Predictive Cognition Underlying Expert–Novice Discrepancies in Maritime Risk Perception

Masashi Sugimoto
College of Design Engineering
Shibaura Institute of Technology
Tokyo, Japan
msugi@shibaura-it.ac.jp

Noriko Nagata
School of Engineering
Kwansei Gakuin University
Hyogo, Japan
nagata@kwansei.ac.jp

Chihiro Nishizaki
Dept. of Maritime Systems Engineering
Tokyo University of Marine Science and Technology
Tokyo, Japan
chihiro@kaiyodai.ac.jp

Hitoi Tamaru
Dept. of Maritime Systems Engineering
Tokyo University of Marine Science and Technology
Tokyo, Japan
tamaru@kaiyodai.ac.jp

Koji Murai
Dept. of Maritime Systems Engineering
Tokyo University of Marine Science and Technology
Tokyo, Japan
kmurai0@kaiyodai.ac.jp

***Abstract*— This study investigated the cognitive processes underlying differences in risk perception between expert maritime pilots and novices during berthing and unberthing maneuvers. Focusing on navigational situations in which experts and novices exhibited different levels of perceived risk, we analyzed their verbal reports using the Evaluation Grid Method. The results indicated that experts continuously engaged in predictive cognition regardless of the perceived risk level, whereas novices relied on predictive cognition mainly in situations they considered risky. These findings suggest that differences in berthing and unberthing risk perception may be linked to the continuous use of predictive cognition during ship handling. Continuous predictive cognition may therefore represent one characteristic of expert maritime risk perception.**

Keywords: (un)berthing, risk perception, predictive cognition, expertise, Evaluation Grid Method

I. Introduction

Berthing and unberthing are among the most demanding processes in maritime navigation [1]. Nevertheless, expert pilots are mostly able to conduct these complex maneuvers safely. This capability is considered to be supported by the pilots' advanced cognitive judgment, particularly their risk perception process [2]. However, in such situations where risk perception diverges between experts and novices, the differences in the cognitive processes underlying their judgments have not yet been sufficiently clarified. Clarifying the causes of this divergence in risk perception between experts and novices would not only help visualize the practical knowledge acquired through expertise but also inform the design of autonomous navigation systems and educational programs that incorporate this knowledge. Therefore, this study focuses on situations in which experts and novices show markedly different levels of risk perception and analyzes the cognitive processes underlying these judgments to clarify the characteristics of expert risk cognition.

II. Expert-Novice Differences in Berthing Risk Perception

Data used in this study were collected via interviews and were identical to those used in the previous study [2].

A. Participants

Three first-class pilots (experts; all males, mean age of 51.7 years) and twelve university students (novices; nine males and three females, mean age of 22.1 years) participated in the experiment. The average duration of experience as captains and first-class maritime pilots was 10.3 years. All student participants had onboard training experience on training vessels, with an average of 89.8 days.

B. Stimuli

Five berthing/unberthing videos were used in the study. Each video consisted of a forward-view scene recorded from the actual pilot's perspective and a temporally synchronized Portable Pilot Unit (PPU) display (Fig. 1).



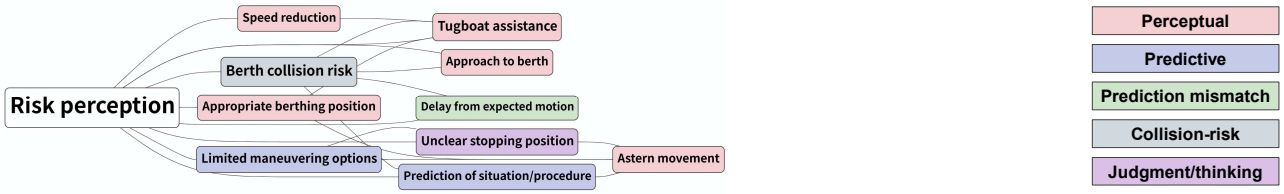
Fig. 1 Sample stimulusresented to the participants

C. Experiment Procedure

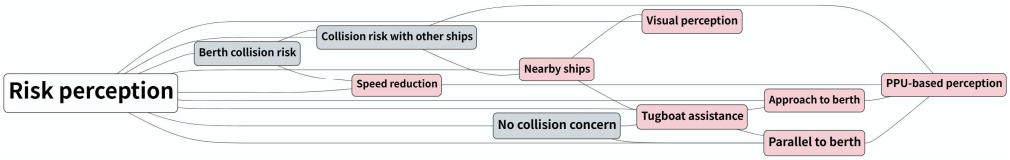
First, the interviewer presented ship-handling information, including the vessel, tugboats, and port conditions. Participants then viewed the video, which was paused 30 s after playback began. They rated the perceived risk at that moment on a five-point scale (1 = not dangerous at all; 5 = extremely dangerous) and repeatedly provided reasons for their ratings using the Evaluation Grid Method [3]. Once they had responded to the 30 s scene, playback resumed. Whenever participants perceived changes in risk level or related factors, the video was paused, and they provided ratings and explanations.

Interviews with the experts were conducted online. The interviewer controlled the videos and asked the questions, while the experts verbally responded to them. Each expert viewed one or two of the five videos, and all five videos were covered collectively by the three experts. In contrast, interviews with novices were conducted remotely using a web-based response form. All novices viewed five videos.

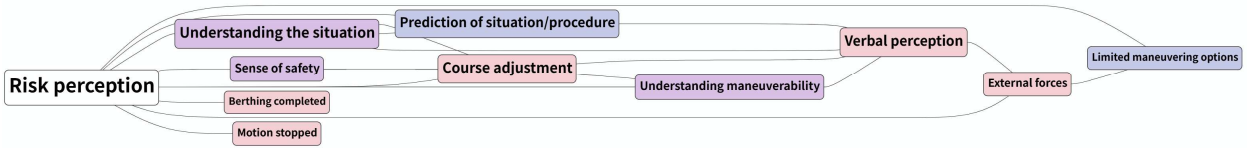
This work was supported by The Nippon Foundation research grant (Quantification (standardization) of seafarers' skills as a basis for safety assessment of unmanned ship operation systems.)



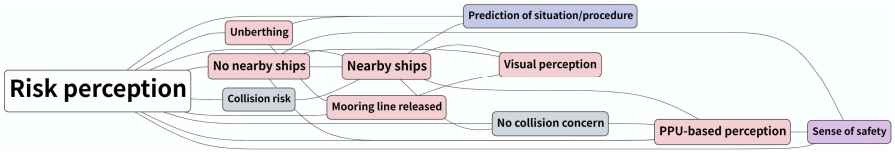
(a1) expert pilots' risk perception in situations where pilots evaluated higher risk than novices



(a2) novices' risk perception in situations where pilots evaluated higher risk than novices



(b1) expert pilots' risk perception in situations where novices evaluated higher risk than pilots,



(b2) novices' risk perception in situations where novices evaluated higher risk than pilots

Fig. 2 Risk perception structure in situations with differing risk evaluations between expert pilots and novices.

D. Analysis Process

Intervals between consecutive ratings were treated as segments of constant perceived risk. For novices, 95% confidence intervals were calculated. Across the five videos, experts rated risk higher than novices for 37 minutes, whereas novices rated it higher for 47 minutes. Interview responses from these segments were analyzed.

E. Results

Fig. 2 shows the risk perception structure in each situation. Nodes are categorized into five factors (perceptual, predictive, prediction mismatch, collision-risk, and judgment/thinking factors). To analyze discrepancies in risk perception between experts and novices, we compared the evaluation structures in situations where experts and novices assigned different levels of risk. Comparison between Fig. 2 (a1) and (b1) shows experts were engaged in prediction (blue nodes) not only in the high-risk situation (a1) but also low-risk situation (b1). In contrast, novices were engaged in prediction when they perceived high risk (b2) but were less engaged when they perceived low risk (a2). In other words, experts were engaged in prediction regardless of the perceived risk level, whereas novices were tended to predict risk only when they perceived high risk.

III. Conclusion

This study analyzed expert pilots' risk perception by focusing on differences in perceived risk levels between experts and novices during berthing and unberthing. The results suggested that experts continuously engaged in predictive cognition regardless of perceived risk level, whereas novices showed predictive cognition mainly in situations perceived as highly risky. These findings suggest that discrepancies in risk perception between experts and novices may be associated with differences in the continuous use of predictive cognition during navigation. These results highlight the importance of educational programs that prompt learners to predict what will happen in the near future, as well as autonomous navigation systems that estimate future vessel states and potential risks.

The present study is qualitative and based on a limited sample. Therefore, the generalizability of the findings remains to be established. Future studies should examine the present findings quantitatively with larger samples, potentially using the digitalized Evaluation Grid Method [4].

Acknowledgment

The authors used Perplexity and Grammarly to improve the clarity and grammar of the manuscript. The final manuscript is solely the responsibility of the authors.

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