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# Experimental analysis of using examples and non-examples in safety training☆

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ABSTRACT

*Introduction:* The effects of training content consisting of examples and/or non-examples was studied on the acquisition of safety-related skills. *Method:* Participants ($N = 160$) were randomly assigned to first receive computer-based training on office ergonomics that included either no examples of safe or at-risk postures, safe examples only, at-risk examples only, or both safe and at-risk examples. Participants then attempted to classify as safe or at-risk various postures depicted in short video clips and demonstrate with their own posture the range of safe postures. *Results:* Groups that were trained with both safe and at-risk examples showed greater classification accuracy and less error in their demonstration of safe postures. Training with only safe or at-risk examples resulted in a moderate amount of error and a consistent underestimation of risk. *Conclusion:* Training content consisting of both examples and non-examples improved acquisition of safety-related skills. *Practical applications:* The strategic selection of training content may improve identification of risks and safe work practices.


## 1. Introduction

Training is an important component of occupational safety and health programs (OSHA, 1998; Burke et al., 2006; Robson et al., 2010; Burke et al., 2011). The primary purpose of training is to provide workers with the knowledge and skills necessary to avoid illness, injury, or death. Because of its importance, there is a continuous need for safety researchers to evaluate training content and methods to improve its efficiency and effectiveness (Robson et al., 2010; Arthur, Bennett, Edens, & Bell, 2003; Cohen & Colligan, 1998).

### 1.1. Training with examples and non-examples

Experts in psychology, education, and instructional design have recommended incorporating examples into training to facilitate concept learning and skill acquisition (e.g., Clark, 1971; Brethower, 2000; Markle & Tiemann, 1970; Merril, Tennyson, & Posey, 1992; Foshay, 2010). In concept learning, *examples* refer to objects, events, or instances that have one or more defining characteristics or qualities of a concept (Merril et al., 1992). Examples are said to be members of a *concept class*. For example, cakes, cookies, pies, and candy are members of the class of *dessert foods*. Examples are usually necessary for concept learning to occur, but they are not always sufficient. Mastery of some concepts may require the use of non-examples. Non-examples are objects, events, or instances that do not have the defining characteristics or qualities of the concept and, therefore, do not belong to the concept class. Wheat bread, hot dogs, broccoli, and crackers are non-examples of the class *dessert food*. Research has shown that mastery of a concept is greatest when training includes both examples and non-examples (e.g., Derenne, 2006; Durkin & Rittle-Johnson, 2012; Grobe & Renkl, 2006; Stark, Kopp, & Fischer, 2011; Wisniewski, Church, & Mercado, 2009).

The importance of training with examples and non-examples seems to extend equally well to safety concepts; however, the explicit use of examples and non-examples in safety training is rarely discussed—if at all—in the safety literature. Consider the problem of teaching a contractor's apprentice safe and hazardous electrical conditions. To best illustrate the distinction between safe and hazardous conditions, the apprentice may be shown several safe conditions (i.e., examples) and several hazardous conditions (i.e., non-examples). Safe examples might include the presence of extension cords with insulated wire and a grounding conductor, wiring enclosed in panels and machinery, use of ground fault circuit interrupters, and use of electric tools in dry conditions. The hazardous instances or non-examples might include extension cords that are frayed, cut, or without a grounding conductor, damaged machinery with exposed wiring, use of an overloaded outlet, and use of electric tools in damp conditions. It seems intuitive that the

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apprentice shown only one type of example may not learn to recognize all possible safe and hazardous electrical conditions, and yet the safety training literature is mostly devoid of the topic of examples and non-examples. Furthermore, we can find no authoritative recommendations in the safety literature concerning the use of safe and at-risk examples, despite a common concern among safety experts that providing both examples and non-examples of safe conditions or practices may create confusion about what is safe and what is not safe.

Using both examples and non-examples may be important in safety training not only to increase accuracy in learning concepts but also to minimize bias. Research in the psychology of learning has shown that training with examples only can result in overgeneralization of the concept (e.g., Wisniewski et al., 2009). For example, a study that investigated learning in a driving simulator showed that training with safe driving examples only, when compared with both safe and at-risk examples, resulted in greater speeds and other risky maneuvers at a traffic signal (Ivancic & Hesketh, 2000). Indeed, the biased training in that study may have contributed to an overgeneralization of safe driving conditions and underestimation of risks, but the effects of biased training is not well understood. More research is needed to evaluate the effects of training with safe and at-risk examples to better understand the conditions under which biased training leads to an overestimation or underestimation of hazards and risks.

### 1.2. Verbal skills versus performance skills

Safety training is used to improve different types of safety-related skills associated with hazard and risk identification and safe work practices. Many of the skills trained are *verbal* (i.e., classification, recognition, discrimination, comprehension, detection, and identification) in the sense that they help workers report differences between safe and at-risk work conditions. As an example, a worker who is trained to inspect scaffolding for sound wooden planks is expected to visually evaluate the planks and accurately report whether they are safe (e.g., straight, consistent, and complete with clean surface, etc.) or hazardous (e.g., splits or warps greater than 1/4 inch, gouges, mold, etc.). Because workplace safety and health depend on verbal skills, it is imperative that the effects of examples and/or non-examples be considered in the development of safety training as they have the potential to either help or impede worker's learning of hazards and risks.

It is also important to determine how training with examples and/or non-examples affects safety-related *performance*, which can be defined as kinesthetic or physical repertoires (Wan, 2014; Tiemann & Markle, 1990). For example, courses on driver safety often use pictures and videos to teach people how to respond during a loss of vehicle control. In response to hydroplaning on a straight road, drivers are taught to keep the wheels straight and to let off of the accelerator or gently apply the brakes. Safe driving programs, like many other classroom and computer-based training programs often incorporate examples of safe practices with the assumption that the ability to recognize correct or incorrect responses will result in the ability to perform the appropriate safe responses. This transfer of learning from verbal skills to performance skills is an example of *vertical transfer* (Blume, Ford, Baldwin, & Huang, 2010).

The transfer of learning among skills seems to be an important consideration for safety training programs, especially those in which safety-related verbal skills are directly targeted and are assumed to also result in acquisition of associated performance skills. The necessary or boundary conditions under which this type of transfer of learning may occur has not been systematically studied in safety research. This void highlights the need for basic research to elucidate the extent to which training with examples and/or non-examples affects acquisition of safety skills. The results of such research could lead to more effective and efficient safety training programs.

### 1.3. Purpose and hypotheses

The main objective of this study was to evaluate the use of examples (safe leg angles) and non-examples (at-risk leg angles) in a computerized training module on postural ergonomics. For the purposes of this experiment, the content in the training module was simplified to focus only on safe and at-risk knee angles when seated at a computer workstation. Four different training modules were tested experimentally. The modules consisted of either (a) no safe or at-risk examples, (b) only safe examples, (c) only at-risk examples, (d) or both safe and at-risk examples. These training conditions were assessed on participants' acquisition of a posture-related verbal skill (i.e., classifying postures as safe or at-risk) and a performance skill (i.e., demonstrating safe postures). It was hypothesized that training with only safe or only at-risk examples will result in more accurate classification than training with no examples, but training with both safe and at-risk examples will result in the most accurate and least biased classification. Similarly, it was hypothesized that training with no examples will result in more error in demonstrations of safe postures than training with either safe or at-risk examples alone, but that training with both safe and at-risk examples will produce the least amount of error. Finally, we explored the transfer of learning by examining the effects of training with both safe and at-risk examples on the correspondence between classification and demonstration skills.

## 2. Method

### 2.1. Participants and settings

Participants ($n = 160$) were recruited from undergraduate psychology courses at Queens College. Each individual participated in one 40-min to 70-min session that took place in a private room equipped with a computer workstation. The study was approved by the college's institutional review board, and all participants signed a consent form.

### 2.2. Experimental design

A randomized group design was used to test the effect of the different training conditions. Participants were randomly assigned in a balanced manner to one of four groups that received training with either: (a) no safe or at-risk examples of knee angles (No Ex); (b) only safe examples (S Ex); (c) only at-risk examples (A Ex); or (d) both safe and at-risk examples (S&A Ex).

### 2.3. Procedure

Participants completed computer-based training and assessment as outlined in Table 1. The S Ex, A Ex, and S&A Ex groups were presented the training and assessment materials with an automated PowerPoint slideshow. The slideshow consisted of pictures and videos recycled from previous studies (e.g., Taylor & Alvero, 2012; Taylor, Skourides, & Alvero, 2012). The sets of pictures and videos depicted a person seated at a computer workstation with their lower leg in one of several neutral, flexion, and extension positions. Leg angles 77° to 100° were classified a priori as *safe*. Angles 40° to 76° (flexion or backward position) and 101° to 165° (extension or forward position) were classified as *at-risk* (ranges of safe and at-risk leg angles were adapted from materials provided by the U.S. Department of Labor, 2011). The pictures and videos of leg angles were measured in angular degrees using a digital protractor (Iconico Screen Protractor; v. 4; New York, NY). The No Ex group received no training and participated in the assessment phase only.

#### 2.3.1. Training phase

Training began with an *information* component that displayed operational definitions of safe or at-risk leg angles to supplement the use of examples in the subsequent training components (cf. Klausmeier &



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