# Postprint: Effects of Search Input Modality and Gender Differences on Children's Information Search Experience

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## Abstract

[Purpose/Significance] Enhancing usability and emotional experience constitutes a crucial approach for guiding children in utilizing information search tools. Through experimental research methodology, this study investigates the influence of input modalities and gender differences on children's search experiences, thereby providing a reference basis for the construction of children's information search platforms. [Method/Process] Children were invited to complete specific closed-ended search tasks to evaluate the impact of three input modalities—keyboard typing, handwriting input, and voice search—on the usability and emotional experience of children's information search. [Results/Conclusions] Search input modalities significantly affect the usability of children's information search, with voice search demonstrating optimal operational usability and the most positive emotional experience for children; gender significantly influences both usability and emotional experience in children's information search, with boys exhibiting superior behavioral performance and emotional experience; an interaction effect exists between input modalities and gender differences on search usability; voice user interface search methods can satisfy children's requirements for usability and emotional experience.

## Full Text

### Research on the Influence of Search Input Mode and Gender Difference on Children's Information Search Experience

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**Abstract**

[**Purpose/Significance**] Improving usability and emotional experience is an important way to guide children in using information search tools. Through experimental research, this study investigates the impact of input methods and gender differences on children's search experience, providing a reference basis for the construction of children's information search platforms. [**Method/Process**] Children were invited to complete specific closed search tasks to evaluate the effects of three input methods—keyboard typing, handwriting input, and voice search—on the usability and emotional experience of children's information search. [**Results/Conclusions**] Search input methods have a significant impact on children's information search usability, with voice search demonstrating the best operational usability and the most positive emotional experience. Gender also significantly affects children's information search usability and emotional experience, with boys showing better behavioral performance and emotional experience in information search. There is an interactive effect between input method and gender difference on search usability. Voice user interface search methods can meet children's usability and emotional needs.

**Keywords:** children's information search; input method; emotional experience; emotional measurement; usability

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## Introduction

In the 21st century, informatization has become a defining characteristic of global economic and social development. As "digital natives," children have a strong need for information access, and their information literacy capabilities are regarded by various countries as a key component of future national competitiveness [1]. In 2019, the internet penetration rate among urban minors in China reached 93.9% [2]. As the most commonly used and simplest tool for information seeking, search engines are frequently used by 44.9% of minors to search for information online [3]. However, children often face many problems during the information search process, and their information search abilities cannot match actual search demands and contemporary requirements.

Current research on children's information search behavior mostly analyzes influencing factors and constructs behavioral models from a macro perspective, while fewer studies conduct empirical research on specific stages of the behavioral process.

## 1. Literature Review

As the main subjects of information search behavior, children's operational experiences and subjective feelings can directly reflect the degree of perfection of

information services [5]. Current research findings are primarily based on children's information search behavior performance, proposing a few empirical models and design strategies. For example, Zhou Jiajun abstracted and extracted characteristics of children's search behavior to form an empirical model of children's information retrieval [6]; Fu Yongmin proposed that children's interface design should follow eight principles: interactivity, ease of use, reasonable layout, iconic visualization, proximity of buttons, eye-catching colors, role-playing, and storytelling [7]; Luo Saifeng guided children's search engine design from five aspects: query, search strategy, user interface, navigation style, and relevance judgment [8]. However, existing research has mostly focused on device usability, lacking emotional insight into target users.

Input method is a key element in information input during human-computer interaction. Whether input is effective is the first step in information search and has an important impact on the overall user experience [4]. Therefore, this study aims to investigate, based on experimental psychology and targeting upper-grade elementary school students, how input methods and gender differences influence children's information search experience, thereby improving the efficiency and quality of information services and enhancing children's search experience.

As an important interface between children and information, search engines' information search performance directly affects user search experience [2, 5]. At the same time, emotional factors also play an important role in information behavior [9]. Since emotional experience directly affects user satisfaction and guides user decision-making and behavior [10], studying children's emotional experience in search engines is essential. Children have a strong sense of self-efficacy [11] and often experience information anxiety due to search uncertainty and information overload [12]. They lack patience during information navigation and search processes and cannot tolerate information delays [13]. However, certain emotional interventions can improve children's emotional experience; for example, encouragement or suggestions from others can improve children's search success rates [14]. Li Xiang once proposed that search engines should provide assistants with cognitive guidance and empathy functions to help children retrieve information, and pointed out that appropriate voice elements would help children search for information [15].

In summary, there is relatively little empirical research exploring how to improve children's information search efficiency and emotional experience, which cannot provide objective basis for design practice. Text input is an important way to achieve human-computer interaction. Accurate, efficient, and user-friendly input methods can assist users in inputting information and improve user experience [16]. Handwriting input occupies less attentional resources and has rich information expression capabilities, with natural and direct operation methods [17]. Keyboard input offers high operational flexibility, but prolonged use can affect physical and mental health, causing irritability and other issues [18]. For children, their knowledge level and reading/writing ability are limited, and their

abstract thinking is not yet fully developed, making it difficult for them to express search queries [13]. How existing search platforms can help children choose appropriate input methods to input information efficiently, conveniently, and pleasantly lacks precise quantitative research and search recommendations for this key issue.

Primary school students are in the early stage of self-construction during their socio-psychological development process. Individual characteristics such as gender have certain differences that directly affect information search behavior. Freud's personality development stage theory indicates that after the age of 7, boys and girls become emotionally distant, and group activities become gender-segregated, with gender differences becoming prominent [19]. Girls mature earlier than boys physically and emotionally, and due to environmental influences on themselves, their self-control ability is significantly higher than that of boys, and their behavior is more compliant [20]. Feedback, as an important intervention means in the learning process, has a greater impact on girls. After receiving negative feedback, they are more inclined to change their behavior to alter their choices [21], and they want to present better performance to obtain the reward of positive feedback [22]. Children of different genders have different performances regarding different things. Therefore, this study selects gender as an important factor to explore its influence on children's information search experience.

Currently, 97.1% of search engine users in China use the service through mobile phones, while the proportion of users accessing search engines through desktop or laptop computers is 65.0% [23]. Search behavior has migrated to mobile terminals; therefore, this study selects mobile smartphones as the specific experimental carrier.

## 2. Research Questions and Hypotheses

**2.1 Search Input Methods** Search engine input methods, broadly defined as input methods, refer to the encoding methods used to input various symbols into electronic information devices. Currently, common methods include keyboard typing, handwriting input, and voice search [23], as shown in Figure 1 [Figure 1: see original paper].

Traditional input methods are widely considered the fastest, most accurate, and simplest input method. Due to their high stability and resistance to external interference, they are extremely popular, with a user adoption rate as high as 96.6%. On the other hand, with the increasing maturity of artificial intelligence and other technologies, diversified input methods such as handwriting input and voice search have gradually been accepted by users and are being more widely applied [23]. Existing research shows that the advantages of these three input methods vary. Wang Li believes that keyboard input is more ideal under single-task conditions, while handwriting input has more advantages under multiple cognitive loads [24]; Chen Jingjun et al. found that both keyboard pinyin input

and paper-and-pen handwriting have positive effects on children's Chinese character learning, with handwriting being more effective [25]; J.C. Read found that paper-and-pen-like tablet input methods are more popular among children [16]; F. Crestani discovered that voice queries not only meet users' needs for natural language expression but also help express more semantics [26]. The three input methods have their respective strengths, and existing research has drawn different conclusions for different situations. However, the most suitable input method for children remains unclear. Therefore, this study focuses on selecting different search input methods as independent variables in the experiment, with usability and emotional experience as dependent variables, to further investigate how search input methods affect children's information search usability and emotional experience.

Common search engine input methods can be divided into two categories: Graphical User Interface (GUI) information search methods and Voice User Interface (VUI) information search methods. Graphical User Interface refers to interaction between users and systems through graphics, usually by directly touching the screen to conduct information searches [27]. Voice User Interface refers to users interacting with the system through voice recognition and commands to achieve information transmission [28], suitable for efficient operation in constrained environments or multitasking situations.

This study selects the three most commonly used input methods in children's information search processes as experimental independent variables, matching them with two types of interface carriers: GUI and VUI. Among them, keyboard typing and handwriting input belong to common graphical user interfaces. Soft keyboard typing is one of the main components for inputting character strings in graphical user interfaces [29], where users directly select letters to construct text. Handwriting input guides users to interact with devices through fingers, including interface design elements such as input box size and position [30]. Voice input is an intelligent method of interacting with the system based on speech recognition and automatic speech recognition technologies [31]. Baidu search's voice input triggers the system to execute individual tasks through actions and voice, and its interactive interface belongs to the voice user interface. Since children's information search abilities are limited and they use verbal expression more than typing and handwriting in daily life, we propose the third hypothesis:

**Hypothesis 3 (H3):** In children's information search, the search experience of voice user interfaces is better than that of graphical user interface search.

**2.2 Gender Differences** Due to differences in information processing between males and females, they produce different cognitive and behavioral tendencies when receiving different information [32]. There are also differences in sustained attention ability between genders: boys tend to pursue speed, with faster responses but lower accuracy; girls tend to pursue precision, with slower responses but higher accuracy [33]. Fine motor skills required for keyboard typ-

ing also show gender differences. Children of different genders have different motor coordination abilities: girls have advantages in rhythmic, balanced, eye-hand non-displacement operations, while boys are better at physical activities, orientation, fast movements, and control of moving objects [34].

Since elementary school students begin information technology courses from the third grade, and based on gender differences among children, this study focuses on upper-grade elementary school students to investigate gender differences in input methods, leading to the following hypotheses:

**Hypothesis 4 (H4):** Gender differences have a significant impact on children's information search usability.

**Hypothesis 5 (H5):** Gender differences have a significant impact on children's information search emotional experience.

**Hypothesis 6 (H6):** Input method and gender difference have an interactive effect on children's information search experience.

**2.3 Usability Evaluation** The International Organization for Standardization defines usability [35] as the degree to which specific users can achieve specific goals effectively, efficiently, and satisfactorily when using a system, product, or service in a specific context. Among them, user-perceived usefulness and satisfaction are key factors that must be considered for continuous use in information systems [36]. Wang Li examined input performance and cognitive load of input methods using input speed, error rate, and subjective evaluation as indicators [24]. Different evaluation criteria are adopted based on different user types and task environments. This study selects traditional usability evaluation dimensions to compare children's effectiveness, efficiency, and satisfaction when performing information search tasks through different input methods. The specific indicator system design is shown in Table 1 .

**Table 1. Usability Measurement Indicators**

| Indicator Level | Primary Indicator | Secondary Indicator | Description |
|---|---|---|---|
| Usability | Effectiveness | Input Error Rate | Ratio of error occurrences to total sample size during information input |

| Indicator Level | Primary Indicator | Secondary Indicator | Description |
|---|---|---|---|
| | Efficiency | Search Time | Duration from start to end of search (excluding loading time) |
| | Satisfaction | Subjective Rating | Likert scale (1 = dislike, 7 = like very much) |

**2.4 Children's Emotional Measurement** Emotional experience refers to users' attitude experiences and corresponding behavioral responses toward objective things based on emotions [37]. F.V.D. Sluis et al. proposed three relevant indicators for children's information search from a child-centered perspective: complexity, interest, and emotional value [38]. Emotional experience is difficult to measure directly and is often analyzed through emotional measurement. Existing methods for measuring children's emotions include self-reporting, interviews, projection, observation, and neurophysiological measurement. Questionnaire scales are commonly used, with classic emotional measurement scales including the PANAS Positive and Negative Affect Schedule, PAD Emotional Scale, and SAM Self-Assessment Manikin. This study adopts the emotional measurement tool Pick-A-Mood (PAM) designed by P.M.A. Desmet et al. [39], as shown in Figure 2 [Figure 2: see original paper]. This is a self-report pictorial scale based on cartoon characters that quantifies emotions from two dimensions—valence and arousal—to study children's emotional experiences when performing different input tasks. Using cartoon images reduces children's cognitive load, and the robot form avoids gender characteristics, making it easy for children to express their emotions intuitively and quickly.

## 3. Experimental Process and Data Collection

**3.1 Experimental Design** This experiment adopted a two-factor mixed experimental design. The two independent variables were input method and gender. Input method had three types: keyboard typing, handwriting input, and voice search. Gender corresponded to male and female. The study was grouped by gender, making gender a between-subjects factor. To balance sequence effects and recency effects, experimental materials were ordered using the Latin square design method, as shown in Table 2 , ensuring that the order of each input method appeared with equal probability. The experiment used closed tasks to maximize the limitation of external conditions and avoid inducing individual emotions. The word count was set at a moderate level—avoiding too short tasks

that would make experimental effects unclear or too long tasks that would trigger negative emotions. The specific search task was "Father of Hybrid Rice," totaling 6 characters. Baidu search engine was selected as the experimental tool because it is currently the most widely used platform in China with high user familiarity, reducing unfamiliarity effects.

**Table 2. Search Task Sequence Design**

| Sequence | First Task | Second Task | Third Task |
|---|---|---|---|
| R1: S1-S10 | A: Keyboard Typing | B: Handwriting Input | C: Voice Search |
| R2: S11-S20 | B: Handwriting Input | C: Voice Search | A: Keyboard Typing |
| R3: S21-S30 | C: Voice Search | A: Keyboard Typing | B: Handwriting Input |

*Note: Three input methods (A: Keyboard Typing, B: Handwriting Input, C: Voice Search)*

**3.2 Experimental Subjects** The experiment was conducted in empty classrooms at Yuying Rongchuang Primary School and Yuhong Wank Primary School under suitable lighting and relatively quiet conditions. The experiment lasted nearly one month. Child participants were first selected through stratified sampling from grades three, four, and five in equal quantities, then selected through random roll call from each stratum using independent simple random sampling. A total of 34 elementary school students were invited to participate in the test, with a 1:1 male-to-female ratio, average age of 9.5 years (SD = 0.82). All participants had no hearing problems, no visual difficulties, and normal color vision. All subjects had smartphone usage experience and some search experience, and were informed about the experiment content. The study was approved by school leadership to ensure no physical or psychological harm to children. The experimental device used an iPhone 6s with a 4.7-inch screen and 1334x750 pixel resolution. During the experiment, the phone's built-in screen recording software was used, and SPSS 26 was used for data analysis.

**3.3 Experimental Procedure** Before the experiment, participants freely operated the three input methods on the device for a period of time to reduce additional unrelated variables caused by unfamiliarity with the device and input methods. They also selected their expected emotions for information search on the PAM emotional scale. Before the formal start, participants freely browsed a neutral picture album selected from the Chinese Affective Picture System [40] for about 30 seconds and self-assessed that their emotions were calm before beginning the experiment. After the experiment began, participants sequentially searched for "Father of Hybrid Rice" on mobile Baidu through the three input methods (with prediction functions turned off and no history records displayed). Immediately after each search, a stopwatch recorded the search duration, the PAM emotional scale assessed participants' emotions, and a Likert

scale recorded subjective satisfaction. Subsequent review of the screen recording files analyzed error occurrences. During the task period, participants freely browsed the neutral picture album to alleviate test anxiety and reduce fatigue effects and differential carryover effects caused by repeated measurement. Each test lasted about 10-20 minutes. The relatively simple experimental tasks could avoid children's boredom and would not delay their coursework. Small gifts were presented after the experiment as a token of appreciation.

## 4. Results

**4.1 Search Duration Data Analysis** The search time for different input methods ranked as: Handwriting Input > Keyboard Typing > Voice Search. For the same text, voice input took the shortest time, averaging about 4.907 seconds, while keyboard typing took about three times as long as voice search. Search duration also differed by gender: boys averaged 10.795 seconds, while girls averaged 15.358 seconds, taking longer. As shown in Table 3 :

**Table 3. Distribution of Children's Search Time by Input Method (Unit: seconds)**

| Input Method | Mean | Std. Deviation | 95% Confidence Interval |
|---|---|---|---|
| Keyboard Typing | 15.043 | 1.3254 | 12.014, 18.073 |
| Handwriting Input | 19.280 | 1.4812 | 15.916, 22.644 |
| Voice Search | 4.907 | 0.2420 | 4.412, 5.402 |

A two-factor repeated measures ANOVA revealed that input method had an extremely significant effect on search time ($F = 44.264$, $p = 0.000 < 0.01$). The between-subjects variable of gender also had an extremely significant effect on search duration ($F = 8.991$, $p = 0.006 < 0.01$). There was an interactive effect between input method and gender on search time ($F = 4.280$, $p = 0.019 < 0.05$). As shown in Figure 3 [Figure 3: see original paper], girls took longer than boys to search, and the average search duration differed significantly across the three input methods, with large within-subject differences, indicating a strong influence of input method. Boys showed small average time differences between handwriting input and keyboard typing. Pairwise comparisons revealed significant gender differences in handwriting input.

**4.2 Input Error Rate Data Analysis** Error rates by input method ranked as: Handwriting Input > Keyboard Typing > Voice Search. Handwriting input had the highest error rate, mostly due to text recognition problems. Specific handwriting recognition errors included: overlapped writing, messy handwriting, writing outside the recognizable area, accidentally shrinking the handwriting area, and premature system recognition—mainly due to interface size issues and children's non-standard writing. Keyboard typing errors occurred because children were unfamiliar with the keyboard letter layout and often typed wrong

letters. Voice input generally had high accuracy, with only occasional problems of children speaking too quickly for recognition or clicking interface buttons without feedback.

Girls' average error rate was higher than boys', mainly due to frequent errors in the handwriting input task. Analysis of error causes for the three input methods included: system failure factors such as untimely human-computer interaction and unresponsive systems; interface design issues such as easily misclicked phone interface buttons and unreasonable handwriting area design; and subjective cognitive reasons such as children's misunderstanding and unfamiliarity with soft keyboard layout. Overall, keyboard typing was most affected by individual experience, while errors in other methods were mainly influenced by the phone's own system reasons.

**4.3 Satisfaction Data Analysis** Children's average satisfaction ranking for input methods was: Voice Input > Handwriting Input > Keyboard Typing. Voice search had the highest satisfaction, averaging 6.23 points, with no low scores. Handwriting input satisfaction was concentrated in the upper-middle range. Keyboard typing had many low scores, which pulled down the average satisfaction and showed large deviations, as detailed in Table 4 .

**Table 4. Frequency Distribution of Search Satisfaction by Input Method**

| Input Method | Mean | Std. Deviation | 95% Confidence Interval |
|---|---|---|---|
| Keyboard Typing | 4.12 | 1.732 | 1.497, 6.743 |
| Handwriting Input | 5.38 | 0.961 | 3.460, 7.300 |
| Voice Search | 6.23 | 1.100 | 4.050, 8.410 |

Girls' satisfaction with each input method was relatively average and slightly higher overall. Boys' satisfaction scores fluctuated greatly, with some children expressing extreme dissatisfaction with keyboard typing, as shown in Table 5 .

**Table 5. Descriptive Statistics of Search Satisfaction Gender Differences by Input Method**

| Gender | Keyboard Typing | Handwriting Input | Voice Search |
|---|---|---|---|
| Male | 3.82 (1.85) | 5.41 (1.12) | 6.35 (0.89) |
| Female | 4.42 (1.59) | 5.35 (0.81) | 6.12 (1.29) |

*Note: Values are means (standard deviations)*

**4.4 Emotional Experience Analysis** This study collected participants' expected emotional experiences from information search. The results showed that 86.7% of children hoped to obtain positive emotions through information search behavior, with 20% expecting an excited emotional state. Another 13.3% of children indicated they had no great expectations and were relatively calm. Before the formal search experiment, emotional induction was used to bring children to a neutral baseline emotion. After the search, most children were in a positive emotional state with low arousal, as shown in Figure 4 [Figure 4: see original paper]. Children's overall emotional fluctuations were small. Participants with short search times often showed positive emotions with higher arousal. In cases of long search times or task execution errors, participants felt negative emotions such as boredom, nervousness, and sadness. Among all input methods, only voice search reported no negative emotions.

Based on P.M.A. Desmet et al.'s scoring of PAM emotional word properties [39], this study plotted a comparison chart of children's expected emotions and emotional experiences with the three input methods (see Figure 5 [Figure 5: see original paper]). Expected emotions were located in the high-valence, high-arousal positive emotional area in the upper right of Figure 5, indicating that children were full of expectations for searching for information on mobile phones. The three input methods were distributed in the right area of the image, with induced emotions having average valence in a positive state and average arousal 偏向中立. Based on the proximity relationships shown in the figure, input methods can be divided into two groups from the perspective of emotional experience: GUI-based keyboard typing and handwriting input as one group, with relatively consistent emotions tending toward calmness; while VUI-based voice search was closer to users' expected emotions, with a larger gap from the other two methods.

From the gender dimension, boys' emotions using each input method and overall were more active than girls'. The interactive effect of different input methods and gender differences on children's search time was significant. Girls had longer average search times, and the average time gap between input methods was also larger than boys', with handwriting input showing particularly significant gender differences and higher error rates. Girls' average search time for handwriting input was 9 seconds longer than boys'.

## 5. Discussion

**5.1 Analysis of the Influence of Mobile Information Search Input Methods and Gender Differences on Children's Search Usability (1) Changes in input methods have a significant impact on children's search usability, supporting H1.** Different input methods have significant differences in their impact on children's search time. Voice search has the highest efficiency, with significantly shorter average time than the other two methods. Voice search also has higher effectiveness, with significantly lower average search error rates than keyboard typing and handwriting input. Voice search also has

the highest average satisfaction score, with particularly obvious differences compared to keyboard typing. Therefore, we conclude that H1 is supported. Suitable input methods such as voice search help improve usability and enhance children's search efficiency and experience.

Some studies have shown that voice occupies cognitive and memory resources that can hinder user performance [41], and more than half of voice queries experience recognition errors [42]. Other studies comparing keyboard typing and voice search found that voice input is faster and more popular [43]. In this experiment, voice search was efficient, accurate, and highly satisfactory. Specific reasons include: the search task was fixed with short text length, resulting in low recognition error rates; with technological development, current deep learning-based speech recognition systems have significantly improved accuracy, ensuring input effectiveness; voice interaction is simple and closest to natural interaction for children, requiring only "press, speak, and search," making it the input method children most want to use.

Unlike adults who pursue a sense of control, quickly and efficiently completing information input is children's primary goal. Voice query methods meet children's information search needs without complex human-computer interaction processes, showing the highest usability. Handwriting input matches children's psychological model of paper-and-pen writing and is a fairly smooth text input method [18], conforming to natural mapping principles. However, current smartphone graphical user interfaces have low affinity for children, and the small handwriting area inhibits their developing writing habits. For primary school students, clicking on unfamiliar 26 letters on a small mobile phone screen requires high memory capacity and fine motor control of fingers, resulting in lower usability for keyboard typing. However, this method is commonly used in future work and learning contexts and is indispensable, so operation guidance for keyboard typing should be increased for children.

**(2) Gender differences have a significant impact on children's search usability, supporting H4.** Children have gender differences in self-control development ability, sustained attention ability, and motor coordination ability, which in this experiment were mainly manifested in search speed and error rates. Experimental data showed that girls' average time to perform information search tasks was significantly longer than boys', with lower efficiency. At the same time, girls' average search error rate was higher than boys', with the largest difference in handwriting input. We therefore conclude that gender differences have a significant impact on children's search usability, supporting H4. This conclusion differs from the general research finding that girls are slower but more accurate [33]. The main reason is that in specific search behaviors, boys' activities tend to be more autonomous [44], and they are more likely than girls to notice shortcut methods of system-recommended words during input, with more widely distributed attention, enabling them to find information faster. Girls are more passive in cognitive activities and less likely to notice system help.

**5.2 Analysis of the Influence of Mobile Information Search Input Methods and Gender Differences on Children's Emotional Experience**
**(1) Search input methods cannot directly affect children's information search emotional experience, making H2 inconclusive.** Input methods affect children's interactive experience with search interfaces through behavioral and cognitive interaction. When performing the same task, there is little difference in emotional experience between keyboard typing and handwriting input, with children generally being calm. Voice search differs significantly from the other two, with search effects more in line with children's ideal emotional experience and no negative emotions reported. Voice search is more expressive than common text input [26], closer to the form of dialogue and communication with others in daily life. Handwriting input and keyboard typing have certain requirements for devices and users, requiring children to actively adapt to the system, which is slow and prone to frustration. The negative emotions in this experiment often occurred in low-usability situations, such as inefficient handwriting input and low-satisfaction keyboard input. Task execution had a greater impact on children's emotional experience, and input methods indirectly affected children's emotional experience. Therefore, we cannot prove the direct effect and differences of input methods on emotional experience, making H2 inconclusive.

Some studies suggest that speech recognition errors cause frustration [42], but in this experiment, children had no negative emotions about voice search experience. They were more familiar with voice interaction methods and had higher acceptance of this technology, with overall search experience being relaxed and natural. The study can preliminarily infer that the simpler, more natural, and less interactive the input method, the higher the valence and arousal, the stronger the pleasure, and the closer to children's expected emotions.

**(2) Gender differences have a significant impact on children's information search emotional experience, supporting H5.** Males and females may experience different emotional responses to the same emotion [45]. Previous research shows that females have more acute emotional perception [32] and are more susceptible to emotional contagion. In this experiment, boys were more likely to induce positive emotions, with more positive average emotions across all input methods. Girls were more sensitive to low-usability situations, easily inducing negative emotions that could not be mediated in time. Boys still had relatively positive emotional experiences when facing low-usability situations. We therefore conclude that gender significantly affects children's emotional experience in information search, supporting H5. Future search engine research should more carefully consider children's gender characteristics.

**5.3 Analysis of the Interactive Influence of Mobile Information Search Input Methods and Gender Differences on Children's Search Experience** Input methods and gender differences have an interactive effect on children's search usability, supporting H6. Girls had longer search times and higher

error rates than boys, but were generally more satisfied, only giving average evaluations for handwriting input. Boys' satisfaction scores fluctuated greatly, with some children expressing extreme dissatisfaction with keyboard typing. For emotional experiences with different input methods, boys had higher arousal and valence, with stronger emotional induction intensity. Thus, children of different genders showed obvious differences in search behavior performance for input methods, with boys having better overall search performance and more pleasant experiences. Input methods and gender differences have an interactive effect on children's search usability, supporting H6.

**5.4 Voice User Interface Search Experience is Better Than Graphical User Interface Search Experience in Children's Information Search** Information visualization can help users quickly read and search for information. The visual cognitive layer of graphical user interfaces directly stimulates children's visual senses [47], enhancing pleasure. In this experiment, the usability and emotional experience of the two GUI-based input methods were both inferior to the VUI-based voice search method. The reason is that keyboard typing requires children to accurately tap on letters, occupying more visual attention; handwriting input requires children to have immediate and fast writing ability. Both directly occupy more visual channels and require limb movement assistance, making them slow and frustrating. Voice user interface-based voice input, however, uses the auditory channel to assist visual perception, resulting in high usability that meets search needs, more pleasant emotional experience, and better overall experience, supporting H3.

Voice user interface breaks free from the constraints of visual attention and limb control [48], reducing children's frustration and improving operational efficiency. This experiment used a closed query task, and information input was not affected by content restrictions such as charts, graphics, or personal privacy [49]. However, there were still a few speech recognition and system delay problems, such as children speaking too fast for the system to recognize, and system information response and feedback issues. Users' own action delays during the search process also directly affected search efficiency. Graphical user interfaces need to be re-planned and adjusted for children in interface design to reduce problems caused by interface layout and component size issues observed in the experiment.

**5.5 Design Recommendations** Based on the conclusions of this experimental study, the following recommendations are proposed for children's search engines:

**(1) Emphasize and increase research on voice input to guide children to use voice search.** Experimental data show that input methods have significant differences in children's information search usability, indirectly affecting children's search emotional experience. Voice search has superior characteristics and is the most recognized among the three input methods. Therefore, under the

premise of functional usability, simple and natural interaction methods—voice search—should be chosen as much as possible. In the design and development of children's information search systems, voice search should be the focus of research and development, and children should be actively guided to use this method to search for information, thereby producing the best search experience.

**(2) Build a humanized children's voice search interface.** For children, the information search experience of voice user interfaces is better than that of graphical user interfaces. However, children still encounter problems during use due to non-intuitive interface design, mismatched knowledge and experience, and 不适应的认知模式. Therefore, interface design and development should focus on children's individual characteristics: Strengthen research on child voice speech recognition technology to reduce voice input error rates; For system delay problems, real-time response should be provided, adjusting system recognition waiting time and reaction speed to give children enough time to organize their speech and actively trigger buttons rather than having the system start automatically in advance; Appropriately increase voice button size to reduce errors children make during interaction; Increase functional introductions and provide system guidance. Baidu voice search can modify text instructions through voice, that is, secondary voice search to correct queries, and can also trigger search through the "Xiaodu, Xiaodu" voice wake-up method, but children know little about these features. System guidance should be strengthened to assist understanding.

**(3) Provide different system support for children of different genders.** The study found gender differences in children's information search process. Girls have lower effectiveness and efficiency in information search and are prone to negative emotions when facing unexpected negative situations. Therefore, children's gender characteristics should be carefully considered in the design of children's information systems. Input methods should be improved in ways that better fit children's mental models to avoid low-usability situations. At the same time, cognitive and emotional support should be provided to timely channel negative emotions, transforming the command-based interaction mode in VUI to a more affinity-based conversational natural language communication mode to stabilize users' emotional states and induce positive emotions, creating the best search experience.

**5.6 Research Limitations** Different information search task types and input methods may have interactive effects. This experiment used a single closed task, which was relatively simple. Although it reduced experimental error, it ignored differences in children's search behavior caused by internal information needs. The short experiment also could not provide more data support. Future research could be conducted based on multiple experimental task types to explore other influencing factors of information search experience and enhance the systematicity and comprehensiveness of children's information search research. With the development of new technologies such as artificial intelligence and 5G,

existing soft keyboard forms are also changing, and voice interaction is being applied in various fields. More surprising search input methods for children will be added in the future. Therefore, continuing research around children's characteristics can increase the completeness and reliability of research.

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### Author Contributions

Hang Lu: Responsible for data collection, research framework construction, data processing, and paper writing.
Chen Yan: Responsible for topic selection and paper revision.
Wang Jiaqi: Responsible for experiment organization and data collection.

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### Research on the Influence of Search Input Mode and Gender Difference on Children's Information Search Experience

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**Abstract:** [Purpose/significance] Improving usability and emotional experience is an important way to guide children to use information search tools.

Through experimental research, we can understand the influence of input mode and gender difference on children's search experience, providing reference for the construction of children's information search platforms. [Method/process] Children were invited to complete specific closed search tasks to assess the impact of three input methods—keyboard typing, handwriting input, and voice search—on children's information search usability and emotional experience. [Result/conclusion] Search input mode has a significant impact on children's information search usability, with voice search showing the best usability and most positive emotional experience. Gender also significantly affects children's information search usability and emotional experience, with boys demonstrating better behavioral performance and emotional experience. Input mode and gender difference have interactive effects on search usability. Voice user interface search can meet children's usability and emotional needs.

**Keywords:** children's information search; input mode; emotional experience; emotional measurement; usability

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