Improving Performance by Encouraging Users to Consider Different Levels of Action Identification (LAI)

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Short Paper

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Abstract

Action Identification Theory proposes that individuals perceive their actions at different levels of abstraction and how this perception can significantly impact their behavior. The paper argues that prompting users to shift between different levels of action identification during their interaction with an information system can improve their performance. The experimental work includes a laboratory experiment and a think-aloud study that explores the effect of users' attention to different levels of action identification and the cognitive fit between on-screen representation and mental models on performance improvement. The discussion analyzes the results and outlines future research plans and expected contributions to the field. This study highlights the importance of considering the user's cognitive processes when designing information systems and suggests potential ways to enhance their performance.

Keywords: User Performance, Lab Experiments, Think Aloud Experiment, Levels of Abstraction, Action Identification Theory

Introduction

In everyday life, individuals may perceive their actions at various levels of abstraction, ranging from low-level means to high-level goals, and at any moment they identify their action at a certain level (Vallacher & Wegner, 1987, 2012). For example, when individuals engage in physical activity, they may perceive their actions in different ways, such as "lifting weights" (low-level identification) or "getting in shape" (high-level identification). Action Identification Theory goes on to argue that how individuals identify their actions has significant implications for their behavior. The theory has been found to apply to various human information processes, such as writing, reading, communication, and problem-solving, and is highly relevant to the study of human behavior with information systems (Te'eni, 2018). For instance, imagine an architect using computer-aided design (CAD) software to plan a house. While designing a wall, the architect must consider the low-level operations such as shaping the window, but simultaneously identify the consequences at higher levels, such as how it fits together with other windows in the house.

This paper aims to demonstrate the efficacy of prompting users to shift between different levels of action identification (LAI) during their interactions with information systems, leading to improved performance in terms of making better judgments and decisions to achieve their goals. The concept of prompting here encompasses a wide range of human-computer interactions that necessitate identifying actions at various levels, including design, scheduling, timetabling, planning, monitoring, categorizing, and comparing. We firmly believe that raising awareness about the potential benefits of facilitating shifts between LAI can serve as an inspiration for both IS scholars and practitioners, including interaction designers, UX designers, and managers. Considering the challenge posed by LAI throughout the lifecycle of systems can ultimately optimize user experiences and enhance decision-making processes and overall performance. By adopting this approach, we aim to encourage broader consideration of the significance of LAI in designing and managing information systems for superior outcomes.

The following section introduces the theoretical basis for our research, followed by a description of the experimental work, which includes a laboratory experiment and a think-aloud study. The think-aloud study explores how performance improvement is affected by the users' attention to different LAI and by the cognitive fit between the on-screen representation and the users' mental model. In the discussion, we analyze the results and outline our future research plans and expected contributions to the field.

Theoretical Development

Previous studies have demonstrated that thinking or acting at different LAI (high or low) can significantly impact a person's ability to make decisions, perceive information vividly, and distinguish between primary and secondary information (Strack, Schwarz & Gschneidinger, 1985; Limbourg & Vanderdonckt, 2004; Shapira, Liberman, Trope & Rim, 2012; Burgoon et al., 2013). Individuals tend to place more emphasis on broader and general aspects, pay attention to goals, and favor the bigger picture when identifying an action at a high level. Conversely, when identifying an action at a low level, individuals tend to place more emphasis on narrower and more concrete aspects and pay attention to particular elements and technical features (Vallacher & Wegner, 1987).

Despite the importance of shifting between LAI in solving problems, people often maintain the same focal level and consequently perform suboptimally (Te'eni, 2018). According to Action Identification Theory (Vallacher & Wegner, 1987), while people can identify an action at different levels, they tend to focus at any given moment on one LAI. The choice of the level on which they focus depends on the specific context prevailing at the time. Once they have chosen a focal level, individuals tend to maintain it as long as they do not feel obliged to shift to a higher or lower level. Shifting to a higher level is expected to occur when the individual gets lost in detail, becomes overwhelmed, or feels confused (Vallacher & Wegner, 1987; Srinivasan & Te'eni, 1995). Shifting to a lower level is expected to occur when individuals feel that the higher level can no longer guide them or when the action is blocked or cannot be executed (Dunbar, 1998). For example, in the case of our architect, not shifting between levels could result in neglecting crucial aspects associated with different levels, such as ensuring that all windows in the neighborhood fit each other concerning size, color, style, and so on. Since users tend to maintain a single focal LAI and are generally less inclined to shift between different levels (Te'eni, 2018), the integration of control mechanisms becomes essential to facilitate appropriate transitions when necessary. Feedback has shown its role in enhancing the user experience (Renaud & Cooper, 2000) learning capabilities, problem-solving processes, and human-computer interaction (Mory, 2004; Hattie & Gan, 2011). Thus, it emerges as a critical component in enabling these transitions and guiding users to change their focal LAI when considered appropriate by the system. By incorporating feedback mechanisms, users can receive timely information and guidance that encourages them to explore alternative LAI perspectives, enabling them to make significant progress toward their goals. Based on Action Identification Theory, we can predict when a move from the focal level is necessary to enhance performance and, accordingly, encourage the user to move.

For our study, we examined two possibilities for determining when to guide the user to move during the problem-solving process. The first possibility is based on determining points in the process that require consideration of different levels. Determining these points relies on an analysis of the process, e.g., detecting points of complexity, and on real-time contextual information about the user's progression. The analysis can be done manually ahead of time (as we did in our experiments) or near real-time by the machine, but the detection of the user's position within the process must be computed in real-time. The second possibility for deciding when a move is necessary relies on analyzing the user's behavior to detect signs of difficulty in making progress, confusion, or hesitation. This can be done, for example, by observing erratic back-and-forth movements or prolonged periods of inaction. This analysis must be performed in real-time. In any event, the precise timing and the direction of the suggested move between LAI also depend on the user's focal level.

In our experiment, the user is prompted to move between LAI with a short message suggesting a move if the user passes a point determined to require a move. Therefore, we hypothesize that prompting users to shift between LAI when needed will improve their performance.

Hypothesis 1: Prompting users to move between LAI at predictable points improves performance.

Prompting the user to shift between levels affects performance in two ways. One effect is cognitive, which involves mentally shifting between LAI. The other effect is behavioral, which involves changing the on-screen representations to fit the new LAI (for example, from a house view to a neighborhood view). The cognitive effect of shifting between LAI may induce users to pay attention to different levels of identification, thus preventing neglect of information found in other levels.

The second effect resulting from changing the on-screen representations to match the focal LAI builds on Cognitive fit Theory (Vessey & Galletta, 1991; Speier 2006). The theory suggests that aligning the on-screen representation with the user's mental model improves performance. A mismatch between representations, however, requires additional effort and time, leading to lower performance. In our case, mentally shifting to a different level but not changing screens may reduce cognitive fit, leading to inferior user performance. Hence, we propose exploratory hypotheses 2a and 2b, to test the mental and behavioral, respectively.

Hypothesis 2a: Prompting users to move when needed, induces a mental shift between levels, preventing neglect of different levels.

Hypothesis 2b: Prompting users to move induces a corresponding change of on-screen representations, leading to improved cognitive fit.

Method

To test our hypotheses, we designed an online lab experiment and conducted two studies: (1) An experimental study that compared the difference in performance between users who received feedback to shift between LAI and users who received placebo feedback (testing Hypothesis 1). Participants were randomly assigned to either a treatment or control group. (2) A think-aloud study that analyzed the verbal thoughts of users regarding the contribution of the feedback to improving cognitive FIT and preventing neglect of LAI (testing Hypotheses 2a and 2b).

Participants

Seventy-three undergraduate management students (52% female, 48% male) took part in Experiment I, and eighteen students took part in Experiment 2 – the think-aloud sessions. The participants chose to take part in the study voluntarily and received academic credit. The study, including the initial guidance, lasted approximately thirty minutes.

The Experimental Task

We selected a specific problem domain called Online Dynamic Constraint Satisfaction Problems (DCSP) (Ghedira, 2013; Mittal & Falkenhainer, 1990) for our study. This problem domain includes business implications such as scheduling tasks to employees, or routes to drivers and is widely used in both research and practical human-computer interaction settings. DCSPs are suitable for studying LAI as they involve frequent thinking and action at different LAI.

For our experiment, we asked users to imagine themselves as designers tasked with painting the windows of a neighborhood while complying with a set of constraints. The action of painting a window can be identified at three different LAI, namely, painting a wall, a house, and a neighborhood. Each constraint was associated with one of three LAI: **Constraint 1** was linked to the high LAI (neighborhood) and required participants to "ensure that each allowed color (yellow, green, blue) is used exactly four times in the neighborhood." **Constraint 2** was linked to the mid LAI (house) and required participants to "ensure that in each of the three houses (i.e., windows 1-4, windows 5-8, windows 9-12), you: (a) use all three colors, and (b) paint the 2nd and the 4th windows in the same color but different from the remaining two windows in the house (1st and 3rd)." **Constraint 3** was linked to the low LAI (wall) and required participants to "ensure that (a) a window whose ordinal number is a prime number cannot be painted in yellow, and (b) when the next window is an even number, the two adjacent windows cannot be painted the same color."

We presented the windows to participants in three formats, corresponding to the three LAI, as shown in Figure 1:

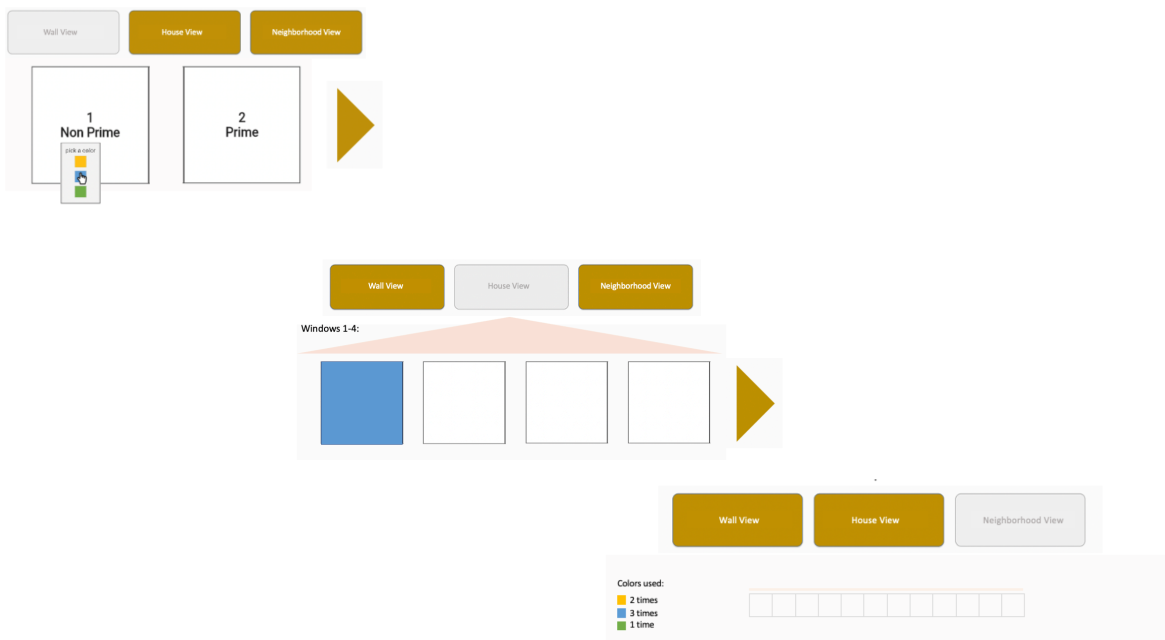

Figure 1. Experimental Environment Design (Three views at low, mid, and high)

Manipulation – Encouraging users to shift between LAI by Feedback

We developed a designated LAI feedback tool that suggests moving to a different level when needed, based on the situation and stage of progress. The feedback for the treatment group was designed with the wording "Consider shifting" and an arrow indicating moving up or down a level, depending on the recommendation and situation. The control group received feedback that indicated the number of windows they had painted so far. Figure 2 depicts the feedback design. In designing the feedback, we followed Mark Silver's (1991) decisional guidance framework, which aims to influence the way users reach a decision rather than guide them to specific decisions. We also made sure that (1) The feedback did not present new information, (2) did not guide users towards the right solution or provide hints related to it, (3) was not imperative but presented as a suggestion, (4) was based solely on system logic and not related to user performance, and (5) the placebo feedback did not add relevant information compared to the treatment group. Before the experiment, we conducted several one-on-one pilot studies to identify and correct any misunderstandings, unclear instructions, or UI issues. The stages at which the feedback is generated are based on both best practices (previous observations) and logical analysis of what stages users will benefit from shifting between LAI. We used the same stages to time feedback for both control and treatment groups, with a limit of three feedbacks during the entire session for both groups.

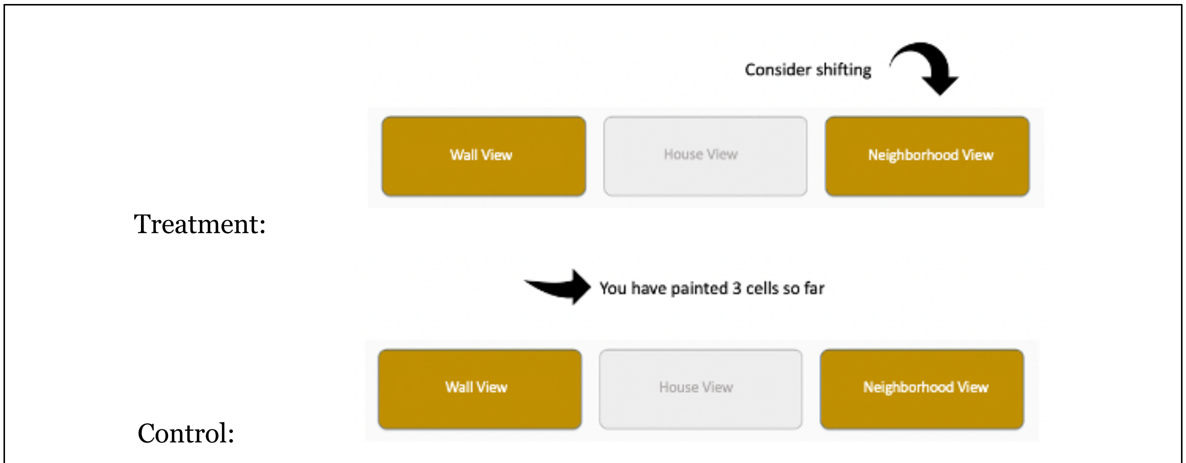

Figure 2. The Feedback Design for Treatment and control groups, respectively

Procedure

Each participant was randomly assigned to either the control or treatment group. Participants worked online with our system for sessions of approximately 20 minutes. They were provided with detailed instructions and began working on the task, receiving feedback during their interaction (placebo feedback for the control group). After completing the task, participants repeated the same sequence with a second task. The first task involved coloring windows 1-12, while the second task involved coloring windows 11-22 with the additional constraint that windows with an ordinal number divisible by three could not be painted blue.

To prevent bias and strengthen our results, we included several *noteworthy* aspects in our study. First, participants received detailed guidance regarding the task, including main instructions, constraints, and different views. They were informed that our study measured their general ability to solve a thinking problem rather than their behavior regarding the LAI. Second, to avoid memory issues, all instructions and constraints were displayed fully on the screen throughout the task, and participants could view and read the constraints as long as necessary. Third, to avoid default bias, the initial view displayed to each user was random. Fourth, to maintain motivation, participants were encouraged to do their best even if they did not feel their solution was perfect. We also ensured that all participants understood the concept of prime numbers (relevant to constraint 3) and reminded them that the number "1" is not a prime number. Fifth, the use of auxiliaries was not allowed to analyze the natural thinking and actions of participants regarding LAI in real time. Additionally, as part of the assignment's instructions, participants had to start at window number 1 and work in sequence. At each step of the process, the system allowed them to correct/change only the last window painted, encouraging participants to think carefully throughout the process.

The following measures were recorded during the session: the level of action identification the participants maintained along the task, the points at which they shifted between levels (window numbers), the points at which they received feedback, their compliance with the system suggestion to shift to a different level, their performance related to each LAI (i.e., the number of errors associated with each LAI), and the time needed to complete the task.

Results

Experiment 1

For the following analyses, we averaged the two tasks for each participant, after conducting a Paired T-test that showed no significant difference in terms of performance between the tasks (M=-0.29, SD=1.9), $t(72)=-1.29$, $p>0.2$. Of the thirty-seven sessions in the control group, thirty-two decided to stay at the same view level along the process (86%), and five decided to shift between LAI (14%). Fourteen decided to solve the problem at the mid-level view, fourteen at the high-level view, four at the low-level view and five decided to shift between LAI. Most of the participants in the treatment group (58%) did not follow the feedback to move and chose to stick to their preferred focal level. We, therefore, tested Hypothesis 1 in two steps. We first compared the treatment and control groups. The average errors, grouped by LAI, are given in the first rows of Table 1. The average number of errors in the treatment group is significantly smaller than in the control group, as hypothesized (t=2.11, p<0.05). We also measured the time to complete a task, which is shown in the rightmost column. Note that the time spent in the treatment group was significantly greater than the control group (t=2.8, p<0.01). Next, we compared (within the treatment group) those who followed the feedback versus those who did not. Those who moved resulted in significantly fewer errors at all levels, as seen in the lower rows of Table 1. Figures 3a and 3b depict these results graphically, for the comparison between groups and comparison with the treatment group, respectively.

Control (37) versus Treatment (36)- Average (sd)													
Errors by LAI												Time (sec.)	
Total errors			HL error			ML errors			LL errors				
Control	Treat		Control	Treat		Control	Treat		Control	Treat		Control	Treat
2.9 (1.91)	2.02 (1.51)		1.05 (1.09)	0.86 (1.00)		0.86 (1.13)	0.51 (0.77)		0.99 (0.95)	0.68 (0.95)		222 (101.9)	286 (93.9)
T=2.11, p<0.05			N.S.			N.S.			N.S.			T=2.8, p<0.01)	
Followed feedback (15) versus Did not follow feedback (21)- Average (sd)													
Total errors			HL error			ML errors			LL errors			Time (sec	
Follow	Not follow		Follow	Not follow		Follow	Not follow		Follow	Not follow		Follow	Not follow
0.87 (0.72)	2.91 (1.35)		0.4 (0.43)	1.19 (1.17)		0.2 (0.37)	0.74 (0.9)		0.27 (0.32)	0.98 (1.13)		329 (87)	256 (88)
T=5.3, p<0.01			T=2.49, p<0.05			T=2.18, p<0.05			T=2.35, p<0.05			T=2.5, p<0.05	

Table 1: Results from Experiment I

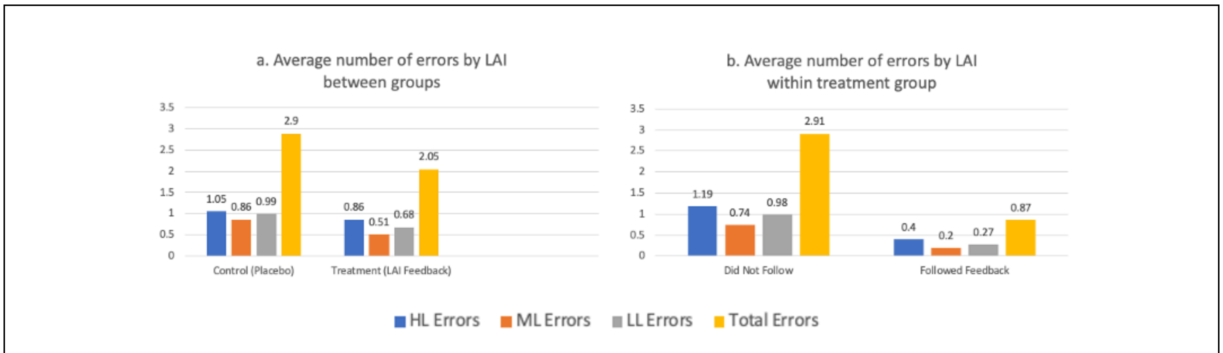

Figure 3. Average errors by selected LAI: Fig 3a. Control vs. Treatment groups; Fig 3b. between those who followed the suggestion and those who did not

Experiment 2 – Think Aloud

Think-aloud studies involve participants verbalizing their thoughts, actions, and feelings as they perform a task. This allows researchers to gain insight into users' mental processes while performing the task by analyzing their verbalizations (Ericsson and Simon, 1980). We conducted 18 one-on-one studies in which users were asked to think aloud during the assignment and reflect on their thinking regarding their actions. The instructor recorded and documented their verbal thoughts (Ericsson and Simon 1993; Harte et al. 1994) but did not guide or interact with the participants except to remind them to keep talking if they fell into silence or did not reflect their thoughts. The sessions were then analyzed using concurrent verbal protocols (CVP) (Huber et al. 1997; Williamson et al. 2000). Our main interest in the think-aloud study was to explore the feedback's contribution to users regarding two major aspects that correspond to Hypotheses 2a and 2b: (1) shifting between LAI to prevent neglect of information, i.e., the feedback serves as a guide or reminder for users to consider the different levels in their mind in order to attend to the information presented in all levels. (2) changing on-screen representations corresponding to shifts between LAI improve cognitive fit.

To explore the former (preventing neglect), we probed the cases in which users overlooked a particular level in their mind (i.e., were too focused on other levels), and thus failed to take it into account (both in mind and on-screen). This neglect may be explored both by looking at the user's actions and listening to the user's verbal thoughts (i.e., the user works on-screen at a particular level and does not consider other levels in his mind). To explore the latter (Improving cognitive fit), we probed the cases in which users considered a particular level in their mind but worked at a nonoptimal level on-screen. This lack of cognitive fit may be explored by looking at the user's actions and listening to the user's verbal thoughts (i.e., the user works on-screen at a particular view level but considers other levels in his mind).

The analysis of the CVP followed previous practices applied to decision research detailed in Harte et al. (1994). From each participant's verbal thoughts, we extracted any phrase relating to our research questions, defined as any unit that expresses a unified predicate (Berman and Slobin 1994; Trabasso and Magliano 1996). Analysis of the user actions and protocols revealed that the LAI feedback helped users prevent neglect and improve the cognitive fit by nudging them to consider the different levels during their work. Along the process, users received feedback to shift up or down according to their actions, particularly when the system detected erratic back-and-forth movement, hesitation, or position in which the feedback could benefit users and assist them in considering the different LAI properly. These are a few examples of the exact words users used during the assignment to describe the feedback they received: "*The recommendation helped me. It gave me a better vision. To see everything. To see the constraints for the numbers that come later*"; "*Oh, it really helps me, because I see what's prime and what's not prime. If I didn't get the message, I'd probably continue to the next house. It clears my head a bit because it causes me to stop and see that I'm really on the right track.*"

We analyzed all think-aloud protocols and identified phrases related to the feedback's contribution. We then categorized these phrases into two main categories that explain how LAI feedback can improve user performance in two ways (as shown in Table 2): (1) By encouraging users to switch between levels to work at the optimal level on the screen (i.e., improving cognitive FIT), and (2) by prompting users to consider all different levels during their work (i.e., preventing neglect).

1. Nudging users to consider different levels (preventing neglect):	**2. Nudging users to work at the optimal view (improving cognitive FIT):**
I would have missed that it was four and I wouldn't have used it.	*Now I can see what color I painted the first and second and look more closely.*
Now I paid attention to it. I should have seen that.	*Now I can see them in a row and it's better to see which colors I did and didn't use.*
If I hadn't received it, I might have painted the window for no reason.	*Now that it's smaller it's more focused so it's more convenient.*
If I didn't get the message, I'd probably continue to the next house.	*I can see now what is prime and what is not prime.*
I will focus more on the fact that the second and fourth windows will be the same color.	*Now I can pay attention to the limitations of the house.*
I'm simply more focused and paying attention to which limitations to refer to, each time it moved me to another perspective.	*Now, here, I have to use each of the three colors.*
I ignored it.	*I'm more comfortable seeing it that way for the second restriction.*
	Now I see what's prime and what's not prime.
	It helps to notice that in terms of colors, I don't repeat too much.

I paid too much attention to the fact that a prime number should not be yellow and to the fact that four of each color should be needed. *I forgot about that, I really only thought about the first one. I looked more at two and three.* *I didn't notice the first one, I forgot about it.* *I missed it. I kind of missed the third for some reason.*	*I'm more comfortable seeing it that way.* *It seems to help me pay attention to a specific limitation instead of looking in a scattered manner.* *It helps me every time to look at it in a way that focuses me - to look at it in a smaller or broader way.*

Table 2: The major contributions of the feedback to users

Initial Discussion and Future Work

Our study supports Hypotheses 1, 2a, and 2b by demonstrating that users tend to stay at the same focal level of action identification (LAI) while interacting with an information system, and that displaying feedback encouraging them to switch between different levels at designated points can improve performance. We found that the feedback contributes to user performance in two main ways. First, users may be aware of different LAI levels but fail to refer to them correctly due to working with an improper screen representation. The feedback can offer a better representation at a particular moment, improving cognitive FIT. Second, users may neglect different levels due to confusion, loss of focus, or improper thinking. The system can nudge them to pay attention and consider all levels during their work, preventing neglect. Interestingly, our initial findings also exhibited a kind of tradeoff between the improvement in performance and the increased time it takes to arrive at a solution. Analyzing the participants' free-form answers, several possible reasons may be considered: (1) shifting between LAI leads them to pay more attention to different details and aspects of the challenge, meaning they may need more time to solve it; (2) shifting between LAI slows them down, objectively, due to the need to get used to different sorts of views. Nevertheless, users who shift between LAI improve their performance, hence, working a bit slower but correct may be better than working faster but wrong. Figure 4 illustrates the essence of the feedback's impact.

Our study has both theoretical and practical implications. Theoretically, we extend Action Identification Theory (Vallacher and Wegner, 1987) to include the impact of information systems. Our research may serve as a catalyst, inspiring IS and HCI scholars to explore and develop methods to facilitate LAI feedback, encouraging IS users to shift between levels and, consequently, enhancing their decision-making processes, judgment, and performance. From a practical perspective, our findings offer a cost-effective approach to enhancing user performance through feedback that encourages users to switch between different levels of action identification. This is particularly significant as such feedback can be easily incorporated into existing systems, without requiring significant changes or investments. In order to further validate our findings, we plan to conduct another experiment before ICIS 2023. This experiment will compare the effectiveness of three types of LAI feedback: (1) Predefined feedback triggered by user position, (2) dynamic intelligent feedback triggered by user action, and (3) random feedback triggered randomly. This comparison will enable us to determine which type of LAI feedback is most effective in improving user performance.

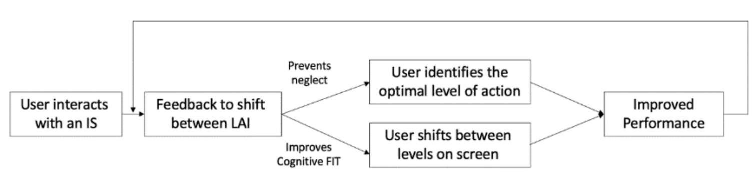

Figure 4. The cyclic contribution of LAI feedback to users in improving Cognitive FIT and in preventing neglect

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