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Implementing Skill Acquisition Research in High-Performance Sport: Reflecting on the Importance of Autonomy-Support for Successful Collaboration

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Abstract

Perceptual-cognitive-motor skills, such as visual anticipation, are pivotal for superior performance in sport. However, there are only a limited number of skill acquisition specialists working with coaches to develop these skills in athletes. The purpose of this paper is to present a brief reflection on the use of psychological strategies to create an autonomy-supportive environment to embed a skill acquisition research project in high-performance sport. The research project was conducted with the Australian national field hockey high-performance unit and investigated individual differences in expert goalkeepers' visual anticipation. The paper first discusses the role of a skill acquisition specialist, how they collaborate with coaches and athletes, and barriers to collaboration. The paper then outlines how psychological strategies can be used to create an autonomy-supportive environment to build a relationship and establish a research collaboration with a team. Further, the paper discusses the importance of continually involving coaches and athletes in the research process to facilitate their engagement and self-determined motivation to complete the project. By applying psychological strategies to create an autonomy-supportive environment, sports scientists may have greater success in overcoming the many barriers to conduct research in an elite sport setting, with the outcomes highly valuable for athlete development.

Keywords: skill acquisition specialist, autonomy-support, perceptual-cognitive-motor skills, coaching, high-performance sport

Implementing Skill Acquisition Research in High-Performance Sport: Reflecting on the Importance of Autonomy-Support for Successful Collaboration

Elite coaches and professional athletes agree that perceptual-cognitive-motor skills, such as anticipation, are critical for expert performance in sport (Fullagar et al., 2019). Yet, there are only a limited number of skill acquisition specialists working with coaches to develop these skills in athletes (Steel et al., 2014). Recent research has outlined several barriers to successful collaboration between skill acquisition specialists and coaches, such as coaches' difficulty understanding a skill acquisition specialist's role in developing athletes (Fullagar et al., 2019). It has also been reported that sport psychologists experience similar barriers when working with coaches and athletes (e.g., see Fortin-Guichard et al., 2018). To overcome these barriers and increase the uptake of collaborations in order to conduct research and/or apply skill acquisition and sport psychology principles, skill acquisition specialists and sport psychologists should utilize psychological strategies (Occhino et al., 2014).

The purpose of this paper is to provide a brief reflection upon strategies used to create an autonomy-supportive environment to embed a skill acquisition research project in high-performance sport. This paper can serve as an example of how skill acquisition specialists and sport psychologists can create more opportunities to work with coaches and athletes in order to conduct research and/or implement practices to assist in the development of athletes.

Skill Acquisition Specialists and How They Collaborate with Sports Organizations

Skill acquisition specialists are sport scientists who investigate principles and processes of perceptual-cognitive-motor skill performance and learning (Steel et al., 2014). These specialists work as academics, including graduate students, at universities and/or as practitioners with private consultancies (Steel et al., 2014). An example of a perceptual-cognitive-motor skill deemed critical for performance in high-speed interceptive sports is visual anticipation (Morris-Binelli & Muller, 2017). Visual anticipation is the capability of a

performer (e.g., field hockey goalkeeper) to pick-up visual cues from contextual (e.g., player field positioning), opponent kinematic (movement pattern), as well as object flight information to anticipate what will happen to guide action (e.g., save a penalty corner drag-flick on goal; Williams & Jackson, 2019).

It has been reported that anticipation of expert (international) athletes can be improved through video temporal occlusion training, which transfers to improved field and match performance (Morris-Binelli et al., 2021). Briefly, temporal occlusion training involves placing of a black video frame at certain events in filmed opponent's action, such as stick-ball release of the drag flicker's action. The performer, such as the goalkeeper, is then required to make a verbal, written, or simulated motor response prediction of ball location. When used for training, an unoccluded replay of the video trial is presented as feedback to facilitate learning (Morris-Binelli et al., 2021). Therefore, video occlusion is an easily accessible and low-cost way to assess and train visual anticipation in athletes.

Sports coaches consistently report that superior perceptual-cognitive-motor skills discriminate expert sports performance (Müller et al., 2019). However, sporting organizations usually assign far less resources to the assessment and training of perceptual-cognitive-motor skills compared to physical components of sports performance, such as strength and speed (Fullagar et al., 2019). Further, there are considerably fewer skill acquisition specialists than other sports science practitioners (e.g., strength and conditioning coach) embedded within high-performance units (see Steel et al., 2014). Consequently, when collaborations occur, either as a research project or through consultancy, these tend to be via adjunct agreements over relatively short-term periods.

Recent research has identified numerous barriers to successful collaboration between skill acquisition specialists and coaches (e.g., Fullagar et al., 2019; Steel et al., 2014). Key barriers are presented in Table 1.

Table 1*Barriers to Collaboration Between Skill Acquisition Specialists and Sports Teams*

Reported Barrier	Brief Description
Misrecognition	Coaches are unaware of how skill acquisition specialists can assist development of athlete skill
Access	Coaches report difficulty accessing skill acquisition specialists who are knowledgeable in their sport
Communication	Disconnect between skill acquisition specialists and coaches' preferable methods of disseminating and accessing sports science knowledge (e.g., journal articles for skill acquisition specialists and one-on-one discussions for coaches)
Perception of non-applicable research	Coaches and high-performance staff may view research that is being conducted as not applicable to their sport
Lack of coach and athlete involvement in research design	Skill acquisition specialists not consulting with coaches and athletes regarding what they believe to be important research areas in order to improve performance
Time constraints	Coaches report a lack of time to conduct research projects and implement additional athlete assessment and training programs

Collectively, these barriers make it challenging to obtain coach endorsement, which is crucial to establish and carry out research or consultancy collaborations (Fullagar et al., 2019).

Similar barriers are also experienced by sport psychologists when attempting to conduct research or implement sport psychology principles with sports teams (see Fortin-Guichard et al., 2018). Therefore, skill acquisition specialists and sport psychologists must find strategies to overcome these barriers in order to increase collaboration with coaches and athletes. This may lead to more skill acquisition specialists embedded in sports teams, which will result in evidence-based capability to develop athlete perceptual-cognitive-motor skills in order to increase athlete performance (Müller et al., 2019).

Importance of Autonomy-Supportive Environments to Increase Collaboration

It is well documented that autonomy-supportive environments increase self-determined motivation wherein a person engages in an activity because the activity is deemed important and aligned with one's values (Occhino et al., 2014). An autonomy-supportive environment is characterized by an individual (e.g., skill acquisition specialist) valuing others' perspectives (e.g., coaches and athletes), recognizing others' feelings and preferences, supporting their sense of choice, encouraging their participation in decision making, being responsive to their thoughts and questions, and providing explanation of the rationale for decisions made (Deci & Ryan, 2008; Occhino et al., 2014). This environment fosters autonomy, relatedness, and competence, which increases self-determined motivation (Deci & Ryan, 2008). Self-determined motivation has been reported to increase persistence, effort, and performance (Mallett, 2005), which may lead to greater participant engagement to complete a research project (Mageau & Vallerand, 2003). To overcome the barriers to successful collaboration, and to facilitate engagement of coaches and athletes in perceptual-cognitive-motor research projects, skill acquisition specialists might consider using some of the strategies implemented in this study to create an autonomy-supportive environment.

Implementing an Autonomy-Supportive Environment to Increase Collaboration: An Example with Hockey Australia

The research project discussed in this paper was a PhD project conducted in collaboration with Australian national field hockey coaches and goalkeepers aimed at improving visual anticipation in the penalty corner. There was no financial charge to Hockey Australia associated with the project, but the lead university did contribute a government PhD scholarship and basic consumables. Rather, benefits to coaches and athletes were the application of skill acquisition principles to enhance performance, whilst for researchers, benefits were access to the high-performance unit and publication of research findings. Table

2 provides an overview of the seven strategies outlined by Mageau and Vallerand (2003), which were implemented to facilitate an autonomy-supportive environment. Therefore, implementing these strategies increased coaches and athletes' self-determined motivation to complete the research project.

Table 2*Autonomy-Support Strategies and How These Were Implemented With Coaches and Athletes*

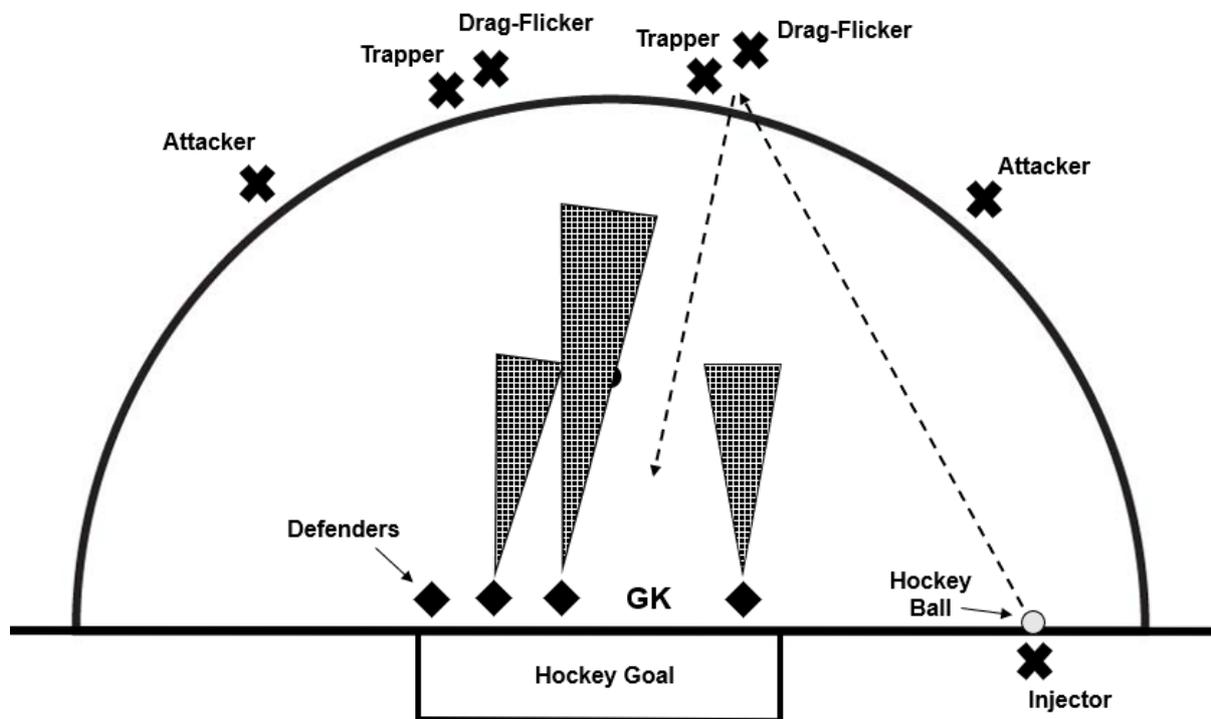
Autonomy-Support Strategy	How the Strategy was Implemented
1. Provided choice with boundaries (e.g., coaches and athletes chose between two options to solve a task)	<ul style="list-style-type: none"> ▪ <i>Semi-structured interviews</i> allowed quantitative studies to be designed around coaches and athletes' beliefs of important factors to anticipate a penalty corner, which increased sense of choice in the research project (also acknowledged coaches and athletes' perspectives, see strategy 3) ▪ <i>One-on-one discussions and small-group meetings</i> continued to foster autonomy regarding the direction of the project ▪ <i>Progressive feedback presentations</i> offered sense of choice with how to proceed with the project
2. Provided a rationale for tasks	<ul style="list-style-type: none"> ▪ <i>Small-group presentation</i> provided a detailed rationale for the project
3. Acknowledged coach and athlete perspectives	<ul style="list-style-type: none"> ▪ <i>Small-group presentation</i> obtained coaches' input on important skills which required improvement ▪ <i>Immersion with the team</i> provided more opportunity for discussions with coaches and athletes regarding planning of the research project, and identified coaches and athletes' desirable communication method ▪ <i>One-on-one discussions and small-group meetings</i> continued to acknowledge coaches' perspectives ▪ <i>Progressive feedback presentations</i> sought coaches' perspectives
4. Provided coaches and athletes with opportunities to take initiative	<ul style="list-style-type: none"> ▪ <i>One-on-one discussions, small-group presentation, and small-group meetings</i> encouraged coaches to take some initiative in determining the direction of the research project
5. Provided feedback with suggestions to resolve issues	<ul style="list-style-type: none"> ▪ <i>Progressive feedback presentations</i> consisted of recommendations rather than demands (also avoided controlling behavior, see strategy 6)
6. Avoided controlling behavior	<ul style="list-style-type: none"> ▪ <i>Immersion with the team</i> may have reduced perception that the skill acquisition specialist is controlling the direction of the research project
7. Minimized ego-involvement (e.g., avoided opportunities for athletes to compare with teammates their performance on tasks)	<ul style="list-style-type: none"> ▪ <i>Small-group presentation</i> emphasized that focus of investigating individual differences was to tailor each goalkeeper's training goals (task-involved), rather than foster comparison between goalkeepers (ego-involved)

Building a Relationship with a Team

Initial stages of the project consisted of one-on-one discussions between the second author and coaches at Hockey Australia to initiate a collaboration. These discussions established an open channel of communication regarding current key topics in skill acquisition, whereby coaches had the opportunity to ask questions to identify potential areas of research interest. This was an important first step to overcome the reported barrier that coaches are often unaware of how skill acquisition specialists can assist them in developing athletes (Fullagar et al., 2019). Through this process, coaches identified that visual anticipation might be pertinent to improve their goalkeepers' performance (strategy 4, see Table 2). Thereafter, the coaches appeared to portray increased self-determined motivation to undertake a research collaboration. This was evidenced by members of the high-performance unit, including the national men's team head coach, assistant coaches, specialist goalkeeping coach, and head of conditioning, agreeing to attend a small-group presentation on visual anticipation at the university campus.

The aim of the small-group presentation was twofold; to further educate the high-performance unit regarding the importance of visual anticipation for goalkeeping and how skill acquisition specialists can assist in developing this skill (Morris-Binelli & Müller, 2017), as well as seek their input on skills that required improvement (strategy 2 & 3, see Table 2). The presentation described that ball travel time in the penalty corner (see Figure 1) is extremely fast (approximately 500 ms), so it is important to use visual cues before ball flight to gain time to save the goal. Previous studies were presented that reported the importance of drag-flicker movement pattern cues to anticipate the penalty corner. Also, it was explained that previous studies had focused less on pick-up of contextual cues, compared groups of experts versus novices with no individual comparisons within expert samples, and had scarcely investigated training of anticipation. After the presentation, coaches reported that the

penalty corner, which provides the opposition team with a key opportunity to score, was an aspect of goalkeeping that they were interested in improving (strategy 4, see Table 2). Coaches, however, also raised concern that goalkeepers anticipating during a penalty corner was the same as “guessing” the shots goal location. The first and second authors reassured the coaches that rather than guessing, anticipation is the use of visual cues to guide action. As a result, coaches appeared more comfortable exploring how to assess and train anticipation (strategy 3, see Table 2). In addition, coaches agreed with the authors and recent literature (e.g., Müller et al., 2015) that the visual anticipation skill of goalkeepers should be assessed and trained at the individual participant level. It was emphasized to coaches that investigating individual differences in performance and learning was not aimed to foster comparison between goalkeepers, but rather, was to enable training goals to be tailored to each goalkeeper. As such, goalkeepers’ ego-involvement throughout the project was minimized (strategy 7, see Table 2). At meeting conclusion, the high-performance staff agreed to provide access to their expert goalkeepers for the first author’s PhD. Therefore, it appears, an autonomy-supportive environment during initial development of the project was critical to initiate coach engagement and formalize the collaboration (Fullagar et al., 2019).

Figure 1*Field Hockey Penalty Corner Drag-Flick Shot on Goal*

Note. The attacking team position themselves around the penalty circle, while the defenders and goalkeeper (GK) are positioned along the goal line. When the penalty corner commences, the injector passes the ball to one of the trappers, who passes the ball to the drag-flicker next to them, who then shoots the ball towards the goal. At the same time, the defending players run out towards the drag-flicker in an attempt to block the shot at goal.

Thereafter, the first author made a deliberate attempt to immerse himself within the high-performance unit (strategy 3 & 6, see Table 2). Consequently, the lead author attended approximately 25 training sessions per year for three years to learn more about the penalty corner, as well as to have one-on-one conversations with coaches and athletes regarding how they thought the research team could assist in the training of visual anticipation. This was imperative to build a sense of relatedness and acknowledge that coaches and athletes have expertise that can be utilized to fine-tune the research project (strategy 3, see Table 2). In addition, immersion within the team allowed the researchers to identify the coaches' preferable communication method (face-to-face discussions) to plan each phase of the

project. Consequently, the researchers were able to obtain timely information to progress the project (Fullagar et al., 2019).

Continually Involving Coaches and Athletes in the Research Process

The first study in the research project consisted of semi-structured interviews with the coaches and goalkeepers to understand their beliefs about important factors for anticipation. These interviews had four main benefits to the overall project. First, that visual anticipation does not refer to “guessing” was also clarified to athletes as done previously for coaches (strategy 3, see Table 2). Second, they continued to create relatedness by conveying an interest in the coaches and athletes’ experiences as experts within their domain (strategy 3, see Table 2; Mageau & Vallerand, 2003). Third, the interviews addressed a gap in the anticipation literature regarding knowledge of what expert coaches and athletes consider to be critical factors for anticipation (see Morris-Binelli et al., 2020). Fourth, insight into the beliefs of factors deemed important to anticipate guided the design of quantitative studies to address not only gaps in the literature, but also athletes and coaches’ interests and priorities (strategy 3, see Table 2). This gave the athletes and coaches an increased sense of choice in the research project (strategy 1, see Table 2). For example, coaches and goalkeepers reported desire to train against opposition drag-flickers to gain exposure to the different movement patterns they face in competition. To illustrate this further, when one goalkeeper was asked what they believed would make them an even better goalkeeper, they replied: “more [drag]flicks on [against] guys who have different [movement] techniques.” As a result, one of the studies in the project included video temporal occlusion training that used match footage of opposition drag-flickers as the stimuli to improve goalkeepers’ anticipation. Therefore, seeking the perspectives of coaches and athletes was crucial to planning and implementation of the project, which was a reported barrier to implementing skill acquisition principles in sport that was overcome by the research team (Steel et al., 2014).

In addition to the interviews, numerous one-on-one and small-group meetings were held to plan specific details of the studies to improve anticipation. A major point of interest from the coaches' perspective was the role the goalkeepers' own defensive runner has in defending a penalty corner. Coaches informed us that at international level, the runner typically executes two run types: (1) a "tight" run, whereby the runner's body passes over the penalty spot restricting the drag-flickers capability to shoot to the left side of the goal, and (2) a "loose" run, whereby the runner's body is to the left of, and misses, the penalty spot, which allows the drag-flicker to shoot towards the left side of the goal. As a tight or loose run can determine the likelihood of the number of goal locations the drag-flicker can shoot towards, it was agreed that the defensive runner could act as contextual information (i.e., player positioning), which the goalkeepers could read in order to anticipate (strategy 1 & 3, see Table 2). Accordingly, the defensive runner was filmed and included in the video temporal occlusion test and training phases of the project. Therefore, the research team was able to gain insight into the use of both kinematic and contextual information, which was important from the coaches perspectives' and advanced knowledge of expert anticipation (Williams & Jackson, 2019).

Along with the one-on-one and small-group meetings, we also provided progressive feedback to the coaches and athletes, which summarized the main findings and provided recommendations of what should be investigated in the next phase of the project (strategy 5 & 6, see Table 2). For example, after the video temporal occlusion test, which identified individual differences in emerging-expert and expert goalkeepers' anticipation skill (Morris-Binelli et al., 2021), the first and second authors presented these results to the high-performance unit. At the end of the presentation, several recommendations were offered, which would address important gaps in the literature to advance knowledge of expert anticipation (Morris-Binelli & Müller, 2017). They included: (a) video temporal occlusion

training using match footage to improve goalkeeper's pick-up of contextual and kinematic information, (b) investigation of whether this training leads to improvements in the goalkeepers' field and match performance, and (c) video temporal occlusion assessment six-months post-training to determine whether training benefits are retained. In line with the predictions of implementing strategies 1, 3, 5, and 6 (see Table 2), the coaches agreed to conduct the next phase and were excited in the potential benefit the training could have to the goalkeepers' performance.

In a later meeting regarding the logistics of temporal occlusion training, the head coach expressed interest about knowing the distance the goalkeepers missed the ball when attempting to save and whether the training would decrease this distance (strategy 4, see Table 2). Accordingly, in the field test, which required the goalkeepers to save live penalty corner drag-flicks before and after the video temporal occlusion training, distance (in cm) between the ball and saving limb was measured. Tailoring the design of the field test to align with a specific interest of the coach (strategy 1 & 3, see Table 2) was instrumental in convincing the coaches to conduct a field test, which is often challenging in high-performance sport due to busy schedules and athlete physical workload restrictions (Fullagar et al., 2019). Further, as distance to the ball was important to the coaches (strategy 3, see Table 2), they approved the number of drag-flicks we required across test to re-test phases to identify individual differences. Including the coaches' perspectives and allowing choice in the study design (strategy 1 & 3, see Table 2) had a significant benefit to the coaches' self-determined motivation to conduct the overall training intervention. Observable behaviors that indicated this included: (a) coaches identifying a four-week block to implement the training, (b) agreement by coaches and athletes on set times during the week when the training would occur, (c) the head coach having these times listed on the whiteboard in his office, and (d) allowing the training and field test to be conducted during regular training sessions.

Conclusion and Future Collaborations

Utilization of the strategies discussed throughout this paper allowed the research team to conduct studies with international and national level athletes to advance knowledge of visual anticipation. Specifically, we were able to address a gap in the literature regarding coaches and athletes' beliefs of important factors for anticipation (see Morris-Binelli et al., 2020). In addition, we were able to identify individual differences in expert goalkeepers' pick-up, and integration, of contextual and kinematic information for anticipation. Through video temporal occlusion training this capability was improved for those goalkeepers who received the intervention and was retained for six-months on a video test. Importantly, video temporal occlusion training appeared to benefit field and match performance (see Morris-Binelli et al., 2021).

High-performance sport is often a stressful and time-constrained environment, whereby coaches and athletes are required to meet numerous commitments outside of training and competition (Olusoga et al., 2009). In order for skill acquisition specialists, and other sports practitioners, to implement applied research, it is imperative to foster coaches and athletes' motivation to increase the chance of collaboration. Based on our experience working with a national high-performance team, we strongly recommend sports scientists and sport psychologists employ the strategies discussed herein to create an autonomy-supportive environment between themselves and coaches and athletes. In doing so, sports scientists and sport psychologists may have greater success in overcoming the many barriers to conducting research in an applied sport setting, which is crucial to prepare athletes for competition. Despite our positive experience, we largely focused on fostering autonomy and relatedness, and to a lesser degree, competence. As all three are important to create autonomy-supportive environments (Mageau & Vallerand, 2003), future collaborations may need to consider ways to further facilitate competence. For example, coaches could be invited to participate in

publications and/or presentations that discuss the planning, implementation, and application of findings related to applied sport research projects.

Reply From Dave Staniforth: National Goalkeeping Coach at Hockey Australia

I thank the authors for the interesting article and the opportunity to comment. The implementation of strategies discussed throughout the paper were very effective in creating a positive working relationship between the authors and coaches at Hockey Australia. I believe these strategies increased the coaching staff's motivation to complete the project, as we were greatly involved throughout the collaboration. From the initial meetings, interviews, and subsequent meetings, it was clear that the researchers were interested in my opinion as well as the perspectives of the other coaches regarding the direction of the research project and the design of each study. I greatly appreciated this approach and noted at the time that it sparked greater interest in the research topic, as well as an increased desire to complete the studies. This has not always been my experience when collaborating with sport science researchers. Often, the scientist will tell coaches what needs to be investigated to improve performance, without asking for the coaches' view or involving them in the design of the studies. A behaviour by the first author that I found particularly helpful was that he would frequently come to training to discuss the next phases of the project with me face-to-face. He also always portrayed a sense of patience and understanding regarding the busy schedules and pressurized environment of high-performance sport. This was important because this environment often makes it difficult to organize additional activities, such as those that come with trying to conduct research. The quick face-to-face communication allowed me to easily and quickly organize suitable timeframes to conduct the next task required to keep the project running. I also found the provision of feedback to the high-performance unit after each milestone instrumental in keeping the coaches involved, as well as ensuring that our opinions and recommendations were heard. Overall, this project allowed me and the other coaches to

investigate and apply key principles of visual anticipation, which provided us with a thorough understanding of how we can fine-tune the training environment to improve goalkeepers' penalty corner performance.

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