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Improving police training from a cognitive load perspective

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Abstract

Purpose – The purpose of this paper is to present a theoretical framework, which describes how police training programs can be developed in order to improve learning retention and the transfer of skills to the work environment.

Design/methodology/approach – A brief review is provided that describes training strategies stemming from Cognitive Load Theory (CLT), a well-established theory of instructional design. This is followed by concrete examples of how to incorporate these strategies into police training programs.

Findings – The research reviewed in this paper consistently demonstrates that CLT-informed training improves learning when compared to conventional training approaches and enhances the transferability of skills.

Originality/value – Rarely have well-validated theories of instructional design, such as CLT, been applied specifically to police training. Thus, this paper is valuable to instructional designers because it provides an evidence-based approach to training development in the policing domain.

Keywords Cognitive Load Theory, Police training, Learning retention, Transfer of skills, Training, Skills

Paper type Conceptual paper

Major advances have been made in the area of police training in recent years. For example, in a number of countries, e-learning has become a common way of delivering training courses to police officers in addition to the standard training that continues to take place in the classroom and gymnasium (Canadian Police Knowledge Network, 2008; European Police College (EPC), 2012; Interpol, 2012; Police Sector Council (PSC), 2010). Indeed, between 2007 and 2009, officers across Canada successfully completed over 8,100 e-learning courses on topics ranging from explosives awareness to fatigue management (Canadian Police Knowledge Network, 2009). Computer-based simulation training has also become a standard way of training officers to perform effectively in different situations, including use-of-force encounters (Bennell *et al.*, 2007), driving exercises (Ross, 2009), and complex multi-agency incidents (Justice Institute of British Columbia (JIBC), 2010).

While new training initiatives such as these undoubtedly have the potential to benefit the policing community and enhance public safety, relatively little attention has been paid, at least in the published literature, to how this training should be developed and delivered in order to maximize its impact. Although some scholars have called for theory-informed police training initiatives (e.g. Birzer, 2003; McCoy, 2006; Vodde, 2012; Willis, 2010), what is currently absent in the police training literature are concrete, empirically supported instructional strategies that can be incorporated into training to promote the long-term retention and transfer of learned skills and knowledge. The purpose of this paper is to address this gap by presenting a well-validated theory of instructional design – Cognitive Load Theory (CLT) – and illustrating how some specific instructional strategies stemming from this theory might be applied to training in a policing context.

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To accomplish our goal, the paper is divided into five main sections. First, a brief overview of the strengths and weaknesses of current theoretical approaches to police training is provided. Second, CLT is introduced as a theoretical framework that can complement current theoretical approaches to police training. Third, a brief description of various instructional design strategies stemming from CLT is provided. Fourth, given the fact that the use of e-learning as a police training tool is rising on a global scale (e.g. EPC, 2012; Interpol, 2012; PSC, 2010), examples of how CLT-based training strategies can be used to enhance the quality of police training in an e-learning environment are provided[1]. Finally, aspects of CLT that require further research are discussed.

1. Current approaches to police training

Throughout the past decade, a number of scholars have proposed changes to police training that generally call for training programs to be designed with educational theories in mind. For instance, a common recommendation in the police training literature is to ensure that training initiatives are consistent with the principles underlying adult learning (e.g. Birzer, 2003; Birzer and Tannehill, 2001; Glasgow and Lepatski, 2012; McCoy, 2006; Palmiotto *et al.*, 2000; Vodde, 2012; Werth, 2011). Generally speaking, adult learning theories focus on the idea that adults are independent learners and therefore respond to active, rather than passive, learning initiatives. As such, adult learning environments should primarily be centred on the student (i.e. andragogical) rather than the instructor (i.e. pedagogical) (Brookfield, 1986; Knowles, 1980)[2]. For instance, rather than using a lecture-based format of instruction, it is suggested that instructors of adults make use of learning activities that support the autonomous nature of adult learners, such as group discussions and problem-solving activities involving real-world case studies (Birzer, 2003; Knowles, 1980, 1990). Moreover, since adults enter the learning environment with a great deal of previous experience, instructors are also encouraged to integrate this experience into learning tasks (Knowles, 1990).

Taking a student-centered approach to adult learning can also allow the many different learning styles of adults to be accommodated in the training environment (e.g. visual, auditory, read/write, and kinaesthetic/tactile) (Sprenger, 2003). As is the case with other adult learners more generally (e.g. Bahadori *et al.*, 2011; Breckler *et al.*, 2009; Johnson, 2009; Murphy *et al.*, 2004), Landry (2011) recently found that the dominant learning style of most officers in his sample was multimodal. Thus, using instructional strategies that appeal to all learning styles is likely to be optimal. For visual learners, this could be in the form of using PowerPoint and pictures for descriptions. For auditory learners, small group discussions and the repetition of difficult concepts are appealing. For read and write learners, case studies can be used. Lastly, for kinaesthetic learners, role-playing and other hands-on activities may be best (Sprenger, 2003).

In the policing literature, it has also been suggested that consideration of Bloom's Taxonomy of Educational Objectives (Bloom *et al.*, 1956) is crucial when developing police training programs (e.g. Cleveland, 2006; Vodde, 2009; Werth, 2011; Willis, 2010). Briefly, Bloom's Taxonomy is used to classify different learning objectives based on three main domains – cognitive (i.e. knowledge) (Bloom *et al.*, 1956), affective (i.e. attitudes) (Krathwohl *et al.*, 1964), and psychomotor (i.e. skills) (Simpson, 1972). Within each of these domains, various levels of learning are defined. The learning that occurs at the higher levels is dependent on having attained the relevant knowledge, skills, and/or attitudes at the lower levels. The cognitive domain is the most frequently cited, and is comprised of six cumulative levels of learning, beginning at the most basic forms of learning (e.g. knowledge recall and comprehension) and progressing to more intermediate (e.g. application of this knowledge) and finally, more complex (e.g. analysis, synthesis, and evaluation) forms of learning (Bloom *et al.*, 1956).

Given the dynamic problems faced by police officers while on-the-job, they are often expected to perform at the highest level of Bloom's Taxonomy (Cleveland, 2006; Werth, 2011). That is, not only are they expected to recall and understand a number of tasks, but they are also required to analyse and evaluate a variety of problems on a daily basis (Cleveland, 2006). As such, training needs to facilitate the development of these higher-order thinking skills. As one way to develop these skills, problem-based learning has been proposed by a number of police scholars (Barrows and Tamblyn, 1980). At the outset of a problem-based learning activity, trainees are given a real-life problem and are expected to outline the key issues, identify available resources to address the problem, and then generate an action plan for solving the problem (Cleveland, 2006; Pitts *et al.*, 2007; Werth, 2011). Problem-based learning activities are believed to tap into the complex skills related to the higher levels of Bloom's Taxonomy, including the critical thinking and communication skills that are at the core of a police officer's everyday job responsibilities (Cleveland, 2006).

Although these theoretical orientations provide a promising general philosophy to guide the development and delivery of police training programs, they do not always offer tangible, empirically driven strategies concerning how curriculum should be designed to achieve optimal learning conditions. Indeed, while Bloom has argued that his original taxonomy should be modified to better fit the needs of learners within a given field (Anderson *et al.*, 2000), it is not always clear how the taxonomy should be modified. Likewise, research has shown that although instructors are generally aware of adult learning principles (i.e. they are taught the principles as a component of their basic instructional techniques courses), they continue to rely on traditional pedagogical forms of instruction (McCoy, 2006). This may be, at least in part, because police instructors have not always been provided with specific training strategies that they can implement, which support the adult learning paradigm.

We argue that the CLT framework may provide curriculum designers, and ultimately instructors, with additional guidance in this respect. For instance, we believe that research on CLT can provide answers to important questions that frequently arise in training, such as how should instructional materials used in police training be designed to ensure that learning outcomes are maximized? What are some concrete strategies that can be used to promote active, rather than passive, learning? How can police training be designed to facilitate the transition from the lower levels of Bloom's Taxonomy to the higher-order thinking skills of analysis, synthesis, and evaluation?

Merely because an instructor adheres to adult learning principles does not mean that learning will always prevail. This is because, regardless of the learning philosophy presumed (i.e. pedagogy or andragogy) or the level of Bloom's Taxonomy that is targeted, the cognitive resources of the learner must also inform training endeavours. We argue that CLT can further enhance these general theoretical approaches by offering a number of practical techniques to ensure that the training environment accommodates the cognitive limitations of trainees while also adhering to the general principles of adult learning. Throughout the remainder of this paper, a number of ways in which CLT can inform current theoretical approaches to police training are provided. First, however, the basic concepts guiding CLT-informed instruction must be outlined.

2. What is CLT?

Since its inception in the 1980s (e.g. Sweller, 1988), CLT has been primarily concerned with how instructional materials should be designed and delivered in order to provide trainees with the optimal conditions for learning. In other words, CLT focuses on the most effective way to design training curriculum in order to positively impact the learner. Training recommendations that are based on CLT draw on knowledge of how the human cognitive system operates in an attempt to facilitate the development of cognitive structures (i.e. schemas) on the part of the learner; structures that are involved in the learning process, including the retention and transfer of knowledge and skills (Ayres and Paas, 2009).

2.1 Memory systems and structures

The cognitive architecture that provides the foundation for CLT-based training strategies consists of two related systems of human memory, including working memory (WM) and long-term memory (LTM). More specifically, the central focus of CLT is on the instructional design consequences of the limited ability of WM to process information, coupled with the virtually unlimited capacity of LTM to store learned information (Kirschner, 2002; Paas *et al.*, 2003; Sweller, 1988). According to CLT, the ability of these systems to process incoming information (e.g. during training) and retrieve stored information (e.g. while on-the-job) is aided by the acquisition and automation of cognitive structures referred to as schemas (Paas *et al.*, 2003).

WM. WM is the memory system that briefly stores new, incoming information while simultaneously manipulating this information in order for learning to occur (Baddeley, 1992). The primary function of WM is to temporarily hold information that is being actively, or consciously, processed (van Merriënboer and Ayres, 2005). Any piece of information that needs to be learned (e.g. a word, a letter, a number) is referred to as an element in WM (Sweller, 1994). WM can only hold between five and nine elements at one time. Moreover, WM can only deal with actively processing two to four related elements simultaneously (Groeger, 1997; Kirschner, 2002; Miller, 1956; Paas *et al.*, 2003).

LTM. Although our WM store is extremely limited, we are able to acquire and recall an extensive amount of knowledge throughout our lifetime. This is due, in part, to the existence of our LTM. The primary function of LTM is to store information when it is not being consciously attended to, but is still essential for everyday understanding (Bower, 1972). LTM is essentially unlimited; that is, it is able to store an immeasurable amount of interrelated information that can (typically) be retrieved when needed (Bower, 1972). The central concern of CLT is how training should be designed and delivered to ensure that trainees can effectively process the to-be-learned information in their limited WM, so as to facilitate the construction of cognitive schemas to be stored in, and retrieved from, LTM (van Merriënboer and Sweller, 2005).

Schemas. Learning is often conceptualized as a change in the knowledge structures that form LTM (Pawley *et al.*, 2005). Changes to an individual's LTM result from the construction of cognitive schemas, which assemble incoming information elements into understandable subgroups or chunks of information that hold the same underlying purpose to the learner (Paas *et al.*, 2003; Tennyson and Elmore, 1997). Schemas range in complexity, from those involving only a few related concepts (e.g. how to identify a type of narcotic) to higher order schemas that can encompass many related pieces of information that have been acquired over time (e.g. the various actions that an officer must undertake when seizing illegal substances) (Pawley *et al.*, 2005). A schema permits an individual to recognize situations as belonging to a specific type requiring certain identifiable actions to reach an appropriate solution (Paas, 1992). Schemas may also be used as a guide in new circumstances, fostering transfer of knowledge to situations that the individual has not previously encountered (Paas, 1992). For instance, a police officer may be confronted with aspects of a spousal assault situation that he or she has never before handled, but their generalized knowledge about domestic assault, embodied in a "domestic assault schema", may suggest a certain response.

In general, schemas have two related functions: storing and organizing information in LTM and reducing the burden placed on WM (Pawley *et al.*, 2005; Sweller *et al.*, 1998). Because of their organizational structure, any given schema in LTM can hold a large amount of information without taxing an individual's cognitive resources (Kirschner, 2002). Similarly, because a complex schema can be dealt with as one element when brought into WM, schemas serve to reduce the strain placed on the learner by freeing up WM space (Sweller *et al.*, 1998). If enough practice occurs, schemas can also come to direct behaviour in a relatively unconscious fashion (i.e. they can become automated; Sweller *et al.*, 1998). Since automated behaviours can be performed with little conscious effort, schema automation also serves to further reduce WM load (van Merriënboer and Ayres, 2005).

Accordingly, CLT proposes that the primary goal of training programs should be to promote schema acquisition and automation (Kirschner, 2002; Sweller *et al.*, 1998). Both processes free WM capacity that can then be devoted to making sense of new instructional materials during training.

2.2 Defining cognitive load

In general, the term "cognitive load" refers to the mental effort experienced by a learner when performing a certain task (Clark *et al.*, 2006). In order to achieve optimal training results (i.e. for schema acquisition and automation to occur) CLT holds that the cognitive load placed on learners' WM must be appropriately managed. According to CLT, three types of cognitive load exist: intrinsic, extraneous, and germane. More specifically, WM load can be affected by: the inherent complexity of the instructional material (i.e. intrinsic load), the way in which the to-be-learned material is presented to the learner (i.e. extraneous load), and the amount of effort directly devoted to schema acquisition and automation (i.e. germane load; Kirschner, 2002; van Merriënboer and Ayres, 2005). CLT generally holds that, for training to be effective, intrinsic load must be managed, extraneous load must be reduced, and germane load must be increased, so long as the limited capacity of WM is not exceeded.

Intrinsic cognitive load. Intrinsic cognitive load is primarily the result of the inherent complexity of the information being conveyed to the learner. It refers to a "base" load that cannot be reduced until new schemas are constructed to guide further learning of related concepts or skills (Kirschner *et al.*, 2009a). Intrinsic load increases with the complexity of the to-be-learned information, and it is largely determined by the number of interacting elements of information that need to be processed in WM simultaneously in order for full understanding to occur (i.e. the degree of element interactivity; Paas *et al.*, 2003; Pollock *et al.*, 2002).

Information low in element interactivity can be grasped relatively easily and understanding does not depend on previously learned information (Paas *et al.*, 2003). For example, basic training on the mechanics of applying restraints (e.g. handcuffs) is relatively low in element interactivity because each step of the process (i.e. withdrawing the handcuffs, placing them on the wrists of an individual, and locking them) can be effectively learned in isolation. Information that is low in element interactivity generates a low level of intrinsic load because, in order to learn the material, only a limited number of elements must be processed simultaneously in WM (Sweller and Chandler, 1994). Likewise, consider an e-learning course on cultural diversity where an officer is learning about the spiritual and cultural characteristics of the community members they serve. Elements of this module could, in theory, be learned in isolation from one another. For instance, learning about the population levels and distribution of different cultural groups within their district, and identifying the key cultural sensitivities that should be taken into consideration when communicating with different cultural groups could be learned independently of one another. As such, this e-learning module would represent a low level of element interactivity.

In contrast, information that is high in element interactivity cannot be fully understood in isolation. That is, a trainee must be able to process all related elements at the same time in WM in order for meaningful learning to occur (van Merriënboer and Ayres, 2005). For instance, consider the previous task of learning how to apply and lock handcuffs. When training officers on how to implement these procedures during common police encounters element interactivity increases. A patrol officer intervening in a domestic dispute, for example, must simultaneously consider a multitude of factors when dealing with the situation, only one of which is whether handcuffs should be used (and how this can best be accomplished). Indeed, in order to determine whether (and how) handcuffs should be used, the officer may first have to consider whether unlawful behaviour is being exhibited, the level of threat that exists in the situation, and how much force is necessary to neutralize the abusive partner. In other words, in naturalistic scenarios, many elements must be considered and processed in a collective fashion in order for the officer to successfully resolve the situation. As a result, material of this nature will impose a high intrinsic load. Similarly, consider an e-learning scenario where officers are learning the basics of conflict resolution with a particular cultural group. Devising a way to successfully resolve the conflict may involve multiple aspects of a police officer's knowledge base, which not only includes the general laws surrounding the dispute, but also the potential cultural sensitivities that the police officer may encounter. Since the information the officer learned in the cultural diversity e-training described earlier must be considered simultaneously with their conflict resolution skills, element interactivity increases.

As mentioned, since element interactivity is directly related to what is being learned, intrinsic load cannot be reduced by changing the format of instruction (Paas *et al.*, 2003). However, intrinsic load can be managed within the training environment (van Merriënboer and Sluijsmans, 2009). This can be accomplished, for example, by providing the learner with simpler training tasks (e.g. the appropriate use of handcuffs) that omit some of the interacting elements (e.g. the circumstances under which handcuffs can and should be used) at the outset of training, particularly if the trainee lacks schemas to direct their learning (i.e. a novice; van Merriënboer *et al.*, 2003). For effective learning to occur, however, all elements central to the task at hand must eventually be processed simultaneously so that a full understanding of the task is realized (Paas *et al.*, 2003; van Merriënboer and Sluijsmans, 2009).

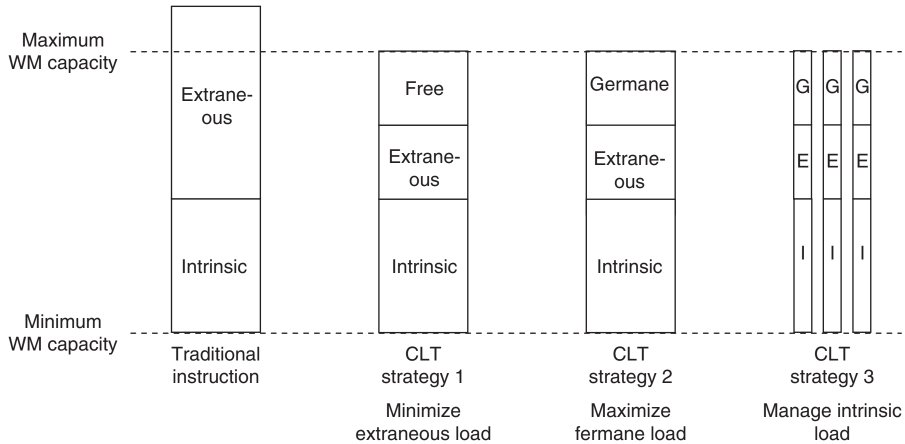
Extraneous cognitive load. Extraneous cognitive load is comprised of the learning-irrelevant demands placed on the learner during training, and is mostly a function of the how training is designed and delivered (Clark *et al.*, 2006). Extraneous load is harmful to learning because it directs a learner's limited WM resources to activities that are unrelated to the essential learning processes of schema acquisition and automation (Paas *et al.*, 2003). Since extraneous load is a result of the manner in which instructional material is structured and presented to trainees, it can be directly reduced by modifying the method of instruction.

Using verbal explanations to describe things that are best explained visually is a clear example of a training method that increases extraneous load. Take, for example, an online firearms identification course where officers are learning the characteristics (e.g. make, manufacturer, calibre, barrel length, working mechanisms, etc.) of various firearms. In this instance, training would be much more efficient and extraneous load would be reduced if the appropriate training medium was used – where different firearms are visually presented to trainees rather than verbally explained (e.g. in graphic form when training is done in an e-learning environment).

Germane cognitive load. Like extraneous load, germane load is also a result of the method of instruction, or how training is designed and delivered. In direct contrast to extraneous load, however, the processing demands placed on WM as a result of germane load are thought to be directly relevant to schema acquisition and automation (Moreno, 2004; van Merriënboer and Ayres, 2005). Germane load is important because it enhances the learners' understanding of why and when to apply a certain solution to a problem, or when to engage in a particular behaviour (Paas and van Gog, 2006). According to CLT, however, the majority of learners do not spontaneously engage in these germane processes (Paas and van Gog, 2006; Renkl, 1997). As a result, CLT proponents argue that a central goal of instruction should be to maximize germane load by stimulating learners to engage in these processes whenever WM space is available to do so (Paas *et al.*, 2003; Paas and van Gog, 2006).

Promoting germane processes among learners can be achieved in a number of ways. For instance, consider a police training program that teaches officers how to communicate effectively with the mentally ill (either in a classroom or e-learning environment). Although learning may initially occur more easily if the training scenarios remain very similar across training exercises (e.g. involving only one type of mental illness), the communication skills that the officer develops as a result of such training will be more restricted (i.e. less flexible or adaptive) than those developed when using more varied training exercises (e.g. involving a variety of mental illnesses). Under the varied training scenario, a higher cognitive load is undoubtedly imposed on the learner, but this load is directly related to schema acquisition. The schema that results from this training (v. the low variability training) will likely be more flexible and adaptive in nature, allowing the officer to ultimately perform more effectively when on-the-job.

CLT-based training approaches. It is important to note that the three sources of cognitive load described above – intrinsic, extraneous, and germane – are believed to be additive in nature (Paas *et al.*, 2003). That is, the total cognitive load experienced by a learner in a given training program is equal to intrinsic plus extraneous plus germane load (Kirschner, 2002). Based on this fact, there are a variety of training approaches that are compatible with a CLT perspective (see Figure 1). If implemented, these strategies should increase the effectiveness of police training (i.e. greater learning retention and enhanced transfer of skills/knowledge).



Source: Adapted from Paas *et al*. (2003) and van Merriënboer and Sweller (2010)

Figure 1. Methods for improving training by taking into account various ways to manipulate cognitive load within the bounds of available WM capacity

As shown in Figure 1, traditional instruction (i.e. instruction that does not take into account the cognitive limitations of trainees) can often result in cognitive overload. When intrinsic load is high, and nothing has been done to control extraneous load, WM is likely to be so overwhelmed that learning will be impaired. However, if measures are taken to reduce extraneous load, and intrinsic load is not so high that WM resources are depleted, the result will be free WM capacity (CLT Strategy 1). Under such circumstances, it is then advisable for instructional designers to incorporate strategies into their training that further facilitate the acquisition and automation of schemas, or to increase germane load (Kirschner, 2002; Sweller *et al.*, 1998) (CLT Strategy 2). Alternatively, in instances where intrinsic load is so high that using techniques to foster germane load are likely to overload WM capacity even after all sources of extraneous load have been eliminated, intrinsic load can be managed by dividing the instructional materials into more manageable, or smaller, parts during the early stages of training (CLT Strategy 3). In sum, rather than developing methods to reduce the overall cognitive load experienced by trainees, CLT researchers are primarily concerned with determining the most appropriate methods to optimize these three types of load in order to maximize training results (van Gog and Paas, 2008).

Importantly, even though these strategies are interrelated, each one can be implemented independently of the others in training contexts. That is, curriculum can be designed that adheres to the approach illustrated in Strategy 1, Strategy 2, or Strategy 3 (van Merriënboer and Sweller, 2010). Indeed, when the instructional material is too complex for instructors to facilitate germane processing (as accomplished in Strategy 2), or when the intrinsic complexity of the material cannot be managed by separating it into meaningful subcomponents (as accomplished in Strategy 3), it may be appropriate for instructors to focus their attention on reducing sources of extraneous load (as accomplished in Strategy 1). Eliminating all irrelevant sources of cognitive load will ensure that learning, at a minimum, is not impeded by WM overload as a result of inefficient instruction.

2.3 Novices v. experts: differences in cognitive load

CLT is also concerned with how a learner's level of expertise can affect the various types of cognitive load experienced by the trainee in the training environment, and as a result, the manner in which learning optimally occurs. This is clearly an issue that must be considered in the policing context. For example, as a police officer progresses through their career, what may have initially been multiple interacting elements (i.e. representing material with a high intrinsic load) will eventually be conceptualized as a single element in the cognitive schema (i.e. representing material with a lower intrinsic load; van Merriënboer and Sweller, 2005). As a result, providing police recruits with instructional guidance that may be crucial for learning to occur at the outset of training (e.g. isolating interacting elements, reducing the level of variability across training scenarios, etc.) can actually become detrimental to learning once schemas have been developed.

Consequently, training for novices and experts should often be designed differently in order to take into account their varying degrees of schema development (Ayres and Paas, 2009). If instructional designers fail to take into account the experience level of their trainees when designing and delivering training materials, the expertise reversal effect can occur. That is, when instructional methods that work well for novices are also used to train learners who have already acquired a certain level of mastery in the area of instruction, learning may not take place and can even be impeded (Kalyuga *et al.*, 2003; Paas *et al.*, 2003). Similar to adult learning theories then, the expertise reversal effect of CLT acknowledges that a trainee's previous experience must be incorporated into the training environment, and that learning should (eventually) be student-directed for a deeper learning to occur. With that said, the expertise reversal effect also demonstrates that these more independent learning strategies should only be used once related schemas have been adequately developed through an appropriate amount of instructional guidance.

3. How can CLT be used to improve training?

According to CLT, training in any area can be enhanced by taking into account the reality of the trainees' cognitive structures and the various types of cognitive load encountered during training. Cognitive load theorists have developed and proposed numerous instructional strategies that have consistently been found to be superior to traditional training approaches. Not only do these strategies make optimal use of the trainees' cognitive resources, but many of them can serve to facilitate a training environment that is consistent with the adult learning paradigm. 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, and/or managing intrinsic load.

3.1 Minimizing extraneous load

Recall from Figure 1 that failing to control for extraneous load can result in WM systems becoming overloaded, which can impair learning. CLT has proposed several instructional effects that serve to reduce the extraneous load placed on trainees. Adopting these techniques make it possible for the learner's attention to be directed to learning-relevant processes that are directly related to schema acquisition and automation. Some of the most well-known effects include: worked example, problem completion, split-attention, redundancy, and modality effects.

Worked example effect. Conventional practice problems provide the learner with a problem to solve without any additional guidance. Such practice problems focus limited WM resources on tasks that are not primarily concerned with learning (e.g. searching for the appropriate solution strategy), which undoubtedly increases the amount of extraneous load experienced by the learner. Worked examples, on the other hand, show learners in a straightforward, step-by-step fashion what information is needed to solve a particular problem (Clark *et al.*, 2006; Schwonke *et al.*, 2009). The learning improvements that occur as a result of employing worked examples constitute the worked example effect (Cooper and Sweller, 1987; van Gog *et al.*, 2006; Hilbert and Renkl, 2009; Rourke and Sweller, 2009; Schwonke *et al.*, 2009). The worked example effect is likely the most heavily studied CLT effect to date (Sweller, 2006).

Research has indicated that worked examples can be an effective instructional tool for both individual as well as group-based learning activities (Retnowati *et al.*, 2010). With that said, research has consistently demonstrated that worked examples are best suited for novice, rather than more experienced, learners (e.g. Kalyuga *et al.*, 2001; Reisslein *et al.*, 2006). This is because as experience increases and schemas are formed, worked examples can become a redundant source of information since the trainees no longer need to invest cognitive effort in studying information (e.g. steps in solving a problem) that they have already acquired (Clark *et al.*, 2006; Kalyuga *et al.*, 2001). As a consequence, traditional problem solving is often superior to learning with worked examples when training experienced learners (Kalyuga *et al.*, 2003).

At first glance, the worked example effect may seem counter-intuitive to the self-directed, independent learning principles that are central to the adult learning framework. However, as Knowles (1990) explains, even with adult learners it may be appropriate to begin with pedagogical instruction (i.e. instructor-driven learning) in situations where the learners are new to the learning environment (i.e. new recruits). Likewise, the use of worked examples is also consistent with Bloom's Taxonomy in the sense that worked examples are designed to ensure an adequate level of knowledge and comprehension before more complex tasks are focused on (e.g. application, analysis, or synthesis). In fact, Werth (2011) found that some police trainees opposed the self-directed nature of problem-based learning due to the fact that they felt ill equipped to accomplish the assigned tasks. Beginning the training program by offering trainees some initial guidance in the form of worked examples ensures that they will have the essential resources they need to carry out higher-order tasks. Not only will worked examples reduce the cognitive load placed on the new recruits' WMs, but it may also make them more comfortable with the more independent, andragogical learning exercises they encounter later in the course of training.

Problem completion effect. In order to ensure that learners process worked examples effectively, trainers may wish to adopt completion examples as an instructional strategy (Paas and van Merriënboer, 1994; Renkl and Atkinson, 2003). A completion example combines the benefits of a worked example with that of a conventional practice problem (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). Research has shown that completion examples improve learning outcomes when compared to conventional problem solving (Clark *et al.*, 2006; Paas, 1992; van Merriënboer and de Croock, 1992), a finding that has been referred to as the problem completion effect.

In line with worked examples, completion examples serve to reduce extraneous load by directing the learner's cognitive resources toward aspects of the task that facilitate learning (i.e. the solution steps explicitly provided). Furthermore, deeper processing (and better learning) of the instructional materials is encouraged by requiring the learner to independently realize the completion aspects of the problem (Clark *et al.*, 2006). In essence, the use of completion examples can help transition recruits from instructor-driven learning events to self-directed learning events, or from the lower levels of learning in Bloom's Taxonomy to the higher levels of learning.

When should completion examples take precedence over fully worked-out examples? Generally speaking, the amount of guidance provided to trainees should be a function of both the complexity of the material being learned as well as the trainee's level of expertise (Cooper, 1998). For instance, novices should be provided with more complete examples (i.e. more guidance) than experienced learners, especially when the material is complex (i.e. characterized by a high level of element interactivity) (Clark *et al.*, 2006).

Split-attention effect. Split-attention refers to the extraneous cognitive load that learner's experience when the material they are studying (e.g. via worked examples) is designed in such a way that the training requires them to mentally relate multiple sources of information that are separated in either space (e.g. text and a diagram) or time (e.g. a diagram and accompanying audio), even though both sources of information are required for full understanding to be achieved (Clark *et al.*, 2006; Clark and Mayer, 2008). The extraneous load caused by split-attention can be avoided by ensuring that the instructional materials are integrated with, rather than separated from, one another (Kalyuga *et al.*, 1999). The improvement in learning that arises as a result of this integration is referred to as the split-attention effect (Chandler and Sweller, 1991, 1992; Sweller and Chandler, 1994; Tindall-Ford *et al.*, 1997).

Redundancy effect. In addition to ensuring that multiple sources of information are integrated in space (e.g. text and diagram) and time (e.g. audio and visual) when presented to learners, it is equally important to ensure that both sources of information are indeed essential for one to come to a complete understanding of the instructional materials (Cooper, 1998; Pawley *et al.*, 2005). If the integrated materials are redundant (i.e. both sources provide learners with the same knowledge), then one source can, and probably should, be removed (Kalyuga *et al.*, 1999; Pawley *et al.*, 2005). When learning is enhanced as a result of eliminating redundant sources of information from training materials, the redundancy effect has occurred (Chandler and Sweller, 1991; Leahy *et al.*, 2003).

The redundancy effect occurs because learners will attempt to process multiple sources of information in their WM even if they provide the same information (Clark *et al.*, 2006; Pawley *et al.*, 2005). This additional processing uses WM resources that could otherwise be directed to activities that are more relevant to learning (e.g. germane processes). In line with the other CLT effects mentioned above, adherence to the redundancy principle is particularly crucial when element interactivity is high, and the learners are novices, rather than experts (Clark *et al.*, 2006).

Modality effect. In situations where physically integrating two related sources of non-redundant information is difficult, dual-mode presentation of instructional materials can be used as an alternative technique to deal with the processing demands resulting from split-attention (Kalyuga *et al.*, 1999; Mayer, 1997). For instance, if incorporating relevant textual information into a diagram makes the instructional material appear too cluttered or complex, the text can instead accompany the diagram in audio format. The enhancement in learning that is observed as a result of this dual mode presentation has been referred to as the modality effect (Brünken *et al.*, 2004; Ginns, 2005; Moreno and Mayer, 1999; Tindall-Ford *et al.*, 1997).

It has been suggested that the modality effect emerges as a result of an increase in WM capacity (Kalyuga *et al.*, 1999; Mayer, 1997). Essentially, WM is thought to consist of two partially unconnected processors for auditory and visual information

(Baddeley, 1992). By using two separate modes of presentation, WM may not be overloaded because both the auditory and visual channels (rather than just the visual or auditory channel) are being used (Kalyuga *et al.*, 1999). It is important to note, however, that the beneficial effects of employing both processing channels seems to arise mostly in situations where: the auditory information adds something above and beyond the visual information (Leahy *et al.*, 2003), the knowledge or skills being learned are high in element interactivity (Tindall-Ford *et al.*, 1997), and less experienced learners are being targeted (Kalyuga *et al.*, 2000; Seufert *et al.*, 2009).

3.2 Maximizing germane load

Not only should extraneous load be minimized by employing the above instructional techniques when applicable, but strategies that encourage learners to engage in deeper processing of instructional materials should also be incorporated into training. Such strategies accord well with adult learning frameworks, as one of the central goals of self-directed learning is to promote more active, or involved, learning among trainees (Brookfield, 1986; Knowles, 1980). Moreover, since these strategies promote more active processing, they can help to move trainees past the basic knowledge and comprehension stages of Bloom's Taxonomy to the more complex stages, such as application, analysis, and synthesis.

Strategies that directly target schema acquisition and/or automation place additional load on WM – germane load – however, this load can be considered "good" load since it can facilitate learning. As shown in Figure 1, if enough WM capacity has been made available by reducing all sources of extraneous load, increasing germane load through the use of specific training strategies can maximize learning results. Some of the most well-known training effects to emerge when germane load is focused on are the: variability, self-explanation, and imagination effects.

Variability effect. When attempting to apply the knowledge (and skills) attained during training while on-the-job, police officers frequently must apply this knowledge (or skills) across a wide range of circumstances that differ from those encountered during training. This makes it very important for training to assist the officer in developing flexible or adaptive schemas that allow for the transfer of skills to the work environment (de Croock *et al.*, 1998; Gick and Holyoak, 1983). CLT researchers have found that the construction of more flexible, adaptive schemas can be achieved by providing trainees with diverse, rather than many similar, training examples throughout the course of training (Clark *et al.*, 2006; Sorden, 2005; van Merriënboer *et al.*, 2006). The enhancement in learning that results from exposure to variation in training has been termed the variability effect (Paas and van Merriënboer, 1994; Quilici and Mayer, 1996).

Similar to other CLT effects, however, the impact of including a range of scenarios in training has also been shown to vary as a function of the complexity of the to-be-learned information. That is, if the instructional material is too complex, positive contributions of variability to learning may not be found (Große and Renkl, 2006). This is because the learner is provided with the additional task of determining the important commonalities across the varied examples (Clark *et al.*, 2006). As a result, incorporating varied solutions into training may overload WM unless other types of cognitive load are appropriately dealt with in advance (e.g. ensuring all sources of extraneous load are eliminated).

With respect to adult learning models, not only can example variability encourage deeper processing of the instructional materials, but varying the manner in which the scenarios are presented to learners can also serve to target different learning styles. For example, as previously mentioned, the majority of police officers are likely to be multimodal learners in the sense that they learn best through the use of a variety of different techniques (Landry, 2011). Using various delivery models to present diverse training scenarios (e.g. case studies, role plays, oral presentations, etc.) can help ensure that each learner is provided with the chance to develop their knowledge and practice their skills in a way that corresponds to their individual learning preferences.

Self-explanation effect. Even when trainees have been provided with varied learning scenarios, they may need additional support to ensure they attain more than surface knowledge of the examples. CLT research has shown that a deeper processing of worked examples can be encouraged by a process called self-explanation (Atkinson and Renkl, 2007; Clark *et al.*, 2006). Self-explanation often entails having the learner explicitly elaborate upon underlying principles of the instructional domain (e.g. Atkinson *et al.*, 2003) or establish connections between different aspects of the problem (e.g. Wong *et al.*, 2002). As a whole, having students self-explain while learning encourages them to "attend to the material in a meaningful way while effectively monitoring their evolving understanding" (Roy and Chi, 2005, p. 272). Although self-explaining increases the cognitive load experienced by learners, a number of studies have found that it results in a deeper, more deliberate, processing of instructional materials, ultimately leading to greater learning gains (e.g. Atkinson *et al.*, 2003; Bielaczyc *et al.*, 1995; Chi *et al.*, 1994; Hilbert and Renkl, 2009; Renkl, 1997). Collectively, such findings provide the basis for what has been labelled the self-explanation effect.

Research suggests that providing learners with specific, or detailed, prompts to explain certain aspects of the task they are being trained on is more likely to result in greater learning achievements than merely providing learners with the more general prompt to "think aloud" (Bielaczyc *et al.*, 1995; Busch *et al.*, 2008; Chi *et al.*, 1994). This appears to be especially true for novice learners who lack pre-existing schemas (Renkl *et al.*, 1998).

Imagination effect. Under certain circumstances, mentally rehearsing the steps required to successfully complete a given task can enhance learning as opposed to merely studying the same materials. The learning gains resulting from adopting this strategy represent the imagination effect (Cooper *et al.*, 2001; Ginns *et al.*, 2003; Leahy and Sweller, 2004; Tindall-Ford and Sweller, 2006). CLT researchers have suggested that the beneficial effects of imagination stem from the fact that using mental imagery enables learners to more explicitly monitor their understanding by allowing them to identify what aspects of the learning materials they are comfortable with and what aspects require additional rehearsal (Leahy and Sweller, 2008).

Unlike the majority of other CLT effects, which have been found to apply mostly to novice learners, mental rehearsal appears to be most effective when used by more experienced learners (Cooper *et al.*, 2001; Ginns *et al.*, 2003; Leahy and Sweller, 2005). This is because the existence of schemas makes more space available in WM so that processes that create additional WM load, such as mental rehearsal, can be carried out effectively (Clark *et al.*, 2006; Cooper *et al.*, 2001). Consequently, experienced learners are more likely to benefit from the imagination technique than novice learners who do not have enough processing capacity available to engage in such a demanding task, and who instead benefit more from repeatedly studying the material presented in worked-out or completion examples, at least at the outset of the training program (Leahy and Sweller, 2005).

3.3 Managing intrinsic load

In many training domains, even when all sources of extraneous load have been appropriately reduced, the complexity of the instructional materials may be so high in the initial stages of training that it inevitably exceeds the trainee's available WM resources (van Merriënboer *et al.*, 2003, 2006). As shown in Figure 1, trainers can resolve this issue by implementing techniques to effectively manage this intrinsic load. Two of the techniques that enable one to accomplish this involve sequencing and fading, which can lead to the sequencing and fading effects. Collaborative learning is also another potential strategy, though it is not yet as well established as a training strategy.

Sequencing effect. As illustrated in Figure 1, one way that intrinsic load can be managed is by initially separating highly complex information into more manageable subcomponents for learners, before slowly presenting the learner with the entire task (Ayres, 2006; van Merriënboer *et al.*, 2006). The improvement in learning that frequently occurs when such a strategy is employed is called the sequencing effect (Clark *et al.*, 2006; Kester *et al.*, 2006; van Merriënboer *et al.*, 2006). The effect occurs because sequencing the complex material artificially reduces the element interactivity experienced by the learner when encountering novel information. Sequencing allows the learner to develop some initial schematic knowledge in the domain by studying the subcomponents in a sequential fashion. After these initial stages, WM can better handle the cognitive demands imposed by the whole task (Pollock *et al.*, 2002; van Merriënboer *et al.*, 2006). When learners have more experience in the task domain, or when the material under question is low in complexity, sequencing may not facilitate further learning, as WM load is likely not overwhelmed under such instances (e.g. Ayres, 2006; Clarke *et al.*, 2005; Pollock *et al.*, 2002).

Fading effect. In order to deal with the fact that learners who are novices at the outset of a training program eventually acquire some level of experience in the domain as training progresses (i.e. they begin to develop more detailed schemas), CLT researchers have recommended that trainers gradually decrease the support and guidance provided to learners (Renkl and Atkinson, 2003). For instance, although problem-based learning is a promising student-driven training strategy that should not be abandoned, new recruits may not be prepared to successfully accomplish these tasks at the outset of a training program (Werth, 2011; Willis, 2010). Fading can be used to resolve this issue, where trainees are first provided with fully worked-out examples (i.e. complete guidance), then completion problems (i.e. partial guidance) and, when ready, conventional problem-solving tasks where no guidance is provided and the trainee is required to independently arrive at a solution (Atkinson *et al.*, 2003; Kalyuga *et al.*, 2003; Schwonke *et al.*, 2009). The superior learning that results from the implementation of this training strategy is referred to as the fading effect, and this strategy has generally been found to combat the detrimental effects on learning that can sometimes occur as a result of the expertise reversal effect (Renkl *et al.*, 2004). Moreover, research conducted in the work setting has shown that this fading technique can be an effective instructional strategy with adult learners (Kissane *et al.*, 2008).

Collaborative learning. Although not yet fully recognized as a CLT effect, recent research has suggested another way to manage the intrinsic load associated with complex learning tasks: collaborative, or group-based, learning. Specifically, research has suggested that, when dealing with highly complex learning tasks, collaborative learning can be more beneficial than individual learning, particularly in terms of learning transfer results (Kirschner *et al.*, 2009a, b).

CLT suggests that the benefits of group learning arise from the fact that many WMs, rather than just one, are available to process the instructional information. The increase in WM capacity is thought to reduce the intrinsic load experienced by any one learner (Kirschner *et al.*, 2009a, b). This results in enhanced learning, provided that the group is able to communicate effectively. Similarly, it is believed that group learning will only be superior to individual learning in instances where the task is high in intrinsic load and thus may overload the WM of one individual (Kirschner *et al.*, 2009a b). Although research on collaborative learning remains in its infancy, this strategy may have value in enhancing learning transfer results within the police training domain, as police officers are often required to work together on a variety of highly complex tasks while on-the-job. Moreover, this effect accords well with training designed to consider adult learning principles where group activities are promoted to facilitate independent, self-directed learning of the instructional materials (Birzer, 2003; Vodde, 2012). Similarly, the instructor can make use of trainees' previous experiences in group-based learning by mixing experts (with more advanced schemas) with novices (with less advanced schemas) so that WM load can be further reduced for the inexperienced trainees.

4. Putting the effects into practice: an example using e-learning

Carefully considering instructional design, and how it can either positively or negatively impact the cognitive resources of trainees, is vital for training in complex domains, such as policing. All of the instructional techniques discussed above have the potential to be applied to the law enforcement context, and as such, improve both the effectiveness and efficiency of police training programs. How exactly can the above CLT principles be incorporated into police training? This section provides an overview of how CLT can be applied to police training in the online environment, as this form of training has become increasingly common across law enforcement agencies (e.g. CPKN, 2009; European Police College, 2012; Interpol, 2012) and can present some unique challenges to instructional designers (Clark and Mayer, 2008).

Just as policing has shifted towards more modern (or technologically driven) forms of training, such as e-learning (e.g. CPKN, 2009), so too has CLT research (e.g. Clark and Mayer, 2008; Kalyuga, 2007; van Merriënboer and Ayres, 2005). E-learning has generally been conceptualized as any form of computer-based training (Clark and Mayer, 2008). The benefits of e-learning are twofold. First, organizations are able to save travel time and costs associated with traditional classroom-based training (Clark and Mayer, 2008). Second, e-learning allows for a greater degree of interactivity between the learner and the training environment (Ayres and Paas, 2007).

As alluded to above, the e-learning environment presents some additional cognitive load challenges to instructional designers beyond those commonly encountered in a classroom setting (Clark and Mayer, 2008). Essentially this is because a wide array of media elements can be easily incorporated into e-training, including text, narration, music, instructional animations, other graphics, and so on (Clark and Mayer, 2008). Although integrating all of these types of interactive elements into e-learning is tempting and might be intuitively appealing, to do so can easily lead to situations where a learner's cognitive resources are exceeded. Properly managing cognitive load by incorporating the instructional design principles outlined above remains an essential component of designing effective instructional materials within the e-learning context (Clark and Mayer, 2008; van Merriënboer and Ayres, 2005).

For instance, instructional animations are often incorporated into e-learning environments. In situations where animations illustrate how to perform a motor skill (e.g. patting down a suspect, taking a fingerprint, applying handcuffs, etc.), they may be more effective than static diagrams (Ayres *et al.*, 2009; Höffler and Leutner, 2007). However, the richness and transient nature of animations can have the negative effect of overloading the learner's WM when static diagrams are sufficient to achieve understanding (Ayres and Paas, 2007; Clark and Mayer, 2008). Similarly, the use of extraneous graphics that are not relevant to learning (e.g. a photo of a police officer talking to a civilian next to a lesson on communication skills) can place unnecessary, extraneous load on the learners WM resources (Clark and Mayer, 2008). As a result, it is important for instructional designers to consider the detrimental effects that seemingly harmless media elements can have on learning within the e-learning environment.

One way that CLT can be used to assist curriculum designers and trainers in the policing context, is that it can prompt these individuals to consider (in a very explicit way) whether the training that is being designed and delivered accords well with what we now know about effective training. To facilitate this, we provide in Table I a series of CLT-based questions that instructional designers/trainers should be asking themselves when designing/delivering a training program for new recruits (i.e. officers

Goal/question	Strategy	✓
Minimize extraneous load		
Have I included a sufficient number of problems in my course where I demonstrate, in a step-by-step fashion, how to solve the problem being learned?	Use worked examples to provide new recruits with adequate guidance	
Have I presented the same material in multiple formats (e.g. text and diagram) when it is understandable in one format alone?	Remove one of the redundant sources of information (e.g. text or diagram)	
Have I avoided splitting the trainees' attention between multiple pieces of non-redundant instructional material?	Integrate related forms of essential instructional information	
Is it too difficult to physically integrate related sources of essential training information, or does the instructional material appear cluttered when integrated?	Use audio in place of text to explain a related diagram or animation	
Maximize germane load		
Have I provided trainees with a range of different training demos in order to improve the transfer of skills to the work environment?	Vary the surface features across the training demos presented to the trainee	
Have I explicitly prompted trainees to engage in a deeper processing of the materials and encouraged them to monitor their learning as it progresses throughout the training program?	Ask trainees to self-explain important features of the worked examples to themselves	
Manage intrinsic load		
If the material is complex, have I adequately dealt with how to present the material to recruits so it does not overload their working memory?	Present the examples in parts followed by the entire example once schemas have been established	
If the material is complex, have I effectively modified the learning environment to help learner's deal with the increased complexity?	Ask trainees to collaborate with one another in order to distribute the working memory load	

Table I.
CLT-inspired checklist for instructional designers

who are not yet experts in the field of training). While not all of the components in Table I will apply to training offered to more experienced police officers, it can be easily extended to the training of new recruits within the traditional classroom setting in addition to training provided in an e-learning environment.

For example, consider an e-learning scenario where new officers are learning basic investigative skills, including how to: respond to a crime scene, take statements, collect evidence, interview suspects, and generally manage the case. When planning this e-course, instructional designers should first ask themselves whether they have taken every measure to reduce extraneous, or unnecessary, WM load. For instance, have they used worked examples when applicable (e.g. by demonstrating the steps involved in the cognitive interview)? Similarly, have they removed redundant sources of information (e.g. text explaining how to restrain a suspect at the crime scene is not included in the training when an instructional animation has already been included that adequately demonstrates the process)[3]? Finally, have they ensured the trainee's attention is not being split between two related sources of necessary information (e.g. text explaining how to properly complete a search warrant form is incorporated into the picture of the search warrant or audio is explaining the correct procedure instead of text)?

Once sources of extraneous load have been dealt with, instructional designers should then consider incorporating strategies into their course that further enhance the learning of basic investigative skills (i.e. strategies that increase germane load). For instance, to improve the ability of trainees to use any new acquired skills while on-the-job, instructors should ask themselves whether they have varied the surface features of the worked examples they plan to give trainees (e.g. by demonstrating the techniques used in the cognitive interview across a wide range of crimes, victim, and perpetrator profiles)? Similarly, instructors should ensure that they have included specific questions throughout the training lesson that encourage deep processing of the instructional materials (e.g. prompting trainees to self-explain how to effectively take statements from victims and witnesses at the crime scene)?

Moreover, many lessons covered in a course teaching officers basic investigative skills are likely to be very high in intrinsic complexity (e.g. how to deal with suspects, victims, and witnesses as the first responder to a crime scene, how to appropriately collect evidence and ensure it is not contaminated, how to prepare a case for court, etc.). Under these circumstances, instructional designers should consider whether further precautions are necessary to ensure the trainee's cognitive resources are not overloaded at the outset of the course. For example, have they presented the instructional material to the trainees in a way that reduces the initial burden placed on WM (e.g. by demonstrating the steps of the cognitive interview one-by-one and then as a whole process once trainees become familiar with each step)? Similarly, have they offered learners additional resources to offset the inherent complexity of the material being learned (e.g. by facilitating collaboration amongst trainees in an e-chat forum during and after each lesson to reduce the load placed on any one trainee's WM)?

Finally, instructors should also ensure that they have taken into account the trainee's developing schemas throughout the course. In other words, have they taken measures to effectively combat the expertise reversal effect? One way to do this is to continually monitor the trainee's learning over the course of the training program (i.e. via short evaluations), fading from worked examples to completion problems when the evaluations demonstrate that learning is occurring (Kalyuga and Sweller, 2004). Eventually, as learning further progresses, trainees can be given traditional problem-based learning tasks in order to acquire all the necessary skills. Similarly, in later stages of the course, instructors may wish to use mental rehearsal instead of self-explanation techniques to facilitate deeper processing of the instructional materials. Modifying the strategies used to accommodate the experience level of trainee's ensures that learning will continue to evolve throughout the entire duration of the training course.

5. Aspects of CLT that require further research

Despite the potential value of CLT as a framework to improve police training, there are still aspects of the theory that require further research. While it is clear from the research reviewed above that an abundance of empirical support has been found for the instructional effects stemming from CLT, some criticisms of CLT do exist. These criticisms tend not to focus on the validity of the effects themselves, but rather on the explanations provided for why these effects emerge (Beckmann, 2010; de Jong, 2010; Schnotz and Kürschner, 2007).

The majority of CLT criticisms fall into two categories: conceptual and methodological[4]. Conceptually, the major criticism levelled against CLT relates to the difficulty in distinguishing between the different types of cognitive load that are thought to be important in training contexts, especially extraneous and germane load. For example, de Jong (2010) makes the point that, conceptually, extraneous and germane load can only be determined in a *post hoc* fashion, after the effect of training is observed (i.e. load is defined as extraneous if the training resulted in poor learning outcomes, but germane if the training resulted in good learning outcomes). Questions have also been raised by critics about whether the three types of cognitive load discussed in CLT are in fact additive and about the concept of cognitive load itself (e.g. whether cognitive load and cognitive effort are synonymous as assumed in some CLT research) (de Jong, 2010).

The most common methodological criticism of CLT is that no standard procedure currently exists for measuring (and distinguishing between) the various types of cognitive load experienced by trainees (Beckmann, 2010; de Jong, 2010; Schnotz and Kürschner, 2007). While physiological measures of cognitive load are available (van Gog *et al.*, 2009), the most commonly used measures consist of self-report questionnaires (e.g. where learners indicate the amount of mental effort exerted during training; Paas, 1992). However, as de Jong (2010) highlights, there is no standard format to these questionnaires. Other methodological issues that have been raised relate to the lack of attention paid by researchers to important individuals difference variables that may influence how cognitive load is experienced by learners (e.g. WM capacity) and the low level of ecological validity associated with some CLT studies, which raises questions about the generalizability of the results to realistic training environments (de Jong, 2010).

Similar to police training itself, CLT is continually evolving and ongoing research will help to address these concerns. While more work clearly needs to be done to better understand the nature of the CLT effects described above, it also seems clear that empirical support for these effects exists. This fact highlights the potential for CLT-based instructional strategies to significantly improve the quality of police training. Indeed, while there have been concerns raised about CLT-effects potentially not generalizing beyond the research laboratory (e.g. de Jong, 2010), the CLT-effects we have focused on do frequently extend to naturalistic settings where authentic training is delivered, such as the classroom setting (e.g. Carroll, 1994; Harskamp *et al.*, 2007;

Kissane *et al.*, 2008; Ward and Sweller, 1990; Zhu and Simon, 1987). It is difficult to think of a reason why this would not also be true for training delivered in the policing context.

6. Where does police training go from here?

Given the extensive empirical support that exists for the instructional effects of CLT across a variety of complex cognitive domains, it is clear that this theoretical framework could be valuable to the area of police training. Although promising, CLT has yet to be integrated into police training theory and practice as it currently exists. The ultimate goal of this paper was to provide some concrete illustrations of how CLT training strategies can complement, and potentially enhance, traditional theoretical approaches to police training.

The few examples provided above clearly demonstrate that CLT principles can be applied to some of the current methods of police training in a relatively easy fashion, but whether CLT-informed instruction leads to significant improvements in learning and transfer in this domain (as compared to traditional forms of instruction) certainly remains an empirical question. Our hope is that this paper will open up a discourse between academic researchers, instructional designers, and police trainers so that the potential benefits of integrating CLT principles into police training may be realized. By implementing some of the recommendations offered in this paper, we are hopeful that future research will demonstrate that CLT can be used to improve both the efficiency and effectiveness of police training programs.

Notes

1. Although we chose e-learning to illustrate how CLT-based strategies can be implemented in the police training context, it is important to note that the same CLT principles can be extended to classroom-based training (Clark *et al.*, 2006; Clark and Mayer, 2008).
2. With that said, some scholars have noted that for certain police training courses (e.g. firearms and defensive training), a pedagogical or instructor-driven approach will continue to be most appropriate (Birzer, 2003).
3. Given the importance we have placed on multimodal learning styles, we would like to stress that removing sources of information from training (to reduce redundancy) does not mean that a multimodal instructional strategy cannot be adopted. Indeed, such an instructional strategy can still be used by trainers so long as it is neither redundant nor splits the learners attention across multiple sources of information at any given time. That is, multiple modes of presentation (e.g. an audio explanation of a diagram) can be used to target different learning styles, as long as they are not providing completely redundant information and they are both presented to the trainee at the same time.
4. For a more detailed explanation of criticisms against CLT, please see de Jong (2010).

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