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DOES USE-OF-FORCE SIMULATION TRAINING IN CANADIAN POLICE AGENCIES INCORPORATE PRINCIPLES OF EFFECTIVE TRAINING?

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Numerous police agencies in Canada incorporate use-of-force simulation training into their overall instructional regime. A prominent theory of learning, known as cognitive load theory, suggests that in order for this training to be effective, instructional methods must facilitate the acquisition and automation of task-relevant schemas without overwhelming the limited processing capacity of the learner. In this article, several instructional effects, proposed and supported by the cognitive load literature, are discussed. These training effects operate by minimizing unnecessary cognitive demands, by drawing on instructional methods that enhance schema acquisition, and/or by carefully managing the inherent complexity of the to-be-learned material. The argument is advanced that although use-of-force simulation training may be able to capitalize on many of these effects, at present there is little evidence to suggest that it currently does. The authors conclude by discussing the urgent need to assess how the knowledge gained from cognitive load theory might serve to enhance the effectiveness of use-of-force simulation training.

Keywords: police, use of force, simulation training, training factors, cognitive load theory

Use-of-force training has been an integral component of police training programs for more than a century (Arnspiger & Bowers, 1996). Recently, however, new and innovative instructional approaches have been introduced. Perhaps the most progressive approach currently included in the training arsenal of Canadian police agencies is use-of-force simulation training (Canadian Police College, 2003). Modern use-of-force simulators expose police officers to highly realistic and interactive scenarios whereby trainees can learn to make appropriate decisions using a wide range of use-of-force options (Seymour, Stahl, Levine, Ingram, & Smith, 1994). These simulators have allowed police agencies to move beyond the point of solely offering isolated training in specific skill areas (e.g., marksmanship). Currently, the focus is on teaching officers the appropriate application of skills under field-compatible conditions (Stock, Borum, & Baltzley, 1998).

Although the concept of use-of-force simulation training may be intuitively appealing, there has been sparse empirical research conducted to date on its

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effectiveness in the law enforcement domain. Indeed, an exhaustive literature search yielded just four studies directly relevant to the topic (Boyd, 1992; Helsen & Starkes, 1999; Justice and Safety Center, 2002; Scharr, 2001). To our knowledge, Helsen and Starkes's (1999) study represents the first and only published attempt to use objective measures of effectiveness in evaluating use-of-force simulation training in a law enforcement context. Results of this investigation suggest that simulation training can indeed facilitate the acquisition and expansion of adaptive behavioral responses when dealing with realistic use-of-force situations. Moreover, such training heightens a trainee's confidence in his or her ability to aptly engage in use-of-force decision making.

Despite the scarcity of empirical research on simulation training in the policing context, a wealth of psychological research has examined training more generally. This body of literature provides a basis from which conclusions may be drawn about the potential effectiveness of use-of-force simulation training as currently practiced in Canada. More specifically, several theories exist that may serve to promote an understanding of the learning processes that occur within such training contexts.

The Purpose of the Review

The objectives of this review are fourfold. First, we introduce readers to one highly established theory of learning called *cognitive load theory* (CLT). Second, we outline specific factors derived from CLT that are likely to enhance learning. Third, we discuss the potential application of these factors to use-of-force simulation training contexts. Fourth, we propose that although these factors can theoretically be incorporated into use-of-force simulation training, they are currently not being considered in any systematic fashion by Canadian police agencies. We conclude the article with some recommendations intended to allow use-of-force simulation training to achieve its potential.

Examining the effectiveness of use-of-force simulation training is important for several reasons and is especially timely because this training method has been adopted by police agencies internationally (Canadian Police College, 2003; Justice and Safety Center, 2002). First, few police officers will go through their career without encountering complex use-of-force scenarios (Walma & West, 2002). Therefore, it is imperative for both the safety of police personnel and the general public that officers receive the training required to render sound use-of-force decisions. Second, police officers will frequently be summoned to court for the purpose of justifying their decisions regarding use-of-force encounters (e.g., *MacPhee v. The Ottawa Police Services Board*, 2003). Participating in a high-quality use-of-force training program should enable these officers to provide such testimony in a more defensible manner. Finally, courts in Canada and elsewhere have occasionally considered whether police agencies should be found liable for providing insufficient and/or inappropriate use-of-force training to their officers (e.g., *Berntt v. The City of Vancouver*, 1999). Relying on training programs that are theoretically sound and evidence driven should reduce future debate of this kind.

Modern Use-of-Force Simulation Training

Before presenting CLT as a theoretical framework for understanding and potentially enhancing use-of-force simulation training, we provide a rudimentary overview of use-of-force simulators and their applications. The focus is on a simulator manufactured by Firearms Training Systems (FATS; 2003) because this system is used by the majority of Canadian police agencies at present (Canadian Police College, 2003).[1]

Like other modern use-of-force simulators, FATS features a life-size screen that permits the projection of high-quality video images. Many scenarios currently exist, each relating to a realistic use-of-force situation that may be encountered by police officers (e.g., a domestic dispute; FATS, 2003).[2] In contrast to earlier use-of-force training scenarios, those presented by FATS are extremely realistic and allow for a high level of trainee interaction. In large part, this is the result of seamless branching technology, which can either be computer or instructor controlled (FATS, 2003). Computer controlled branching functions in response to the trainee's infrared-light emitting weapons (including firearms, tasers, batons, and chemical spray). Essentially, the trainee's action or lack thereof automatically lowers or raises the level of threat presented on the video without interrupting the motion picture. Hence, the on-screen consequences of a trainee's decision provide immediate performance feedback. Instructor controlled branching can override the preset computer programmed branching alternatives in order to modify the outcome of a scenario on the basis of the trainee's actions. The instructor can also control a variety of environmental factors in a given scenario (lighting, etc.).

For feedback purposes, FATS can replay the actions of the trainee using a picture-in-picture format (FATS, 2003). In addition, after the training session is complete, the simulator can provide a printed summary of the trainee's performance, highlighting shooting accuracy, judgment errors, and additional performance measures. The use-of-force instructor can also provide detailed comments to the trainee about his or her performance independent of the simulator's output. More specifically, the instructor can provide an assessment of whether a use-of-force response represented an appropriate judgment according to predetermined standards of performance. The learner can then be exposed to additional scenarios to refine his or her use-of-force decision making. Moreover, the instructor can discuss the legal ramifications of the trainee's decisions and provide recommendations regarding how one might best describe and explain such decisions before a court of law.

The application of FATS in Canadian police agencies does not appear to have been based on any formal analysis of training needs. Indeed, a recent survey conducted by the Canadian Police College (2003), which is discussed in more detail later in this review, suggests that only about 14% of police agencies in

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[1] Other simulators, such as the PRISM simulator used by many American police agencies, are similar to FATS with respect to their features and method of operation (Justice and Safety Center, 2002). Hence, the ensuing discussion likely generalizes to training delivered on these alternative simulators.

[2] In addition to these interactive scenarios, FATS also allows for marksmanship training by simulating traditional firing lanes with bull's-eye type targets.

Canada that use use-of-force simulation training have actually conducted an evaluation of this training approach. However, some information is available on how these agencies incorporate FATS into their instructional regime. For example, it is clear from the Canadian Police College (2003) survey that most Canadian police agencies use simulators for both practice and testing, primarily during use-of-force refresher training. The emphasis in refresher training is on improving marksmanship, tactical, and decision-making skills. However, a number of Canadian police agencies also use FATS to train new recruits and specialized officers, such as emergency response team members (Canadian Police College, 2003).

The focus in this article is on use-of-force simulation training generally (i.e., when delivered to officers of varying levels of expertise), though much of the discussion relates to the importance of considering learner experience when developing, implementing, and evaluating simulation training programs. Indeed, in our discussion of CLT below, we show that training techniques that are effective with novices can often become ineffective when applied to more experienced learners and vice versa (Kalyuga, Ayres, Chandler, & Sweller, 2003; Paas, Renkl, & Sweller, 2003).

Definitions

CLT

First proposed in the late 1980s and expanded throughout the 1990s, CLT proposes ways that instructional material can be presented to trainees to promote learning. CLT considers the structure and complexity of the task in relation to the individual's cognitive architecture, which facilitates the processing of the to-be-learned information (Paas et al., 2003). This theory explicitly considers the restrictive capacity of working memory (WM) and the virtually unlimited capacity of long-term memory (LTM; Kirschner, 2002; Paas et al., 2003; Sweller, 1988).[3]

Cognitive architecture encompasses various systems of human memory, including WM and LTM (Paas et al., 2003). According to CLT, the ability of these systems to process information is aided by the acquisition and automation of cognitive structures referred to as schemas (Paas et al., 2003).

WM

WM is defined by Baddeley (1992) as "a brain system that provides temporary storage and manipulation of the information necessary for such complex

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[3] There are a number of other theories that pertain to learning in training contexts, constructivism being the primary alternative to CLT. Constructivism posits that learners acquire knowledge and solve problems by actively constructing their own solutions in a self-directed manner within a given environment (Kirschner, Sweller, & Clark, 2006; Tennyson & Schott, 1997). In contrast to CLT, advocates of constructivism argue that providing learners with explicit instruction interferes with the process of knowledge construction (Wickens, 1992). There are a variety of reasons as to why the focus is on CLT in this article and not on constructivism—the most important one being that CLT is corroborated to a larger extent by empirical research. In contrast, a large number of empirical studies have failed to support the assumptions underlying constructivism (e.g., Inhelder, Sinclair, & Bovet, 1974; Lee & Thompson, 1997; Shulman & Keisler, 1966).

cognitive tasks as . . . learning and reasoning" (p. 556). WM is used during any conscious cognitive activity to organize, compare, or manipulate information (Narayanan, 2005). Any piece of information that needs to be learned (e.g., a word, a letter, a number) is referred to as an element (Sweller, 1994). At any given time, WM is limited to the processing of approximately seven single elements or two or three interacting elements (Groeger, 1997; Kirschner, 2002; Paas et al., 2003).

LTM

LTM is the system used to store knowledge that is not currently being processed in WM but is needed for intellectual understanding (Bower, 1972). Unlike WM, LTM is unlimited and stores information that may be retrieved as required (Bower, 1972). LTM stores information in the form of schemas, which are developed after repeated exposure to information or by the deliberate rehearsal of a task (Groeger, 1997). Proficiency in any domain is due to knowledge accumulation and storage in LTM, coupled with the ability of WM to efficiently retrieve that knowledge by recalling or recognizing it (Kirschner, 2002).

Schemas

The adequate processing of information by a learner results in the formation of schemas, which are stored in LTM. Schemas are "cognitive structures that serve to organize information into meaningful concepts" (Tennyson & Elmore, 1997, p. 58) by incorporating "multiple elements of information into a single element with a specific function" (Paas et al., 2003, p. 2). For example, a schema in the use-of-force context can represent anything from a type of weapon to the various behaviors in which an officer typically engages when using a firearm. Schemas generally serve two functions (Sweller, van Merriënboer, & Paas, 1998). First, acquired schemas assist with the storage and organization of large amounts of information in LTM. Because of their network structure, schemas serve as efficient storage mechanisms (i.e., a large amount of information can be stored without placing a strain on one's cognitive resources; Kirschner, 2002). Second, once schemas are automated, they serve to reduce WM load by allowing learners to quickly access information from LTM (Marshall, 1995). According to CLT, training contexts that foster schema acquisition and automation are likely to be more effective than those that do not (Kirschner, 2002). In order to enhance training in this way, proponents of CLT argue that trainers must consider the cognitive load placed on the trainee when learning a particular task.

Types of Cognitive Load

According to CLT, three types of cognitive load exist: intrinsic, extraneous, and germane. Each one bears an impact on the load placed upon WM. Specifically, "WM load is affected by the inherent nature of the [to-be-learned] material" (Kirschner, 2002, p. 4) (i.e., intrinsic load) as well as by the ways in which the to-be-learned material is presented to the learner (i.e., extraneous and germane load).

Intrinsic cognitive load. Intrinsic cognitive load is generated by the inherent complexity of the information being conveyed to the learner. Intrinsic load increases with the complexity of the information. Intrinsic load is determined largely by the amount of interactivity that exists between the elements of the to-be-learned information, which can range from low to high (Paas et al., 2003; Pollock, Chandler, & Sweller, 2002). Information that is low in element interactivity can be learned on its own and an understanding of the material is not conditional on the prior learning of other elements (Paas et al., 2003). For example, upon receiving instruction on how to shoot a Glock pistol, one needs only to learn how to aim and pull the trigger. Each one of these elements can be learned independently of the other. Information that is low in element interactivity generates a low level of intrinsic load because for one to learn it, only a limited number of elements must be processed simultaneously in WM (Sweller & Chandler, 1994).

Information that is high in element interactivity can also be taught element by element. However, this type of information cannot truly be learned until one fully appreciates the manner in which these elements interact with one another (Paas et al., 2003). For example, an officer entering the scene of a bank robbery with his or her Glock pistol will not only need to consider those elements that are required to fire his or her weapon (aiming and pulling the trigger) but will also be forced to consider a range of additional elements that will determine whether a shot should actually be fired (e.g., "Is the officer justified in shooting the suspect?" "Are there any bystanders in the bank?" "Is police backup close?"). In such naturalistic scenarios, attention must be accorded to all of the aforementioned elements, which must be processed collectively. As a result, material of this nature will impose a high intrinsic load.

Because element interactivity is inherently tied to the information presented to the learner, the associated intrinsic load cannot be altered by changing the instructional format (Paas et al., 2003). Consequently, the only way to manage intrinsic load in a situation in which the trainee must learn a complex task is by initially giving the learner a simpler task that omits some of the interacting elements. This is especially true if the trainee is a relative novice (van Merriënboer, Kirschner, & Kester, 2003). As stated previously, however, the simultaneous processing of all essential elements must eventually occur for effective learning to take place; it is only then that a complete understanding of the to-be-learned information can be achieved (Paas et al., 2003).

Extraneous cognitive load. Extraneous cognitive load consists of extra and unnecessary demands placed on WM, which are produced by the learning materials and methods of instruction used in the training context (Clark, Nguyen, & Sweller, 2006). Extraneous load directly interferes with learning because limited WM resources are expended on irrelevant activities (i.e., activities that are unrelated to schema acquisition and automation; Paas et al., 2003). Given its source, extraneous load can be reduced by manipulating the manner in which information is presented to the learner.

Consider a situation in which an officer is required to learn marksmanship skills. Typically, this task is accomplished by initially presenting the officer with stationary bull's-eye type targets before eventually moving toward the presentation of mobile targets (i.e., a perpetrator) within interactive training scenarios. Given the ultimate goal of teaching officers to respond effectively to real-world events, the use of stationary targets in training is most likely unnecessary and potentially counterproductive (Morgan, 1991). More specifically, stationary practice may foster schematic representations that are in fact inappropriate to the target task of responding effectively to perpetrators that are in motion. As a result, the trainee may experience high levels of extraneous load when attempting to mentally integrate what was learned in stationary target practice with what is presented in interactive training, thus preventing the acquisition of appropriate schemas. Proponents of CLT would argue that the appropriate instructional strategy is the removal of unnecessary training components (i.e., stationary target practice) in order to decrease the extraneous load experienced by the learner (Cooper, 1998).

Extraneous load becomes a particularly important consideration in instructional settings when intrinsic cognitive load is high because these two types of load are presumed to be additive (Paas et al., 2003). Accordingly, if intrinsic load is low, the level of extraneous load becomes less important because the total load experienced by the trainee may still be below the threshold of processing capacity afforded by WM. Therefore, instructional formats designed to reduce extraneous load are most beneficial when element interactivity is high (i.e., in typical cases of use-of-force training; Paas et al., 2003).

Germane cognitive load. In contrast to extraneous load, germane cognitive load promotes learning through direct efforts to enhance schema acquisition (Moreno, 2004). However, both germane and extraneous load are generated from the method of instruction. Essentially, the goal from a CLT perspective is to increase germane load whenever possible within the bounds of WM capacity (Paas et al., 2003). This can be accomplished in a variety of ways. For example, although learning may occur more easily if simple scenarios are provided to trainees, the skills that emerge from such training will be more limited than skills built from more realistic (i.e., complex) training examples (e.g., simulating weapon malfunctions during a scenario;[4] Clark et al., 2006). Under the latter circumstances, a higher cognitive load is imposed on the learner. However, the learner will ultimately develop a broader schematic framework, allowing him or her to perform more effectively in a wider range of use-of-force situations.

As mentioned earlier, the various types of cognitive load are additive. Therefore, the total cognitive load experienced by a learner during training is equal to intrinsic plus extraneous plus germane load (Kirschner, 2002). It is assumed that if a trainee experiences low intrinsic load as a result of the nature of the information being learned and/or low extraneous load as a result of the use of appropriate instructional procedures, the result will be unused WM capacity. This situation may be further enhanced by structuring the training in such a way as to promote schema acquisition (i.e., increasing germane load; Kirschner, 2002; Sweller et al., 1998). However, increasing germane load will be successful only if the total cognitive load experienced by the trainee is within the limitations dictated by WM (Kirschner, 2002). In other words, intrinsic and extraneous load must be low enough to ensure that adding germane load will not overburden the trainee.

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[4] This is a relevant example given that weapon malfunctions in use-of-force situations are not uncommon (National Law Enforcement and Corrections Technology Center, 2000).

Differences Between Novices and Experts: The Effects on Cognitive Load

A primary component of CLT relates to the effect of the learner's level of expertise on cognitive load (and by extension, on one's ability to learn). This factor is a main focus in the remainder of this article. When a trainee has little prior knowledge in a given domain, schema acquisition has not yet occurred. Therefore, cognitive load during learning will necessarily be high, unless the task is incredibly simple (i.e., low intrinsic load; Kalyuga, Chandler, & Sweller, 1998; Moreno, 2004; Sweller, 1988). However, once a learner becomes proficient in a particular domain, the amount of cognitive load will diminish when the same type of complex information is encountered because appropriate task-relevant schemas have already been acquired and automated. As a result, training for novices and experts can, and should, be structured differently (e.g., experts may be able to cope with higher amounts of intrinsic and/or germane load). As already indicated, if training is not tailored to the experience level of the learner, a phenomenon known as the *expertise reversal effect* can occur, whereby "instructional techniques that are effective with novices can lose their effectiveness and even become ineffective when used with more experienced learners" (Paas et al., 2003, p. 3).

The Instructional Implications of CLT

From a cognitive load perspective, the quality of instruction in any domain can be improved through an appreciation of cognitive architecture and the various types of cognitive load that learners can experience. Through a growing number of empirical studies conducted since the 1980s, cognitive load theorists have developed and proposed numerous instructional strategies that are demonstrably superior to other training approaches (e.g., constructivist approaches). In this section, some of the primary instructional design strategies that have emerged from CLT are reviewed. These strategies focus on decreasing extraneous load, increasing germane load, or managing intrinsic load.

Decreasing Extraneous Load

Through the application of several instructional strategies, it is possible to reduce extraneous load so that one's limited cognitive resources can be used for schema acquisition and automation. Related to these strategies are a number of training effects, including the worked example, problem completion, split-attention, and redundancy effects.[5]

Worked example effect. The *worked example effect* refers to the enhancement of learning that occurs when worked examples are incorporated into the

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[5] This is not an exhaustive list of the training effects discussed in the CLT literature in relation to extraneous load. Indeed, some of the effects not discussed in this article (e.g., the modality effect, whereby learning is enhanced when visual information is explained by auditory narration) are among the most robust effects found by proponents of CLT (e.g., Mousavi, Low, & Sweller, 1995). These additional effects are not discussed because their specific application to use-of-force simulation training is unclear. Because of space limitations, only those effects that are clearly relevant to this form of training are discussed.

training context. In contrast to conventional practice problems, worked examples are "step-by-step demonstration[s] of how to perform a task or solve a problem" (Clark et al., 2006, p. 190). For example, a conventional practice problem typically consists of providing students with a problem, which they are asked to solve. A worked example, on the other hand, consists of presenting the worked-out solution in addition to the problem (Sweller & Cooper, 1985). In contrast to traditional practice problems in which one's limited WM resources are dedicated to identifying the best solution to a problem, the study of worked examples focuses the learner's attention on the relevant problem-solving information, thus decreasing extraneous load and facilitating learning (Clark et al., 2006).

Although the use of worked examples has been demonstrated to enhance learning (Carroll, 1994; Cooper & Sweller, 1987; Paas & van Merriënboer, 1994; Sweller & Cooper, 1985), they are not always an appropriate instructional choice. For example, the beneficial effects of this instructional strategy tend to be achieved primarily with novice learners. As argued by Clark and her colleagues (2006), "this is because once a learner has acquired a basic schema for the skill or concept, he learns best by applying the schema to problems, rather than investing a redundant effort in studying more worked examples" (p. 197). In addition, a major drawback to using worked examples is the fact that many learners may not actually pay attention to and thoroughly study the example (Clark et al., 2006). Without focused attention, relevant schema acquisition will be prevented, and the benefits of this strategy will be lost. As discussed below, to ensure that this does not occur, trainers can incorporate completion examples into their training programs.

Problem completion effect. A completion example is a hybrid between a conventional practice problem and a worked example (i.e., portions of the problem are provided in a step-by-step solution format, and other parts require completion by the learner; Clark et al., 2006). The use of completion examples has been shown to reduce extraneous load and enhance learning outcomes among trainees, resulting in the *problem completion effect* (Clark et al., 2006; Paas, 1992; van Merriënboer & de Croock, 1992). For example, in a study involving the teaching of basic statistics, Paas (1992) found that students required to study conventional practice problems had to exert more mental effort during the learning phase and exhibited poorer transfer performance compared with students presented with completion examples. As Clark et al. (2006) argued, like worked examples, completion examples reduce a learner's cognitive load by focusing the learner's attention on the task-relevant information included in the worked-out portion of the example. In addition, requiring the learner to complete the unfinished portion of the example ensures a deep level of cognitive processing, which has been shown to enhance learning (Clark et al., 2006).

Exactly how completion examples should be incorporated into training is still a question under investigation. What cognitive load theorists do know is that the degree to which the examples should be completed for the learner and the rate at which completion examples should be incorporated into training depends on the complexity of the material relative to the expertise of the student (Cooper, 1998). For example, it is currently recommended that novices receive more complete problems and more experienced learners receive less complete problems (Clark et al., 2006). In addition, it is recommended that completion examples be introduced into training contexts more rapidly for learners with a higher level of expertise (Cooper, 1998).

Split-attention effect. Although it is essential for learners to attend to relevant information provided in worked or completion examples, it is also necessary to ensure that their attention is not split between multiple sources of information (e.g., by separating information into a diagram and a block of text rather than incorporating the text into the diagram; Clark et al., 2006). In the CLT literature, split attention is defined as "the extraneous cognitive load imposed when the learner needs to integrate two or more dependent sources of . . . information that are physically separated" (Clark et al., 2006, p. 77). The enhancement of learning that occurs through the integration of these separate sources of information (in the form of faster learning, lower mental exertion, enhanced test performance, etc.) is referred to as the *split-attention effect* (Chandler & Sweller, 1991, 1992; Sweller & Chandler, 1994; Tindall-Ford, Chandler, & Sweller, 1997).

As was the case with the previously discussed training effects, the split-attention effect also appears to be dependent on the complexity of the to-be-learned information. For example, Cerpa, Chandler, and Sweller (1996) determined that an integrated instructional format enhanced learning outcomes with respect only to high complexity tasks. As a possible explanation for this finding it has been suggested that when the information provided to the learner is self-explanatory in only one format (e.g., either as a diagram or text), the split-attention effect will not be observed (Clark et al., 2006). Thus, for low complexity information, the integration of multiple sources of information (e.g., a diagram and text) may be unnecessary.

Redundancy effect. Although it is often beneficial to present information to a learner in an integrated format, it also is important to ensure that the integrated sources of information are in fact necessary for one's understanding of the to-be-learned material (Cooper, 1998). If the integrated information is redundant (i.e., the two sources of information provide the learner with similar knowledge), then one of the sources of information can be eliminated. The enhancement in learning efficiency that occurs when redundant information is removed from training is referred to as the *redundancy effect* (Chandler & Sweller, 1991; Leahy, Chandler, & Sweller, 2003).

The redundancy effect emerges because despite the fact that the superfluous information adds little to one's understanding of the to-be-learned material, it is nonetheless processed in WM (Clark et al., 2006). Hence, valuable cognitive resources, which could be expended more productively, are wasted. However, as with the other techniques designed to decrease extraneous load, presenting learners with redundant information is "most detrimental when high demands are made on working memory, such as when the content [of the training material] is complex and the learners are novices" (Clark et al., 2006, p. 122).

Increasing Germane Load

As indicated above, the use of certain instructional strategies increases the amount of cognitive load experienced by the learner. When these strategies specifically contribute to the generation and/or automation of schemas, this imposed load is termed *germane load*. A number of training effects are achieved through the use of such strategies. These include the variability, self-explanation, and imagination effects.

Variability effect. When applying knowledge acquired within a training context to the naturalistic environment, one must typically generalize that knowledge beyond the context in which learning has occurred. Thus, for any given task, it is necessary to assist the learner in developing highly evolved, flexible schemas so that he or she can adapt readily to novel situations when encountered (Gick & Holyoak, 1983). To this end, cognitive load theorists have argued that providing the learner with a diverse set of examples or exercises during training (as opposed to a single or a homogeneous set) creates a more generalizable repertoire of transferable skills (Clark et al., 2006; Sorden, 2005). The enhancement in learning that results from exposure to variation in training has been termed the *variability effect* (Paas & van Merriënboer, 1994).

Although the use of variability in training has been shown to result in enhanced learning (Paas & van Merriënboer, 1994), the ultimate impact of incorporating variability into training is not without qualification. In fact, it has been demonstrated that the benefits associated with the variability effect are a function of the complexity of the to-be-learned information. For example, Große and Renkl (2006) observed that knowledge acquisition in combinatorics (i.e., permutations and combinations of objects) is enhanced when the learner is presented with varied solutions to problem examples. However, the authors found that as the complexity of the material increased, the positive effects of solution variability disappeared. Clark and her colleagues (2006) have suggested that "the deeper processing required to abstract principles from diverse examples imposes an additional load on working memory" (p. 225). One way to offset this germane load would be to use varied worked examples.

Self-explanation effect. Even when presented with varied worked examples, the learner may only acquire surface knowledge of the steps required to perform the demonstrated tasks. If the principles underlying the worked examples are not understood or the specific conditions under which these apply are not appreciated, learning may ultimately be hindered. More specifically, poor performance may result on transfer tasks that differ substantially from those presented during training (i.e., far transfer tasks; Clark et al., 2006). Research has demonstrated that this situation can be remedied by using an instructional method referred to as self-explanation (Clark et al., 2006). Self-explanation typically involves having a student talk aloud during a problem-solving session to elaborate on underlying principles, to generate goals and subgoals involved in task performance, to establish connections between problems, and so forth (Renkl, 1997). The practice of self-explanation increases the degree of cognitive load experienced by the learner, but it also has been shown to enhance schema acquisition by encouraging the deeper processing of the material in question (e.g., Bielaczyc, Pirolli, & Brown, 1995; Chi, De Leeuw, Chiu, & LaVancher, 1994; Renkl, 1997). This ultimately results in more successful learning outcomes, which is referred to as the *self-explanation effect.*

The mere act of prompting self-explanation in a learner is apt to improve subsequent task performance (Chi et al., 1994). However, research suggests that providing students with minimal training on proper self-explanation techniques achieves greater learning gains than simply prompting them to "think aloud"

(Bielaczyc et al., 1995). This appears to be especially true for novice learners, who lack preexisting schemas (Renkl, Stark, Gruber, & Mandl, 1998). For example, Renkl and colleagues (1998) had participants study worked examples pertaining to interest rate calculations, with one group receiving an additional training session on generating self-explanations. In contrast to the control participants, who did not receive this additional training, the trained group generally demonstrated superior posttest performance, and this increase in performance was more pronounced for novices. Thus, the benefits of self-explanation are particularly apparent in participants with minimal preexisting knowledge of the subject matter in question (Renkl et al., 1998). As one's schema becomes highly developed, self-explanation simply imposes additional load that is no longer necessary.

Imagination effect. Under qualified conditions, mentally rehearsing the steps required to complete a problem can produce learning outcomes that are superior to learning based solely on conventional study problems. In cognitive load terms, this phenomenon is known as the *imagination effect* (Cooper, Tindall-Ford, Chandler, & Sweller, 2001; Ginns, 2005; Leahy & Sweller, 2004). However, the benefit of mental rehearsal is largely contingent on the degree to which one has constructed a cohesive schema for a given task. As Clark et al. (2006) stated, "mentally rehearsing the steps to perform a task or solve a problem requires free capacity in working memory" (p. 236). In the initial phases of learning, a novice learner will not possess the cognitive resources to perform a reasonably complex task while also developing the necessary task-relevant schemas that will enhance learning. Thus, it is only once schemas have been constructed that space is made available in WM, enabling the learner to reap the benefits of mental rehearsal (Cooper et al., 2001).

Managing Intrinsic Load

In the initial stages of learning, the presentation of a complex problem is likely to exceed one's WM capacity (van Merriënboer et al., 2003). To circumvent this issue, one can implement certain methods of instructional design to effectively manage intrinsic load. The implementation of these strategies results in the sequencing and fading effects.

Sequencing effect. One method by which intrinsic load can be managed for novice learners is to first segment a complex task into its major constituents and then present these part-task components sequentially to the learner such as to initially impose a lower intrinsic load (Ayres, 2006). It is only once the learner has mastered each subtask that these are integrated into a whole task (van Merriënboer et al., 2003). The enhanced learning outcome that results from this instructional strategy is known as the *sequencing effect* (Pollock et al., 2002). The sequencing effect occurs because whole-task training requires the simultaneous processing of each interacting element in the task, which can easily overwhelm the learner (particularly novices; Pollock et al., 2002). On the other hand, by presenting each component of the whole task individually, the learner can engage in serial processing, thus reducing intrinsic load and preparing the learner to assimilate the components of the entire task (Clark et al., 2006).

It is noteworthy that in some studies (e.g., Pollock et al., 2002), the sequencing effect disappears with low complexity items and/or when students possess a degree of domain-specific knowledge. In effect, both of these conditions serve to reduce the load imposed by the whole task (Pollock et al., 2002). However, in instances in which the end task is complex or the learner has low prior knowledge, segmenting and sequencing the to-be-learned material is clearly beneficial in managing intrinsic load, ultimately leading to more favorable learning outcomes.

Fading effect. As reported above, the use of worked and completion examples are useful to many learners because they reduce the degree of extraneous load experienced when learning a task. However, as already indicated, the benefits of these training strategies are most notable with novice learners. Thus, it is beneficial to gradually transition from worked examples to conventional practice problems (e.g., through the use of completion examples that gradually require more and more work from the learner) as learners gain experience in a particular domain (Atkinson, Renkl, & Merrill, 2003; Kalyuga et al., 2003). The superior learning that results from the implementation of this training strategy is referred to as the *fading effect* (Renkl, Atkinson, & Grosse, 2004).

An interesting issue that arises regarding fading relates to the problem of determining the rate at which it should proceed. The problem is essentially one of increasing the complexity of the learning task in line with the learner's level of expertise. To accomplish this task, trainers must develop methods for quickly and accurately quantifying expertise during training (Clark et al., 2006). These methods would enable a trainer to determine whether a learner has acquired a level of knowledge that is sufficient for understanding the next stage of the to-be-learned task. Recent attempts have been made to develop rapid tests of expertise, especially in the area of e-learning (Kalyuga & Sweller, 2004). Although initial results are promising, it remains to be seen whether these same tests can be used when delivering other forms of training.

Applying CLT to Use-of-Force Simulation Training

Having discussed the instructional strategies that have been shown to enhance training effectiveness across a range of domains, we now want to determine whether use-of-force simulation training can (and does) incorporate these principles. In the following section, we argue that in theory, use-of-force simulation training has the capacity to incorporate all of the aforementioned strategies for decreasing extraneous load, increasing germane load, and/or managing intrinsic load. However, this form of instruction appears to be deficient in several of these key areas as currently implemented by the majority of Canadian law enforcement agencies.

Use-of-Force Simulation Training in Theory

Decreasing Extraneous Load

From a theoretical standpoint, use-of-force simulation training can adhere to all of the previously discussed training principles that have been designed to reduce a learner's extraneous load. For instance, both worked and completion examples could easily be implemented in use-of-force simulation training. One possible procedure might involve an instructor walking through a series of scenarios while the trainee assumes an observer role. In the initial phase of training, the instructor could present worked examples by modeling all steps of the decision-making process as a way of focusing the learner's attention on the relevant problem-solving information (the proper distance to assume from the target, the appropriate use of verbal commands, the specific use-of-force options that should be considered, etc.). As the trainee gains experience, completion examples could be implemented whereby at a certain point in the scenario the student would be required to intervene and assume the lead role. The point in time at which control of the scenario is relinquished to the learner could be varied as a function of the learner's level of expertise.

It should be noted that use-of-force scenarios are more dynamic and ill-defined than the typical tasks faced by learners in the majority of CLT studies (i.e., use-of-force scenarios rarely involve one set pathway to successful completion, as is the case, e.g., when solving an algebra problem; Bennell & Jones, 2004). Hence, efforts need to be made to ensure that worked and completion examples do not result in the acquisition and automation of inflexible schemas. In a naturalistic use-of-force decision-making context in which the trainee is required to adapt to yet-to-be observed situations, a rigid schema could potentially result in fatal errors. However, as a method of instilling in the trainee some basic competencies that generalize across a range of use-of-force scenarios, worked and completion examples are likely to be helpful training strategies (Clark et al., 2006).

In addition, use-of-force simulation training can capitalize on the split-attention and redundancy effects, especially in circumstances in which the information being learned is complex and/or the trainees are relative novices. For example, consider the feedback that could be presented to a novice trainee in use-of-force simulation training (e.g., in relation to shooting accuracy, quality of verbal commands, use of cover). Presenting the learner with results on all performance measures and then engaging him or her in a general discussion of implications related to these decisions would likely result in the splitting of attention. Instead, results and discussion can more appropriately be grouped according to task. In other words, in the context of administering feedback to the trainee, results and discussions should relate to one specific performance measure at a time (e.g., by first providing results regarding shooting accuracy, at which point implications are discussed with respect to this behavior). In other contexts, this very procedure has been demonstrated to increase the efficiency and effectiveness of training through a reduction in extraneous load (e.g., Chandler & Sweller, 1992).

Related to this issue is the fact that use-of-force simulation training permits several feedback options, some of which may provide redundant information to the learner. For example, when using a simulator such as FATS, the trainee can be delivered feedback on shooting accuracy via bullet holes presented on a screen (indicating the locations where the student shot) or through a computerized printout generated by the simulator itself (FATS, 2003). Arguably, these two modes of feedback present identical information to the learner, and therefore, they are considered redundant. According to CLT, the elimination of one of these two sources of feedback (e.g., the on-screen bullet holes) will reduce extraneous load, thus resulting in the enhancement of instruction.

Increasing Germane Load

As is the case with training methods designed to decrease extraneous load, use-of-force simulation training can, from a theoretical standpoint, adhere to all of the previously discussed training principles that have been designed to increase a learner's germane load. For example, with respect to the issue of training variability, use-of-force simulation training is an ideal training platform for implementing diverse instructional exercises supported by CLT (FATS, 2003). Indeed, variability can be introduced into use-of-force simulation training in several forms. In addition to varying the general type of scenario presented to the trainee (e.g., domestic dispute vs. school shooting), variety can also be incorporated within the context of a specific scenario (e.g., different forms of domestic disputes). Furthermore, within any given scenario, simulators also permit the introduction of complications (e.g., weapon malfunctions) as well as exposure to a wide range of environmental conditions (e.g., changes in lighting). This strong potential for variety in the simulation training context provides the opportunity to increase a learner's germane load, thus facilitating the development of schemas that are sufficiently flexible to deal with the unpredictability inherent in naturalistic settings (Paas & van Merriënboer, 1994).

To maximize the impact of varied training on novice learners, trainers can also use self-explanation in use-of-force simulation training. During the problem completion phase described above and/or when involved in full-length simulations, the police trainee can be encouraged by the instructor to self-explain in relation to his or her decision-making process as a scenario unfolds. Moreover, with minimal instructional effort, the learner can be provided with directives illustrating optimal self-explanation strategies (Clark et al., 2006). As an example, a learner prompted to verbalize his or her thoughts as he or she proceeds through a use-of-force scenario might provide the following self-dialogue:

> Has the individual become more aggressive and resistant?
> Yes.
> OK, I think I should proceed from a verbal noncontact strategy to a more extreme use-of-force option . . .

According to CLT, such a dialogue will likely result in improved use-of-force training outcomes as the learner will be more apt to effectively integrate knowledge from the task into the creation or revision of schemas (Chi et al., 1994).

In a similar way, mental rehearsal can, in theory, be used to promote learning once a police trainee has engaged in full-length use-of-force scenarios and has achieved a certain level of expertise (i.e., schema acquisition). This is likely to be especially true in situations in which the complexity of the to-be-learned information is high (e.g., prolonged and ambiguous scenarios, in which use-of-force decisions are not immediately apparent). In order to gain further practice at this point, the trainee might be encouraged to capitalize on the imagination effect by engaging in the mental rehearsal of scenarios or portions thereof. Rehearsal via imagination in these later stages of instruction is likely to be advantageous in encouraging the automation of certain skills. Moreover, this strategy is beneficial from an economic perspective in that it does not require expending potentially scarce training resources.

Managing Intrinsic Load

Lastly, use-of-force simulation training can also incorporate all of the previously discussed training principles that have been designed to manage a learner's intrinsic load. For example, in an attempt to achieve the sequencing effect, use-of-force instructors can segment entire simulated scenarios (whole tasks) into various subcomponents (part tasks) to initially focus on promoting the acquisition of particular skills (e.g., how to properly unholster a weapon). Such part tasks can be presented and mastered prior to having the student engage in entire scenarios (i.e., appropriate sequencing). Alternatively, trainees can initially partake in simplified versions of full-length scenarios (e.g., a bank robbery scenario). In the later stages of instruction, simulators can be programmed to introduce complexity (e.g., in the form of weapon malfunctions). Either of these approaches is likely to reduce a learner's intrinsic load and result in an enhanced learning experience (Clark et al., 2006).

Likewise, use-of-force instructors can theoretically incorporate principles of fading into their training by presenting the learner with ample instructional aid at the onset of training and slowly fading out the amount of support trainees receive. For instance, students might first be presented with worked examples of scenarios, which then transition to problem completion tasks. Gradually, elements of instructional support could be removed such that the amount of scenario completion and consequent problem-solving demands required of the students increases over time. Once these tasks are mastered, instructional support could be eliminated altogether as the trainees become capable of the independent completion of full-length use-of-force scenarios. As with segmenting the training material, fading is likely to result in enhanced learning if it is introduced at a pace that corresponds to the learner's level of expertise (Clark et al., 2006).

Use-of-Force Simulation Training in Practice

Although use-of-force simulation training programs in Canada can theoretically adhere to the aforementioned principles, an equally important question is whether use-of-force simulation training, as it is currently implemented in Canada, incorporates these CLT-based principles. To answer this question, one would ideally have access to a survey of police forces and training schools that directly examined the application of principles related to CLT in use-of-force simulation training programs. Unfortunately, such a survey does not exist.

However, as indicated previously, a survey of simulator use by Canadian police agencies has recently been completed by the Canadian Police College (2003), and the responses from this study provide indirect evidence of the extent to which Canadian use-of-force simulation training strategies adhere to CLT-based principles. As outlined below, the results indicate that the simulation training programs accessed by the majority of surveyed forces are likely deficient in several key areas according to the cognitive load perspective. However, anecdotal evidence gathered by Craig Bennell is also briefly presented, suggesting that certain instructors may unknowingly rely on CLT-based principles when delivering use-of-force simulation training. However, for reasons that emerge from the Canadian Police College (2003) survey, it is clear that the widespread use of such training strategies is unlikely.

The Canadian Police College Survey

A recent survey conducted by the Canadian Police College (2003) examined how the Canadian police community uses use-of-force simulators. However, the primary focus of this survey was not on the training principles that guide simulation instruction in Canada but rather on the "functionality, reliability and manufacturers' support [of the simulators in use by Canadian forces]" (Canadian Police College, 2003, p. 1). Key issues examined in the survey include the distribution of simulation training across Canada, how simulation training is used by Canadian forces, the perception of simulation training in terms of its technological components and the training material, and views on manufacturer support. In essence, the survey was a "consumers report" on use-of-force simulators (Canadian Police College, 2003, p. 1). Nevertheless, the results of the survey do elucidate certain issues related to the manner in which simulators are used in law enforcement training. Therefore, a brief discussion of the Canadian Police College survey and some of its main findings may prove instructive for our purposes.

Initially, survey questionnaires were distributed to 69 police agencies, consisting of all major municipal, provincial, and federal forces in Canada. Of these 69 agencies, 61 responded, representing an 88% response rate. Thirty-two of these 61 agencies reported that they had access to a use-of-force simulator (nearly all of these agencies were located in the province of Ontario), with an additional 10 agencies reporting that they planned to start using a simulator in the next year. It was estimated that approximately 13,000 Canadian police officers of varying ranks (slightly less than one quarter of the Canadian police community at the time) received some use-of-force training on simulators in the 12-month period preceding the survey. However, the authors of the survey indicated that this is a significant underestimate in the number of Canadian police officers actually receiving simulation training given that only police services with 100 or more members were sampled (Canadian Police College, 2003).

The important results for the purpose of the present study emerge from the section of the survey detailing the application of use-of-force simulation training by Canadian police agencies. It is clear from these results that use-of-force simulation training is a major component of general use-of-force training in most Canadian police agencies (71%) and that the majority of agencies view such training in a positive light.[6] However, several serious concerns were also raised.

One of the most relevant concerns includes the report that 89% of agencies strongly feel that their officers do not receive enough training time on the simulator. In fact, the survey suggested that "on average, officers are exposed to four scenarios during annual refresher training . . .. A typical scenario may last only five seconds and when this is combined with the time taken for debriefing, an officer may be exposed to simulator training for only five minutes annually" (Canadian Police College, 2003, p. 3). In addition, a reasonably high percentage of agencies (25%) believed that the time allotted for critiquing officer perfor-

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[6] For example, 100% of agencies viewed simulation training as realistic, and 78% indicated that the use-of-force training scenarios currently used provide officers with a good exposure to all of the stages outlined in Canada's use-of-force model.

mance was insufficient, leading the authors of the survey to state that "providing exposure to these systems in the absence of a full debriefing represents an incomplete learning experience" (Canadian Police College, 2003, p. 4). Furthermore, a number of agencies completing the survey (percentage unreported) raised concerns about the variability of training by commenting that "officers get bored and lazy after seeing the same scenarios year after year" (Canadian Police College, 2003, p. 6).

Although such responses do not tap directly into all of the CLT-based training principles described above, they certainly raise doubts as to the likelihood that use-of-force simulation training in Canada incorporates the majority of these principles. For example, given the extremely short duration of training received by many of the officers, it seems highly unlikely that worked or completion examples form part of the training routine, and it would be impossible for appropriate segmenting and fading to take place under such conditions. In addition, although it is unclear from the survey findings whether split attention or redundancy is problematic with respect to instructor feedback, a sizable percentage of agencies indicated that effective debriefings are precluded by minimal training times. Furthermore, comments from some of the respondents directly indicated that training variability is an issue when it comes to being exposed to an adequate range of scenarios, let alone the other forms of variation discussed above. Moreover, although the use of appropriate self-explanation or mental rehearsal as training strategies were not discussed in the survey, it seems unlikely that they could effectively be used given the above concerns related to training time.[7]

Anecdotal Evidence

Although perhaps less objective than the results from the Canadian Police College (2003) survey, anecdotal evidence does suggest that some Canadian use-of-force instructors are using certain CLT-based principles in their delivery of training, despite the fact that they might not recognize their training as such. Indeed, personal communication between Craig Bennell and use-of-force instructors at certain police training schools in Canada provided evidence of some innovative approaches to implementing some of the aforementioned CLT-based training strategies (though, as indicated earlier, it was also clear that these strategies were often used in a relatively haphazard fashion).[8] For example, although worked examples may not be frequently integrated into simulation training per se, a similar strategy has been incorporated within the more theoretically based presimulation phases of instruction by some instructors. In these cases, the instructor walks the students through a variety of use-of-force scenarios, detailing appropriate decision-making processes.

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[7] In a 1998 study by Renkl et al., the delivery of a training program to promote proper self-explanation techniques took 20 min, making it unlikely that such instructions could be provided in the time space allotted for a typical use-of-force simulation training session.

[8] These discussions also highlighted the fact that there are use-of-force simulation training programs currently being delivered in Canada that do not possess some of the problems highlighted by the Canadian Police College (2003) survey, such as insufficient training time.

In addition, variability in training, particularly with respect to presenting a range of use-of-force scenarios, appears to be appreciated by some use-of-force instructors as a strategy for enhancing adaptability in trainees. For example, the branching capability of simulators is often used to expose trainees to different versions of a similar scenario (e.g., by varying the suspect's level of resistance and/or aggression) so that they can learn to be flexible in their responses. Mental rehearsal is also sometimes used as a training tool to achieve the same goal. For instance, one use-of-force instructor who was consulted has his students observe their peers undergoing simulation training when they themselves are not actively involved in training. These observers are instructed to mentally rehearse what they would do in the scenarios being projected onto the screen in front of them.

Finally, the importance of appropriate segmenting and sequencing was mentioned as a key training issue. It is certainly the case that some Canadian use-of-force instructors initially use part-task training as a means of promoting the acquisition of particular skills before exposing trainees to whole-task training. The sequencing of scenarios in terms of their level of complexity (i.e., introducing low-complexity scenarios earlier in training) is also a training strategy that is commonly used. The remaining CLT-based principles discussed in this review (i.e., issues related to problem completion, split attention, redundancy, self-explanation, and fading) appeared to be used less often by the use-of-force instructors who were contacted.

Recommendations

Learning in simulated environments offers several advantages over both training in real-world contexts or through observation. For example, from a purely logistical standpoint, simulator training allows (in theory) many more practice trials than would occur ordinarily (Means, Salas, Crandall, & Jacobs, 1993). In addition, using simulators as training devices is valuable from a safety perspective. A learner is afforded the commission of misguided actions, which in real-world contexts would result in fatal consequences to oneself or others (Geber, 1990). Moreover, training can be tailored to meet a range of instructional purposes and the ability of the learners themselves (Dennis & Harris, 1998). For instance, as discussed earlier, with the flip of a switch use-of-force instructors can cause a trainee's firearm to malfunction in order to teach him or her how to effectively deal with such an unexpected event.

For these advantages to be realized, however, the existing gap between what is theoretically possible with use-of-force simulation training and what is currently practiced must be bridged. Bearing in mind the learner's cognitive limitations and the nature of the to-be-learned material, CLT offers a potentially valuable framework for enhancing the effectiveness of use-of-force simulation training. Use-of-force simulation training can theoretically abide by the principles outlined by cognitive load theorists. However, the only objective sources of information that are available indicate that for the most part, training strategies designed to enhance schema acquisition and automation are not currently implemented in law enforcement training contexts (Canadian Police College, 2003). Even the anecdotal evidence, which does suggest that some CLT-based principles are occasionally observed within use-of-force simulation training, highlights that these methods are applied only in a rather haphazard fashion.

Given this state of affairs, the first recommendation to come out of this review is that a large-scale standardized survey should be administered to police forces and training schools to gain a more lucid and detailed understanding of use-of-force simulation training practices (and use-of-force training more generally). More specifically, it is essential to assess the training situation in Canada and elsewhere with respect to the current application of principles related to CLT, as they are discussed in this article. This clearly was not the primary purpose of the recent survey conducted by the Canadian Police College on the use of training simulators in Canada (Canadian Police College, 2003). Therefore, we are limited in the extent to which we can effectively discuss these issues at present. We are currently constructing such a survey, with the assistance of several Canadian use-of-force instructors.

Second, given the extensive empirical support for the above-mentioned training effects (Clark et al., 2006), a research program should be developed and specifically tailored toward examining the relevance of CLT-based training methods in use-of-force simulation training to determine whether they result in greater training gains compared with current instructional methods. As indicated above, the training tasks presented to participants in the majority of CLT studies are of a procedural nature, typically involving one set pathway to completion. In contrast, the use-of-force scenarios in which police trainees must participate are dynamic and fluid and may involve more than one effective method of resolution (Bennell & Jones, 2004). Given these task differences, it should not necessarily be assumed that each of the aforementioned training effects would emerge in the context of use-of-force simulation training.[9] Discussions of these issues are currently underway with Canadian police agencies.

CLT has clearly had a positive influence on training across a wide range of domains (Clark et al., 2006). In a similar way, the research program being proposed here could potentially have an immediate and direct impact on the effectiveness of use-of-force simulation training for police officers across Canada and elsewhere. As indicated in the introduction to this article, improving the effectiveness of this form of training will likely enhance the safety of police officers and the public alike in veritable use-of-force situations. In addition, CLT-based training modifications may provide police officers with an enhanced ability to understand, recall, and effectively defend their use-of-force decisions when required to do so by courts of law. Finally, incorporating effective training methods into use-of-force simulation instruction should also reduce the possibility that police agencies will be found liable for providing inadequate or improper training to their officers.

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[9] Clearly, such a research program will first require the completion of a formal training-needs analysis, not only to determine what the primary training objectives are in use-of-force simulation training but also to determine the specific instructional requirements of trainees possessing different levels of expertise.

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