handling the problems that have arisen since they became convenient. The goal was to be aware of the problems that could have been prevented if not all of them. Therefore, there is a need to understand problems that arise prior to convenience. To address this, it is crucial to identify the influence of idea introduction. We identified the problems arising from the identification of these influences.

This aimed to induce awareness of the side effects of convenience during idea generation. This method supports the following hypotheses:

- Identifying “Disappear Actions” (DN) and “Arise Actions” (IN) from variable actions due to convenience.
- Considering the influence of DN/IN.

The process of thinking about conveniences is illustrated in Fig. 2, which is necessary for fostering awareness of these side effects during idea generation. The flow of this process is as follows:

1. Presenting current challenges.
2. Considering solutions to these challenges.
3. Reflecting on the adverse effects of proposed solutions.
4. Evaluating the trade-off between side effects and intended convenience.
5. Formulating ideas that incorporate side effects.

The final process involved thinking of ideas that included the side effects (Process 6). However, the side effects were challenging to consider when variable actions could not be imagined. Therefore, this method added an additional process called “Process 3”, which presents variable actions (i.e., increases/decreases). Subsequently, the user identified “Disappear Actions” and “Arise Actions” from the presentation (Process 4), aiming to induce awareness of side effects. This method categorizes actions as “Disappearing Action Sentences” (DA: DP, DN) and “Appearing Action Sentences” (IA: IP, IN) to facilitate the discovery of unintended variable actions (DN, IN). The flow of this process is converted into questions, guiding the user through the idea generation process and visualizing their thought process. This visualization supports the awareness of unconscious and forgotten thoughts due to confirmation bias.

#### 4. Generating sentences method

This chapter described the method for generating sentences (i.e., variable actions) presented in the proposed mechanism. ChatGPT was used [7] as an estimation method for variable actions. Initially, ChatGPT was utilized to list actions associated with an object both before and after convenience. Subsequently, variable actions were estimated and generated by analyzing the differences between these actions using ChatGPT. The web version of ChatGPT was used for this purpose. Since the aim of this paper is to examine the impact of presenting variable actions on awareness of the side effects of convenience, sentences must be generated. ChatGPT is a model learned from a large number of past documents, so it would be difficult to generate sentences about the target objects if they did not exist in real.

##### 4.1. Generating actions related to objects

We use three items to output actions related to objects: (1) A series of actions performed when the object is used, (2) Executable actions involving the object, and (3) Scenes in which the object is used. These items are used to extract

Table 3. ChatGPT output examples; answers obtained by crowdsourcing, their Cosine similarity, and the average of the Top 10 Cosine similarity for each sentence (e.g., maps and e-maps).

	ChatGPT	Crowdsourced	sim	Ave
(i)	Pull out a map	Pull out a map Borrow a map	1.00 0.89	0.71
(ii)	Use a compass for direction	Use a compass to check direction put one's compass to the map	0.94 0.86	0.55
(iii)	Fold maps into origami or paper airplanes	Fold the map and make a paper airplane Origami with map	0.89 0.88	0.63
(iv)	Speak while tracing a route with your finger	Trace with a finger Trace the route to take with your finger	0.80 0.76	0.66
(v)	Tearing paper when folding a map	Accidentally tearing up a map Tears as the map is unfolded	0.82 0.80	0.66
(vi)	Point to each other's homes and meeting places	Explain location of your home on a map Share maps and make travel plans	0.71 0.61	0.59

(1) Actions that are performed unconsciously before and after a series of actions involving the object, (2) Actions that are possible due to the nature of the object [8], or actions that are performed simultaneously with the object, and (3) Actions other than those in the ordinary use of the object.

Prompts were inputted into ChatGPT to generate sentences meeting the above elements, and the output sentences were treated as actions related to the object.

The prompts included:

- (i) A series of actions in using the object
- (ii) Actions used simultaneously with the object
- (iii) Actions unrelated to the object's original purpose
- (iv) Unconsciously performed actions
- (v) Actions resulting from mistakes or accidents
- (vi) Actions occurring in relationships with others

Table 1 lists examples obtained from the output.

#### 4.2. Presumption of Increase / Decrease in Actions

Variable actions before and after convenience were estimated using ChatGPT by comparing the output sentences from section 4.1. Figure 3 illustrates the flow of sentence generation using these processes. The output is a variable action for convenience.

- A prompt was entered into ChatGPT to measure the differences between actions, resulting in Actions performed only before convenience categorized as “Disappearing Action Sentences”
- Actions performed only after convenience categorized as “Appearing Action Sentences”

The prompt used was: “Output the actions that are only performed before or after the convenience, considering the actions related to the object.”

Table 2 lists examples obtained from this output.

#### 4.3. Validation of outputs

We conducted validation of the ChatGPT outputs through crowdsourcing on Yahoo! <sup>1</sup>. Two experiments were conducted to verify the validity of the outputs:

<sup>1</sup> [https://crowdsourcing.yahoo.co.jp/\(2024/4/24\)](https://crowdsourcing.yahoo.co.jp/(2024/4/24))

Table 4. Percentage of correct answers for output per question

Question	before:ave	after:ave
(i) A series of actions	0.575	0.695
(ii) Used simultaneously	0.540	0.605
(iii) plaything	0.605	0.610
(iv) Unconsciously	0.620	0.565
(v) Miss or accident	0.650	0.600
(vi) Relationship	0.455	0.415

Table 5. Things with a high average percentage of correct answers (e.g., maps and e–maps)

	map	score:ave	e-map	score:ave
(i)	open a map	0.75	Enter your destination in the app	0.95
(ii)	Use a compass for direction.	0.65	Use the voice guidance	1.00
(iii)	Use the map as origami	0.45	Explore remote areas on Street View	1.00
(iv)	Fold the map.	0.80	Zooms the screen	0.85
(v)	Go the wrong way	0.65	GPS Disconnected	0.95
(vi)	Ask others for directions	0.40	Share location with friends	0.80

1. Validation of related actions
2. Validation of variable actions

Validation 1 verified the validity of ChatGPT output as actions related to the object. Fifty respondents were asked to provide responses to questions (i)–(vi), regarding actions related to the “map.” After removing inauthentic responses and duplicates, 523 actions were collected. These responses were considered as actions related to the object based on human perception. The validity was assessed by measuring the similarity between the collected responses and ChatGPT output using sentenceBERT [9], a machine learning method for calculating sentence similarity. Table 3 shows the calculation results for validation 1. Based on cosine similarity, we inferred that ChatGPT’s output is included in the manually collected action sentences, allowing ChatGPT to generate what people consider “actions related to the object.”

Validation 2 validated ChatGPT’s ability to make judgments about variable actions. Judgments were made about the validity of the actions output in section 4.2. Ten objects were selected out of 52 cases, and 200 respondents were asked to assess the validity of the Disappearing Action Sentences and Appearing Action Sentences generated in section 4.2. Respondents evaluated whether actions became infeasible due to convenience or feasible when returning to pre-convenience conditions. Respondents were asked to select either “It is no longer possible because of the convenience” or “It can be done without changing.” For instance, smelling the book became impractical when transitioning from books to e-books for convenience, but discussing the books remained feasible. The response “It is no longer possible because of the convenience” corresponds to variable actions. The actions where this response and the output matched were considered correct and the match rate was calculated. We calculated the percentage of correct answers no longer possible, collecting 2,400 responses.

Tables 4 and 5 list the calculation results for validation 2. This suggests that ChatGPT’s output could somewhat assess variable actions using this method.

## 5. Experiment and Discussion

We developed a web application aimed at increasing awareness of “variable actions” when generating ideas. This application guides users through each step of the idea generation process outlined in Fig. 2 (see Figures 4 and 5). Each process step was made interactive, allowing users to progress through the ideas in a structured flow. Thus, each step was transformed into a question item, and users input their answers to proceed with the ideas. The application consists of six questions, described below.

The first step in the flow of ideas involved presenting questions about the before and after states of convenience. This section aimed to recognize the inconvenient state and how it becomes convenient. Next, variable actions were presented after a question asking about the characteristics of post-convenience objects. Variable actions presented

The screenshot displays a user interface for an application. It consists of several text boxes and buttons arranged in a flow. At the top, there are three buttons labeled 'Book', 'Map', and 'Cash'. Below them, a question asks for the purpose of the selected object. The user has selected 'e-book' and answered that the purpose is to obtain information by reading. The next question asks what is inconvenient about the object. The user has answered that multiple objects are heavy and take up a lot of volume, and that it is not possible to purchase the object if it is sold out. The next question asks how the e-book makes that inconvenience more convenient. The user has answered that many e-books can be carried on a reading device, and they can be bought in electronic format and read immediately. The next question asks for a detailed description of the e-book. The user has answered that many books can be read just by having one of these things, and they can be downloaded in electronic format and read anywhere. The final question asks to elaborate on the e-book based on the concept of variable actions. The user has answered that many books can be read just by having one of these things, and they can be downloaded in electronic format and read anywhere. To add the following functions: The pages can be flipped through with a sound by using the gesture of flipping the pages like a conventional book. Create and insert a favorite bookmark. The book cover can be changed. The book has a dress-up function that adds a "unique book quality" to the book. For example, you can change the color of the book cover to an old-fashioned book color, put a sticker of a spill, reproduce a tear, or draw a graffiti, etc. The user can position the books on the bookshelf as they like. At the bottom right, there is a 'Decision' button.

Fig. 4. Screenshot of the proposed application (1): The user enters answers to the presented questions in the text box. After entering an answer, the next question is presented. After answering question 4, Fig. 5 is displayed. After answering question 5, the final question, question 6, is presented.

12 questions (i)–(vi), two of each. Subsequently, users were asked to judge whether the variation was desirable or undesirable (see Fig. 5). They were asked to choose whether it is really “ok to be decreased (or increased)”<sup>2</sup>, “not ok to be decreased (or increased)”<sup>3</sup>, or “not decreased (or not increased).” They were prompted to consider the influence of the action arising from convenience. Finally, we raised awareness of the side effects of convenience by asking for further details about post-convenience objects based on this.

Experiments with the proposed application were conducted as follows:

1. Effect of the presentation of variable actions on ideas
2. Effects of the application on idea generation

Experiment 1 assessed the impact of considering things after they become convenient. Users were asked to contemplate variable actions in idea generation using the application, allowing us to observe how ideas differ depending on this thinking process. We measured whether these differences led to an awareness of the side effects of convenience caused by the variable actions. Experiment 2 measured the effect of the application on idea generation. We observed how using the application influences idea generation by asking users to consider variations in their actions before and after convenience, thereby measuring whether idea generation incorporates this variation and includes considerations of the side effects of convenience.

## 5.1. Experiment 1: Effects of variable actions

### 5.1.1. Experiment Procedures

We conducted this experiment using crowdsourcing, involving 100 participants (50 presented with Disappearing Action Sentences and 50 with Appearing Action Sentences). Participants were instructed to utilize the proposed application to generate ideas for an invention, selecting something inconvenient. They were then prompted to generate ideas while responding to interactive questions about the chosen item, with the “post-invented things” representing post convenience items listed in section 4.2. For example, if the original item chosen was a “book,” the invention would be an “e-book.” The questions posed by the application were as follows:

1. What is the purpose of that object?

<sup>2</sup> “ok to be decreased” corresponds to DP, “ok to be increased” corresponds to IP

<sup>3</sup> “not ok to be decreased” corresponds to DN, “not ok to be increased” correspond to IN

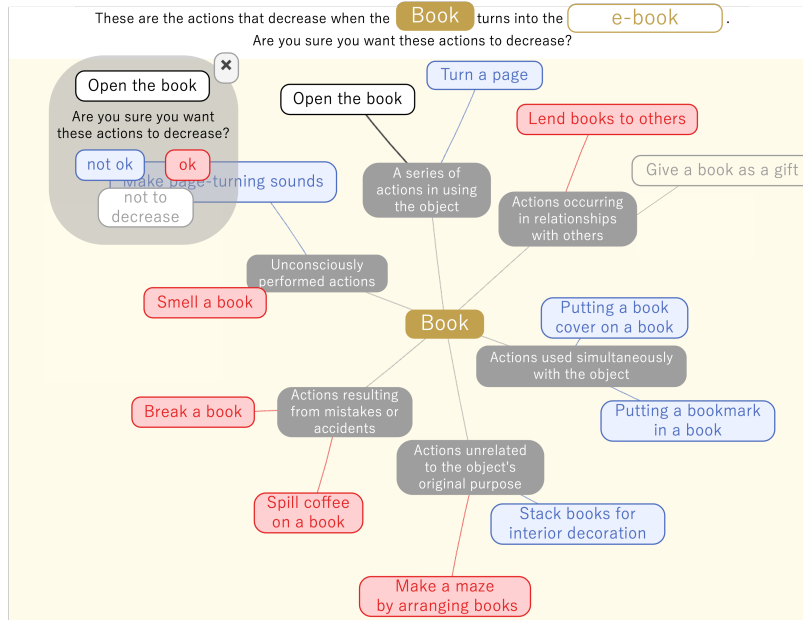


Fig. 5. Screenshot of the proposed application (2): It presents the Disappearing (Appearing) action sentence of the object. First, each action is displayed as a gray node, and actions related to the object are displayed as white nodes. The user selects an action and then chooses “ok” or “no ok.” “ok” turns the node red, and “no ok” turns the node blue. Additionally, selecting “not to decrease” turns the node transparent.

2. What do you find inconvenient about it?
3. How does the “post-invention thing” make that inconvenience more convenient?
4. Please provide a detailed description of the “post-invention objects”.
5. These are the actions that decrease (or increase) when the “pre-invented object” turns into the “post-invented thing.” Are you sure you want these actions to decrease (or increase)?
6. Please elaborate on the “post-inventive object”, based on the concept of variable actions (you may change the original function).

The application was designed such that answering one question led to the next (see Fig. 4), allowing participants to build their thoughts progressively. Following the completion of question 4, a network-like list of Disappeared Action Sentences (or Appeared Action Sentences ) was displayed at the bottom of the application (see Fig. 5). Two actions were randomly selected for display with each question, drawn from the answer output in section 4.2. Following the response to question 5, participants were asked to reconsider the “post-invention things” in question 6. Here, they were allowed to modify the original function to encourage consideration of the influence of variable actions. Participants underwent this process using the application as part of the experiment.

### 5.1.2. Experimental Results and Discussion

We collected a total of 133 responses (66 Disappearing Action Sentences and 67 Appearing Action Sentences) and filtered out inauthentic answers, resulting in 61 valid cases (36 for Disappeared Action Sentences and 35 for Appeared Action Sentences). Our analysis focused on responses to questions 4 and 6 to measure the effects of considering variable actions. The responses were broadly categorized as follows:

- 1–1 No additional explanation: Answers containing the same information in questions 4 and 6.
- 1–2 Additional explanation: Answer to question 4, with supplemental explanation in question 6.

Response rates were 12.28% for response 1–1 and 85.96% for response 1–2. We observed how the participants perceived the variable actions in question 5 to understand the characteristics of each answer. In response 1–1, 93.65% of



the answers indicated willingness for the action to be decreased (or increased) in actions (i)–(iv) and (vi). For action (v), 57.14% of the answers did not mention if the action decreased (or increased). We inferred that the presentation of variable actions considered the influence of actions caused by mistakes or accidents, while the influence of other variable actions may not be considered.

The characteristics of the answers varied between Disappeared and Appeared Action Sentences. For Disappeared Action Sentences, in actions (i) and (vi), 48.80% of the responses indicated dissatisfaction with the action disappearing. In actions (ii) to (v), answers varied, with several emphasizing customizability (e.g., attaching a book cover) and entertainment (e.g., creating a map puzzle, gifting a book). This variability suggested differing perceptions of enjoyment. Similar trends were observed in question 6, where responses that indicated a preference for actions not to be decreased included explanations of the fun and pleasure associated with using the object, such as “can also be played like” or “can be utilized like.” Conversely, answers that were willing to be decreased provided additional explanations for newly possible or convenient actions. Additionally, in question 4, the average answer length was 35.76 characters, which increased by 1.87 times in question 6.

Considering the answers that presented Appeared Action Sentences, in actions (i)–(iv), 84.82% of the answers said it would be desirable if increased. In action (v), 82.14% of the answers said it would be undesirable if increased, prompting them to think, “Actions that happen by mistake or accident may not increase.” Sparse responses were noted in action (vi). In question 4, the average answer length was 28.42 characters, increasing by 1.95 times in question 6. We assumed that presenting variable actions prompted consideration of their influence, stimulating thoughts on “ideas that are hard to think of” and “objects that have once again become useful.” However, we suspect differences in the considered influence between the “DA” and the “IA.”

## 5.2. Experiment 2: Effects of the proposed method

### 5.2.1. Experiment procedures

We conducted a user observation experiment with six university students in a face-to-face setting. The experiment comprised the following steps:

1. Initial task: Participants were asked to think of new problems that could arise from the introduction of a mechanism to make city-walking more convenient. Given that IT-based support for sightseeing tours, such as tourist guides, was available [10], participants were tasked with envisioning potential issues.
2. Use of proposed application: Participants then utilized the proposed application. They were asked to engage with the application and reflect on how it influenced their thinking about the task.
3. Revisiting task: After using the application, participants were instructed to revisit the initial task of thinking about potential problems with city-walking made more convenient.
4. Idea generation: Finally, participants were asked to generate ideas, incorporating any insights or shifts in their thinking prompted by their use of the application.

Additionally, a semi-structured interview was conducted after the experiment to gather feedback on potential areas for improvement and the participants’ impressions of the application.

### 5.2.2. Experimental results and discussion

We analyzed the answers collected by the application following the same methodology as described in section 5.1. All participants provided responses categorized as 1–2, indicating additional explanations of question 4 in question 6. Explanations included examples utilizing the object, points of convenience, and problems arising from considering variable actions. In question 4, the average answer length was 77.5 characters, increasing by 1.92 in question 6. However, a different trend was observed in the perception of variable actions in question 5.

For Disappeared Action Sentences in actions (i), (ii), and (v), 79.16% of the answers indicated satisfaction towards actions decreasing. In actions (iii),(iv), and (vi), 62.50% of the answers indicated dissatisfaction with actions decreasing. For Appeared Action Sentences, in actions (i)–(iv) and (vi), 90.00% of the answers favored actions increasing, while in actions (iii),(iv), and (vi), 75.00% of the answers indicated dissatisfaction with actions increasing.

We investigated the thought processes behind these answers through semi-structured interviews. For Disappeared Action Sentences, participants used judgment criteria such as “replace it with myself” or “I don’t mind, but others

may find it necessary.” They judged that what was “pleasing, enjoyable, and necessary” for themselves and others may not disappear. Conversely, for answers indicating it would be good for actions to disappear, comments suggested that detailed actions felt unnecessary in their lives or could be replaced by something else. Participants often considered the influence of variable actions to enhance convenience but expressed concerns about losing enjoyment or other experiences due to changes.

However, more answers indicated it would be no good for actions to increase for Appeared Action Sentences compared to Disappeared Action Sentences. Therefore, we inferred that answers to this question might not have prompted consideration of the influence of arising actions.

We measured the effect of using the application on idea generation by analyzing task results. We compared ideas, considering problems before and after using the application. Before using the application, the average answer length was 105.1 characters, increasing by 1.89 times afterward. Participants described problems arising from the object’s characteristics, actions related to using it, and the disappearance of features unrelated to the original purpose. They also considered problems arising when others (such as children and the elderly) use the application. Participants noted that using the application made them think about others’ perspectives and relate seemingly unrelated actions and other occurrences. Several participants reported deeper opinions and solutions after using the application, considering problems from different viewpoints. However, no new viewpoints were considered, possibly due to a lack of focus on alternative perspectives.

## 6. Conclusions

This study proposed the idea support method aimed at raising awareness of the side effects of convenience. Through the development of an application that presents variable actions and facilitates interactive idea consideration, we conducted an experiment to assess its impact on idea generation. The results indicated that participants were able to adopt different viewpoints and consider ideas from others’ perspectives, suggesting that the influence of side effects could be identified and reflected in ideas at the idea generation stage.

Consequently, it is important to explore methods to support the clarification of problems arising from variable actions and to consider the rationale behind the decrease (or increase) in value. While the application currently outputs variable actions in terms of existing convenient objects, there is a potential to expand its capabilities to include actions associated with new ideas as they are introduced.

Additionally, future research could investigate the effects of visualization on the number of people who engage in idea generation. By further refining the application and exploring its impact on idea generation processes, we can continue to advance methods for considering the side effects of convenience and fostering innovative thinking.

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