

RICE UNIVERSITY

**Age and Training:
A Meta-analysis Examining Training Features**


by


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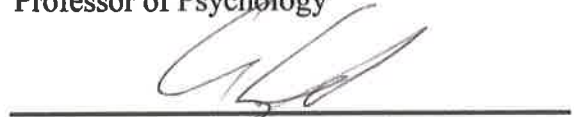
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ABSTRACT

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In light of an aging workforce and constant advances in technology, organizations are faced with questions about best practices for training and retraining their workers. Rapid technological developments create a need for organizations to train their employees on new technologies in order to stay competitive within their industries. However, the baby boomers that comprise a large portion of the workforce are aging, making older workers the prime targets for training. Age functions as a proxy for developmental changes in psychological capabilities that can affect learning. As such, organizations need to consider how their current organizational training practices align with the needs of older workers, and how to adjust their training programs such that they are comparably effective for younger and older workers alike. A meta-analytic study was conducted using lifespan motivation and cognitive resource theories to examine the relationship between age and training outcomes; namely trainee reactions, performance, and training times. Results demonstrate that the relationship between age and training outcomes changes with the specific outcomes that are valued. Furthermore, factors such as task content, task complexity, along with the structure and pacing of training programs, differentially impact training outcomes in ways that can help diminish age differences. These findings can be used by researchers and practitioners to work toward creating training that supports older workers by improving their training times and performance.

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CHAPTER 1: Introduction

The Importance of Aging and Training

Current workforce trends illustrate an important demographic shift in the global workforce; employees are getting older. As of 2014, approximately 61% of employed workers in the United States were age 55 or older (Bureau of Labor Statistics, 2015). Similar demographic shifts have been observed in Europe and the Asia-Pacific also, with some economies projected to have over 40% of their workforce comprised of people aged 50 or older as early as the year 2020 (Skirbekk, Loichinger, & Bakarat, 2012; Van Katwyk, 2012). As the labor force continues aging, organizations stand to gain a competitive advantage by understanding and accommodating for the needs of their older workers (Beier, 2016). With a rapidly-changing workplace and an increasing demand for up-to-date skill sets, training has quickly emerged as a valuable organizational process that employers can invest in to maintain organizational performance and productivity (ATD, 2016).

Fortunately, organizations already see the value in training. According to the Association for Talent Development (ATD), organizations spent an average of \$1,252 per employee for training and development in 2015. Furthermore, each employee received 33.5 hours, or over four full working days, of training per year (ATD, 2016). Additionally, training is an expensive endeavor; organizations must pay employees for their time spent in training even though progress on their primary work tasks is not being made. Failure to produce an effective training program can be costly, both in terms of monetary costs and organizational performance. If a training program is ineffective, an organization has essentially spent a sizeable portion of its financial resources to slow an

employee's productivity with little to show for job performance improvement. Because an employer serves as the working adult's primary provider of training (Cross, 1981), it is critical for organizations to first understand how age and training outcomes are related before creating training programs.

The relationship between age and training outcomes, especially performance, is important for multiple reasons. First, from a practical standpoint, aging is an inevitable process for all employees and age serves as a proxy for the development of various psychological capabilities – such as motivation and cognitive ability – that are critical determinants of skill acquisition and performance (Beier, 2008; Kanfer & Ackerman, 1989). Under the Age Discrimination in Employment Act (ADEA) of 1967, employees who are 40 years old or older are a protected class when it comes to employment practices; thus, training that puts these older workers at a disadvantage relative to younger workers could be legally problematic. Therefore, understanding how age impacts the way people work is not only beneficial for optimizing productivity, but pragmatic for current and future employment practices. Second, a large portion of employees who need training will be at least 45 years of age or older (Bureau of Labor Statistics, 2015), making them a critical population for training. Relative to younger workers, older workers have been in the workforce longer and will more than likely need their skills updated at some point during their career; when coupled with an aging global workforce and rapid advancements in technology, it becomes imperative for organizations to keep their older workers' skills updated with training and prevent issues such as skill obsolescence (Charness & Czaja, 2006; Lee, Czaja, & Sharit, 2009). Lastly, training requires the use of many cognitive resources, which are impacted by the aging process.

Psychologists have been examining the relationship between age and performance at work, both in terms of overall job performance and training performance, for many years (McEvoy & Cascio, 1989; Ng & Feldman, 2008; Waldman & Avolio, 1986). Decades of research suggests that cognitive ability and motivation are integral parts of the skill acquisition process; cognitive ability has been found to be one of the strongest and most consistent predictors of training performance and success (Ree & Earles, 1991; Schmidt & Hunter, 1998), and motivation for training also explains unique variance in training outcomes above and beyond cognitive ability (Colquitt, LePine, & Noe, 2000). Therefore, age-related changes in these psychological capabilities can reasonably be expected to affect older employees in the workplace. Indeed, changes or declines in motivation and cognitive ability can make training less appealing to older learners and make it more difficult to acquire new information, thereby affecting performance in learning situations (Charness, 2009). In particular, the cognitive and motivational changes that older adults experience may lead to less participation in training activities (Birdi, Allan, & Warr, 1997) and greater difficulty when performing certain types of tasks (Rogers & Fisk, 2000). Thus, some researchers have suggested that training may need to be tailored specifically for older adults in order to account for these developmental changes and promote success in training interventions (Charness, Schumann, & Boritz, 1992; Glass, 1994; Moseley & Dessinger, 2007).

Training can target different groups of employees and older adults are rapidly becoming the population of interest for many training programs. Past research has consistently demonstrated that training programs are effective, with the caveat that how training is designed, delivered, and then implemented are crucial elements that must be

considered (Salas, Tannenbaum, Kraiger, & Smith-Jentsch, 2012). Furthermore, researchers have recognized that older adults bring unique needs to training situations and in combination with empirical evidence of age-related training performance differences (Callahan, Kiker, & Cross, 2003; Kubeck, Delp, Haslett, & McDaniel, 1996), have proposed various training design guidelines intended to “close the performance gap” between younger and older learners. Many of these suggestions are rooted in the cognitive development literature, which shows that there is general cognitive slowing that occurs with age. Specifically, these cognitive aging approaches note that older adults experience decrements in performance due to general cognitive slowing (Salthouse, 1996), a reduced ability to focus attention on relevant material while inhibiting irrelevant content (Hasher & Zacks, 1988), and decreased working memory capacity as a result of having less processing resources (Balota, Dolan, & Ducheck, 2000).

As a result, researchers have proposed a variety of theoretically-driven suggestions for tailoring training towards older workers (Wolfson, Cavanagh, & Kraiger, 2014), such as active participation or discovery learning (Belbin & Belbin, 1972; Bell & Kozlowski, 2008), creating overviews of training content covered in the program (Czaja & Sharit, 2012), allowing for self-pacing (Belbin & Belbin, 1968, 1972; Callahan et al., 2003), and spacing out practice sessions (Charness, 2009). Many of these suggestions are based on cognitive aging theories, and thus are intended to alleviate the demand on cognitive processes during skill acquisition. Though many recommendations have emerged, meta-analytic evidence pertaining to the effectiveness of these techniques is limited and has become dated (Callahan et al., 2003; Kubeck et al., 1996), leaving much to be discovered in regards to which current training design elements benefit or hinder

older adults' learning. In addition, existing meta-analytic work has primarily examined the age and training relationship with theory from two very different perspectives: cognitive aging theories as applied to Murphy's (1989) model of job performance (see Kubeck et al., 1996) or andragogy learning theory (Knowles, 1990), which assumes that adult learners are experienced and take responsibility for their own learning, but need to know why training is important before engaging in skill acquisition activities. While both of these theoretical applications provide different perspectives on what underlying mechanisms may drive age differences in training performance, they do not examine how the developmental trends of cognitive ability and motivation over the lifespan impact skill acquisition together.

Purpose and Research Questions

Consideration of both motivation and cognitive ability is critical for understanding any impacts on the skill acquisition. Generally speaking, the skill acquisition framework follows a cyclical process with three core components: motivation, cognitive abilities, and skill acquisition (Charness, 2009; see Figure 1). The path to skill acquisition starts distally with motivation (i.e., individual differences, self-efficacy), which people use to decide whether or not to pursue skill acquisition opportunities. If someone is sufficiently motivated to learn, a more proximal key determinant of their performance will be cognitive abilities, such as working memory capacity, processing speed, prior knowledge and other factors of general intelligence. Finally, once the learner has completed the skill acquisition experience, any resulting feedback circles back to inform motivation levels for future skill acquisition endeavors. See Figure 1.

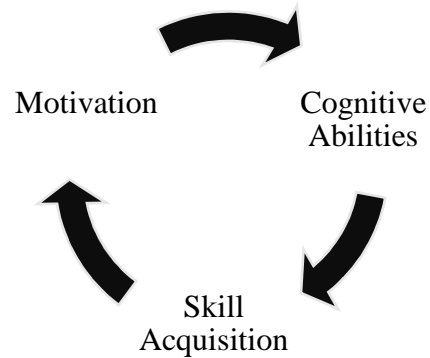


Figure 1. Framework for skill acquisition process (Charness, 2009)

Given the essential roles that motivation and cognitive abilities play in determining participation and success in skill acquisition situations, consideration of how both develop over the lifespan is necessary. The present study used a theoretically-based, meta-analytic approach to investigate the relationship between age and training through key influences that impact the skill acquisition process, namely motivation and cognitive abilities. By examining the development of these two influences over time, I sought to address the following research questions:

1. How do psychological changes linked with aging impact training outcomes?
2. How effective are different theoretical training techniques in supporting older learners in training?
3. What are some practical and effective recommendations that can be used to close the age differences gap in training outcomes?

As psychological processes associated with aging are difficult to measure directly, particularly on a meta-analytic scale, age will serve as a proxy for developmental changes. Even though U.S. federal law considers workers aged 40 or older to be part of a protected class, there is not a universal age at which every adult becomes an older worker and begins experiencing changes in cognitive ability and motivation. Consequently, this

paper will examine age along a continuum. Researchers have repeatedly found age to be largely unrelated to job performance (Avolio, Waldman, & McDaniel, 1990; McEvoy & Cascio, 1989, Ng & Feldman, 2008; Sturman, 2003; Waldman & Avolio, 1986), yet there is evidence that older adults perform more poorly than younger adults in training situations (Kubeck et al., 1996). Clearly establishing a main effect of age on training performance would help establish age as an informative proxy for developmental changes in psychological processes that are important for skill acquisition.

In addition to obtaining a comprehensive perspective of the age and training literature, I am interested in discovering how the relationship between age and training manifests in the workplace, along with ways that practitioners can effectively tailor training to older workers and encourage this population to engage in developmental activities. Therefore, I examined additional training outcomes used in the workplace besides performance and various moderators of the age and training relationship, specifically variables that can be adjusted when creating a training intervention to impact participation and performance (e.g., focus of training, task complexity, structure, self-pacing, and training content). Gaining insight into how different training properties of training affect participation and performance for older workers will better inform organizations and researchers on how to design training to meet the needs of the modern workforce. Thus, the primary goals of the present study were to (1) use a theoretically-driven approach to examine how age - as a proxy for changes in motivation and cognitive abilities - can impact training outcomes, (2) provide a broad update of the age and training literature by meta-analytically assessing studies with adult workers of all ages, (3) bridge scientist and practitioner priorities by examining a range of training outcomes

used in academia and in industry, and (4) identify theory-based training features that can potentially support older employees in the workplace.

Theoretical Background

The psychological literature surrounding aging, industrial gerontology, and older adult training and retraining has focused on creating training recommendations designed to help older learners succeed during training. One prominent theoretical framework that considers developmental changes in both motivation and cognitive ability is the industrial gerontology model (Sterns, 1986; Sterns & Miklos, 1995). This model posits that there are five major areas of consideration when designing training for older adults: (1) motivation, (2) program structure, (3) familiarity, (4) organization, and (5) time.

Motivation refers to ensuring that older adults want to participate in training and persist through a training intervention. Program structure, familiarity, organization, and time are related more to the training environment created as a result of training materials and how the program is set up; specifically, they refer to the sequencing of training tasks, degree to which training builds on prior knowledge and ability, how training material is organized, and the amount of time allowed during training respectively. Using the industrial gerontology model as a theoretical lens, I examine the age and training outcomes relationship as they relate to each of these five areas. This paper is organized as follows; first, I will address how motivation and cognitive ability develop as people age, using both theory and empirical evidence that reflects how these changes impact training. Then I will discuss the importance of training design, highlighting training features that target the five components of Stern's (1986) framework, and how I expect them to impact training through motivation or cognitive ability to support or hinder skill acquisition in

older adults.

Motivational development. As people age, their motivation for engaging in certain behaviors or performing specific tasks changes (Kanfer & Ackerman, 2004). What may have motivated someone as a teenager to work hard may not hold as much weight when that same person has become a middle-aged or older adult. Therefore, it is important to understand how motivation develops throughout the lifespan and how changes in motivation impact older adults in the workplace. A classic framework for understanding motivation is expectancy theory (VIE; Vroom, 1964). According to expectancy theory, a person's motivation for engaging in a specific task is the product of (a) the *expectancy* or the person's belief that exertion of effort will result in reaching performance goals, (b) the *instrumentality* or belief that attainment of performance goals will produce rewards and (c) the *valence* or value a person places on rewards resulting from task engagement (Vroom, 1964). The greater the magnitude of each component, the greater one's motivation will be. However, if any of those components are not valued, the person will not be motivated to pursue the task. Within the psychological literature, there are lifespan theories of motivation that provide insight on the types of goals that older adults prioritize, and how these goals drive their behavior during goal pursuit.

According to socioemotional selectivity theory (Carstensen, 1992, 1998), over the course of the lifespan people have three primary social motives that fluctuate in salience and guide goal-directed behavior: emotion regulation, self-concept, and information seeking. The perception of time as either open-ended or limited plays an important role in predicting how people pursue each of these different goals. For most of a person's life, time is largely perceived as open-ended until about middle age. During this time, the

perception of time shifts due to thoughts about approaching mortality and people start seeing time as limited; a perspective that persists through old age (Carstensen, 1992).

In the early stages of life (i.e., adolescence and young adulthood), social motives of self-concept and information seeking are highly salient while emotion regulation is less prominent; during this time, people are future-oriented, pursuing self-concept and information seeking goals, sometimes at the cost of emotion regulation (Carstensen, 1992; Lockenhoff & Carstensen, 2004). For instance, someone in their early 20s may work long hours at a new job to earn a valued promotion, despite the stress experienced as a part of working more. But with the onset of middle age, the motivation to develop one's self-concept and seek out information decreases in prominence while the motivation to regulate emotions becomes increasingly important, leading to all three social motives reaching equal levels of moderate salience (Carstensen, 1992). Then as people progress into older age, the prominence of each of these three social motives changes once again. Emotion regulation continues increasing in importance while self-concept and information seeking continue decreasing in importance. At this stage of life, people focus on present-oriented goals, prioritizing the feeling of positive emotions and familiar social ties, eliminating social relationships that they find unrewarding, and not pursuing new relationships (Carstensen, Isaacowitz, & Charles, 1999; Lockenhoff & Carstensen, 2004). Understanding how these different motives are prioritized and change over time can provide insight on the different types of goals people value, along with their anticipated motivation towards engaging in specific behaviors and activities.

A second lifespan theory of motivation by Baltes and Baltes' (1990) asserts that people strive for successful adult development, which is dependent on three regulatory

processes: selection, optimization, and compensation. Their model of selection, optimization, and compensation (SOC; Baltes & Baltes, 1990; Baltes, 1997) posits that aging successfully involves being selective about the number of domains in which they work, which manifests as restricting their efforts to domains they know well or believe they can master as opposed to electing to become familiar with a broad range of topics. SOC theory also states that individuals will engage in optimization of their general reserves to maximize pursuit of their personal goals. Lastly, people engage in compensation to account for losses that affect functioning and pursuit of personal goals. For example, if someone experiences hearing loss, he/she will use a hearing aid to compensate. As people age, these three regulatory processes become increasingly salient influences on behavior.

Both socioemotional selectivity theory (Carstensen, 1992, 1998) and SOC theory (Baltes & Baltes, 1990) are relevant to training because they determine whether or not older adults will engage in learning activities, and how they behave in learning situations once they decide to participate. According to socioemotional selectivity theory (Carstensen, 1992, 1998), older adults will perceive training outcomes that provide affiliative and intrinsic needs (e.g., emotion regulation) as more valuable than training outcomes that provide new skills and fulfill instrumental goals, such as those related to career advancement. For instance, if an organization provides training on new computer software, older adults will likely have low motivation to participate because they are focused on the present, and the reward provided by engaging in training (i.e., knowing new computer software) is future-oriented. Additionally, industrial gerontology theory notes that older adults may be wary of training due to negative feelings developed from

prior learning experiences and may fear failure or an inability to compete against younger adults (Sterns, 1986).

If older adults decide to participate in learning situations, selection optimization compensation theory provides insight on the type of training in which older adults will participate. Specifically, older adults will be more likely to participate in learning situations that are oriented to emotional goals than learning situations that are oriented to achievement goals (Baltes & Baltes, 1990). SOC theory (Baltes & Baltes, 1990; Baltes, 1997) also states that older adults will be predisposed to optimizing their resources by learning about a familiar or work-relevant topic, with which they have some familiarity, as opposed to an entirely new topic. Lastly, older adults will likely engage in compensation when they experience the effects of decreased reasoning ability, using their prior domain knowledge or other aids to mitigate difficulties and achieve their intended goals (Baltes & Baltes, 1990). Collectively, these behaviors are distinct from those expressed by younger adults. Therefore, if both younger and older adults are given the same training incentives and programs, organizations may experience different participation rates and varying degrees of success depending on the age of their employees.

Cognitive development. Though motivation is important for understanding why older adults pursue certain goals, cognitive development is equally important for understanding how those goal pursuit behaviors translate into performance. Various aspects of the human body change with age and cognition is no exception. The psychological literature has commonly delineated components of cognitive ability into two types: reasoning ability and knowledge (Cattell, 1987; Salthouse, 2010). Reasoning

ability refers to how efficiently people can process information; it includes processes such as working memory capacity and is used for actions such as thinking and acting quickly, acquiring new information, or solving novel problems (Salthouse, 2010).

Knowledge can be thought of as the product of prior interactions of reasoning ability with a person's environment (Salthouse, 2010). Facts and skills obtained through life experiences would fall under this category. Average levels of reasoning ability and knowledge change throughout a person's lifespan. Reasoning ability increases from infancy up until young adulthood. After peaking in young adulthood, reasoning ability starts to decline, sometimes as early as age 40, and continues declining into old age. In the context of learning, reasoning ability (Cattell, 1987; Schaie, 1994) is important for determining how much attentional resources are available for performance (Kanfer & Ackerman, 1989). People rely heavily on reasoning when learning, particularly if they must process and retain information at the same time or learn completely new information (Kane & Engle, 2000); thus, a person's performance during learning will depend on the quantity of attentional resources available and any task characteristics that can make the task more or less resource-intensive. Even though performance can depend heavily on reasoning ability, knowledge also plays an important role in the learning process.

When people use reasoning ability to process information in their environments, they end up acquiring procedural skills (e.g., knowing how to ride a bike) and declarative knowledge (e.g., the capital of Canada) by engaging in information processing (Cattell, 1963; Horn & Cattell, 1967). Cumulatively, these products of information processing are known as domain knowledge and can be broad or specific in nature. Knowledge

demonstrates a different developmental trend than reasoning ability. People increase their domain knowledge through exposure to a variety of life experiences such as schooling and employment. Thus, as people age, they accumulate more experiences that can increase the amount of general and specific knowledge they have; this knowledge remains stable or increases throughout life until old age (Horn & Cattell, 1967; Horn & Donaldson, 1980). In other words, older adults end up knowing a lot about the world – about hobbies, vocations, social relationships, and other topics. Previous research has found that despite declines in reasoning ability, older adults perform as well as or even better than their younger adult counterparts in independent learning opportunities if they had some prior knowledge or experience in the same domain as the content they learned (Beier & Ackerman, 2005). Additionally, prior knowledge is a strong predictor of knowledge acquisition (Ackerman & Beier, 2006). However, there are limitations; knowledge cannot be used to compensate for reasoning if the domain to be learned is completely novel to the learner (Beier, Teachout, & Cox, 2012).

In addition to changes in reasoning ability and knowledge, adults also experience decreases in processing speed as they age (Birren, 1974; Salthouse, 1996; Salthouse, 2000), difficulty coordinating and integrating information (Mayr & Kliegl, 1993), and slower cognitive response times (Birren & Fisher, 1995). Attention division and allocation also becomes harder for people as they age (Salthouse, Rogan, & Prill, 1984). This developmental change is particularly important because attentional/executive control is the cognitive system responsible for functions such as maintaining attention, inhibiting dominant responses, or changing between different tasks (Miyake et al., 2000), all of which are important for goal pursuit. Attentional control has been argued to subsume

systems responsible for managing goal-directed behaviors (i.e., executive functioning, see Baddeley & Hitch, 1974), and temporarily storing and manipulating information (i.e., working memory capacity, see Baddeley, 1992) for use on complex tasks. Both executive functioning and working memory are highly related to reasoning ability, with researchers finding strong relationships between the two constructs (Engle, Tuholski, Laughlin, & Conway, 1999; McCabe, Roedinger, McDaniel, Balota, & Hambrick, 2010).

Collectively, developmental changes in reasoning ability and information processing can make the learning process difficult, leading older adults to master less learning material, take more time to learn and execute tasks, and commit more errors during task engagement than younger adults (Kubeck et al., 1996). Furthermore, some types of tasks, such as those that are high in complexity, can exacerbate performance deficits (Oberauer & Kliegl, 2001; Spirduso & McRae, 1990). Thus, if older adults are given the same learning conditions as younger adults, particularly for learning a complex task, adults may not perform as well as younger adults. If one were to focus on reasoning ability as the sole determinant of performance, it may appear that older adults are in dire straits when it comes to training. But research also suggests that knowledge has a hand in determining training performance (Beier & Ackerman, 2005).

Ackerman and colleagues have found that on average, older adults are no more or less intelligent than younger adults (Ackerman, 2000); in fact, research suggests that prior knowledge may facilitate skill acquisition (Beier & Ackerman, 2005). However, the learning literature has reported performance differences among younger and older adults for adult intelligence and cognitive performance tests (Salthouse, 2010). This discrepancy may be due to previous learning research focusing primarily on general cognitive ability

as a whole, without separating it into reasoning ability and knowledge. In learning situations, this is problematic because each component of cognitive ability can be beneficial under different conditions. Reasoning ability is used in primarily situations where people process novel information so having higher levels of reasoning ability is advantageous for these types of situations. Thus on tests or activities that involve a high level of reasoning ability to process new or abstract information (e.g., Raven Advanced Progressive Matrices), older adults typically score lower (Denney & Heidrich, 1990). Knowledge, on the other hand, is used more often in situations with content that is somewhat familiar to a person so that pre-existing declarative knowledge or procedural skills can be recalled and used.

Moreover, knowledge in many domains is positively correlated, exhibiting a phenomenon called positive manifold (Ackerman, 2000). The amount of prior knowledge a person has predicts how much information he or she will learn. In more colloquial terms, this means that the rich get richer - people who have more knowledge end up learning more (Ackerman & Beier, 2006). These findings provide positive implications for older adults because they tend to have higher levels of knowledge than younger adults.

Effects of Developmental Changes on Learning

Older adults and valuation of learning activities. Training is defined as an organizational activity that presents employees with job-related information and is designed with the purpose of teaching them job-related knowledge, skills, and attitudes, ultimately for application on the job (Cascio & Aguinis, 2011). For middle-aged and older adults, the workplace serves as the largest provider of formal and informal learning

opportunities (Cross, 1981). Organizational training programs are typically administered for the purposes of teaching employees new skills and helping organizations maintain a competitive edge within their industries. Human capital is arguably a company's most important asset (Fulmer & Ployhart, 2013) and preventing skill shortages, also known as skills gaps, is a major area of concern for organizations (Bessen, 2014). Consequently, understanding how age can affect participation in employee learning and development programs is critical, especially given that older adults are quickly becoming the target population for these activities.

As adults age, they increasingly perceive time as limited and begin to shift away from prioritizing future-oriented, developmental goals, and more towards immediate, emotionally-fulfilling goals (Carstensen, 1995). In other words, younger adults are more likely to pursue instrumental goals compared to older adults (Beier & Kanfer, 2010). Aging also makes selection optimization and compensation more salient; older adults become choosier about where they invest their efforts, optimize the use of their limited resources by choosing to engage in tasks that they are familiar with, and compensate for difficulties by using their prior domain knowledge (Baltes & Baltes, 1990). In the context of learning, this means that some types of training will be perceived as more fitting to achieve older adults' needs.

Maurer, Weiss, and Barbeite (2003) have proposed an involvement model to understand what variables contribute to employee participation in learning and development. The model posits that adults are aware of their developmental changes in cognitive ability and know that they need to expend more effort to achieve their desired performance levels as they age (Heckhausen, Dixon, & Baltes, 1989; Hummert, Garstka,

Shaner, & Strahm, 1993; Ryan & See, 1993). They also perceive themselves as being less prepared for learning situations and less able to reap the benefits of training relative to younger adults (Maurer et al., 2003). According to this model, a person's chronological age negatively affects individual and situational antecedents of training motivation (e.g., general self-efficacy), which in turn negatively affect how older adults perceive learning situations, their attitudes towards training, and ultimately, participation in learning and development activities.

Collectively, these motivational theories imply that older adults value learning environments differently than younger adults. Vroom's (1964) expectancy theory further helps identify how these different values affect motivation and subsequent participation in learning activities. First, older adults tend to perceive themselves as less suited for learning and development activities due to awareness of developmental changes; this can manifest as the realization that more effort is needed than before to achieve a high level of performance (Kanfer & Ackerman, 2004) and lowered self-confidence for learning (Maurer, 2001). As such, older adults may be less motivated to participate because of the decreased value they place on expectancy. If expectancy perceptions do not dissuade an older adult from considering participation in learning activities, motivation can also be affected by the valence placed on learning.

The valence or value a person places on learning outcomes depends heavily on a person's needs, goals, and motives. According to lifespan motivation theories, selection, optimization, and compensation techniques are amplified in old age and older adults strive to fulfill immediate, emotional needs. Learning that fulfills immediate, emotional needs and are deemed to be relevant to their current work are likely to be viewed as more

valuable than learning that teaches irrelevant or novel skills for use in the distant future (Beier & Kanfer, 2010). As a result, learning situations that provide novel skills as a reward are likely to be perceived by older adults as having low value.

Thus, the motives and priorities that older adults hold will affect the expectancy and valence with which they assess learning and development situations. This shift in values has been reflected in the psychological literature, with researchers finding that older adults do not participate in training and development as much as their younger adult counterparts (Birdi et al., 1997; Cleveland & Shore, 1992).

Older adults and difficulties in learning. Fortunately, not all older adults decline to participate in learning opportunities. But when they decide to participate, changes in cognitive ability can influence how older adults perform. In order to examine the potential impact of these changes on learning, one must understand the task demands imposed by the skill acquisition process. Skill acquisition is composed of three sequential phases that impose varying degrees of cognitive demand on learners: (1) declarative knowledge, (2) knowledge compilation, and (3) procedural knowledge (ACT Theory; Anderson, 1982). According to Ackerman (1988), general ability, perceptual speed, and psychomotor ability act as determinants of performance during the first, second, and third stages of skill acquisition respectively.

The first stage of skill acquisition is called declarative knowledge. During this stage, learners need to gather new information and remember enough of it to recall for future use. Performance at this stage is effortful, requiring a person to apply their reasoning ability to gain knowledge about the training task (Ackerman, 1988). After progressing through the declarative knowledge stage, learners transition to the knowledge

compilation stage and begin to assemble and organize the knowledge obtained from the previous stage. During this stage, learners also practice their newly acquired skills and start executing tasks with less cognitive effort (Anderson, 1982). Perceptual speed, or how quickly one can process information, becomes important for performance during this stage (Ackerman, 1988). The final stage of skill acquisition is called procedural knowledge and represents a phase of performance whereby learners are able to automatically perform the skill that was taught without conscious attention (Anderson, 1982). Thus, performance during this stage will be dependent on how quickly and accurately a person can physically react to stimuli with his/her motor skills (Ackerman, 1988; Ackerman, 2007; Kanfer & Ackerman, 1989). In summary, when a person initially learns something new, processing the information requires reasoning ability (e.g., working memory, executive control, etc.) and effort. The amount of cognitive resources and effort needed decreases only after a person has had the opportunity to extensively practice the skill and automatize the process. As early stages of skill acquisition rely heavily on cognitive ability, age-related changes in reasoning ability and knowledge can potentially influence training performance. Researchers have proposed several cognitive resource theories that address how an individual's mental resources are anticipated to affect performance on tasks.

Cognitive resource theories. Cognitive resource theories are centered around the training environment and learner; specifically, the competing dynamic between any mental activity requirements that arise as a function of the skill acquisition process, also known as *cognitive load*, and the amount of *cognitive resources* (i.e., reasoning ability and knowledge) a learner has available for performance. The concept of cognitive load

originates from cognitive load theory (CLT; Sweller, 1988), which asserts that people have a limited capacity for working memory that can be used during skill acquisition. Cognitive load theory asserts that cognitive load can be categorized into three different types: (1) intrinsic, (2) extraneous, and (3) germane (Sweller, van Merriënboer, & Paas, 1998). Each type of cognitive load originates from different parts of the skill acquisition situation. Intrinsic load comes from components of training that relate to content difficulty and is considered fixed in nature; harder content will impose a greater amount of intrinsic cognitive load on learners than easier content (Sweller, 1988). There is also extraneous load, which originates from difficulties that are unrelated to training objectives, such as instructional design (Sweller, 1988). For example, a concept that can be explained clearly through a graphic will impose less extraneous cognitive load than if that same concept is explained solely through text. Finally, germane cognitive load arises from information processing and schema development during the learning process (Sweller et al., 1998).

According to CLT, the greater the overall amount of cognitive load present, the more cognitive resources a person will need to handle it. Resource allocation theory (Kanfer & Ackerman, 1989), a similar cognitive resource theory, asserts that one's cognitive ability puts a fixed ceiling on the total amount of cognitive resources available; higher cognitive ability levels translate to a greater amount of cognitive resources availability. Furthermore, the degree to which a learner is motivated for training will dictate the percentage of the total cognitive resources one uses during task engagement. In the event that cognitive load exceeds one's cognitive resource capacity, a person can experience decrements in performance, such as reduced cognitive speed, reduced

working memory capacity, and reduced coordination and integration of information (Wolfson et al., 2014). Consequently, in training situations, instructional designers should attempt to minimize extraneous cognitive load and promote germane cognitive load, which furthers learning, while taking care to not overload learners' cognitive resources (Kirschner, 2002; Paas & Van Gog, 2006). This is particularly important for older adults, who have lower levels of reasoning ability relative to younger adults, and are likely to experience the detrimental effects of cognitive overload more easily.

Cognitive resource theories have implications for older and younger adult performance during training. Early on in a training program, learners must invest a large portion of their cognitive ability to processing information and learning the training task (Shiffrin & Schneider, 1977); this can make training demanding on reasoning ability. Given the assumptions of cognitive load theory (Sweller, 1988), resource allocation theory (Kanfer & Ackerman, 1989), and developmental trends in cognitive ability, older adults can be reasonably expected to perform worse than younger adults during training when given the same training conditions. Some elements, such as having to learn a completely novel task, may even exacerbate the difference due to reliance on reasoning ability (Salthouse & Babcock, 1991).

Indeed, past research has examined the relationship between age and training, demonstrating that there are differences in performance with age. Overall, older adults performed more poorly in training than younger adults; older adults showed less mastery of the training material ($r = -.26$) and took longer to complete training tasks ($r = .28$) and programs ($r = .42$) relative to younger adults (Kubeck et al., 1996). These findings suggest that differences in cognitive resource capacity do impact older adult training

performance. Because cognitive resource theories assert that cognitive resources are fixed by one's cognitive ability, the best pathway to address these age differences and help support older workers would be through manipulation of cognitive load. Thus, using the industrial gerontology model (Sterns, 1986) as a guide, in the next section I focus on identifying different ways to design training that will minimize cognitive load for older learners, and hopefully lead to diminished age differences.

Training Design and Current State of Research

Recent literature has found evidence that the way training is designed, delivered to learners, and implemented can contribute to the effectiveness of training programs; best practices such as training needs assessment recommend the consideration of instructional strategies, content, and trainee needs when creating training programs (Salas et al., 2012; Goldstein & Ford, 2002, Wexley & Latham, 2002). This evidence sounds promising for creating training that can support older workers and facilitate their success. But first, researchers and practitioners need to understand the training components and mechanisms that can potentially benefit older workers before jumping into customized training for older adults; ineffective training programs will not only fail to teach employees new job-related information but also cost the organization money along with valuable employee time (Goldstein & Ford, 2002).

Researchers historically have argued for different training instruction for older adults relative to younger adults, citing that changes in cognitive effects related to aging can affect learning (Glass, 1994; Sterns & Doverspike, 1987). Some psychologists argue that the use of certain training strategies can increase or decrease the cognitive load placed on trainees (Chandler & Sweller, 1991) and have proposed different training

principles to address the needs of older workers during training. Sterns' (1986) industrial gerontology model suggests that researchers and training specialists focus on five dimension when designing training older adults (1) motivation, (2) program structure, (3) familiarity, (4) organization, and (5) time. According to this framework, older workers can yield good performance when they are encouraged to enroll and persist throughout training, training tasks are arranged in order from least to most difficult, training content builds off prior knowledge and abilities, the training materials are organized to allow knowledge to be built at each step of the program, and they are given sufficient time to progress through and master training. Each of these proposed accommodations either addresses older learners' motivational concerns or helps alleviate cognitive load during training to prevent cognitive overload.

Efforts to identify the best ways to support training of older learners have been limited, with the literature focused primarily on training mediums (i.e., training that requires trainee interaction with a simulation system or person vs. reading written instructions; Gist, Rosen, & Schwoerer, 1988; Rogers, Mean, Walker, & Cabrera, 1996), instructional methods (e.g., lecture, modeling, etc.) or delivery environments such as lab versus field (Callahan et al., 2003; Kubeck et al., 1996). This research has shown that better performance for older adults can be achieved, and the theoretical basis for exploring these features has focused primarily on general cognitive slowing exerting an overall effect on any cognitive-related activities, rather than viewing cognitive load as a mechanism through which an interaction between age-related developmental changes and training features can manifest to affect training outcomes. Additionally, existing literature has yet to connect lifespan development theories about motivation to proposed training

suggestions despite recognition that motivation is an important area of concern for older adults during skill acquisition. Consequently, the following section will highlight the need for a meta-analytic update on age and training, discuss the hypothesized overall relationship between age and training outcomes, and detail specific training features anticipated to benefit older workers based on Sterns' (1986) industrial gerontology model.

CHAPTER 2: The Present Study

Motivation for Research

Though researchers have recognized the unique needs of older workers in training contexts, obtaining an updated, comprehensive picture of the age and training performance relationship and how a broad range of training design features affect this relationship is needed. Using recent literature conducted until April 2016, the current study examines six moderators of the age and training performance relationship, which are related to motivation (i.e., focus of training) and cognitive ability (i.e., task complexity, training structure, self-pacing, training content, and training outcomes). The most recent meta-analysis focused explicitly on the age and training performance relationship was conducted over a decade ago by Callahan et al. (2003) and primarily examined the effectiveness of instructional methods (i.e., lecture, modeling, and active participation), self-pacing, and training group size. Furthermore, this study limited its analysis to primary studies that solely examined older workers aged 40 and older. As such, no comparisons were made with younger workers, limiting the external validity of their conclusions. Another age and training meta-analysis conducted by Kubeck et al. (1996) over 20 years ago focused mostly on differences amongst lab and field research, along with computer skills and non-computer-based tasks. Lastly, Ng and Feldman (2008) conducted a meta-analysis on the relationship between age and ten dimensions of job performance, one of which was performance in training programs. Due to the primary research questions being focused broadly on job performance, the quantity of included studies was limited and the authors reported a weak, negative relationship between age and training performance ($r = -.04$) without examining any moderating effects of training

design. Thus, obtaining a more comprehensive picture of how different training features can affect training performance for older adults will give researchers and practitioners useful insight to inform future training creation efforts.

The relationship between age and training outcomes. Through the years, there have been multiple competing frameworks for how to best evaluate training. One of the most prevalent frameworks for measuring training outcomes in practice is Kirkpatrick's (1959) four levels of training evaluation. According to this model, there are four different criteria for evaluating training that measure the impact of training on employees' affect and behavior. These four levels from proximal to more distal outcomes are: (1) reactions, (2) learning, (3) behavior, and (4) results. Reactions pertain to what trainees think about the training intervention; specifically, how useful employees perceived training to be and whether or not they found it enjoyable. Though trainees' reception of a training program can contribute to its success, the primary purpose of training – to positively impact job performance – is what most training evaluators are primarily concerned with. Thus, Kirkpatrick's (1959) three remaining levels are concerned with measuring the impact of training with outcomes that become increasingly more distal from the occurrence of the actual training program. One way that training can be evaluated is by assessing the degree of *learning* that has occurred; specifically, the facts, techniques, and attitudes that have been mastered as a part of the training objectives. Learning can be evaluated as soon as immediately after training or after a delay period, but these measures are not equivalent to measures of job performance. If a training evaluator wishes to evaluate how well trainees can apply what they learned during training on the job, then they measure *behaviors* of job performance. And lastly, to assess the impact of a training program in

relation to organizational objectives, training evaluators would measure *results*, which pertains to metrics such as turnover, absenteeism, morale, along with costs and gains associated with the specific program. In theory, all four levels of training evaluation should be measured in the workplace to assess the full impact of training on an organization's productivity. But in reality, organizations have many organizational initiatives competing for time and resources, and a limited capacity to engage in thorough training evaluation. In practice, participant reactions are one of the most commonly collected criterion measures (Saari, Johnson, McLaughlin, & Zimmerle, 1988).

Though an employee's reactions may not be reflective of what an employee has learned or how he/she will perform the trained behaviors on the job, reaction information can be useful for gauging employees' reception of the training initiative. Organizations already spend a large amount of resources investing in employee learning and development (Miller, 2014); thus, if specific training experiences are negatively received by trainees, this can impact where organizations decide to allocate those resources in the future and the degree of continued investment in similar organizational training efforts. Additionally, in line with the general framework of skill acquisition (Charness, 2009), training programs that leave trainees feeling unpleasant can impact their motivation to participate in similar opportunities in the future, which can become problematic if a company wants to maintain a competitive workforce in a rapidly-changing, global environment.

Researchers and organizations also tend to assess how much material trainees have mastered by administering performance tests once training has been completed. These tests can be knowledge tests or short demonstrations of the skills trainees were

supposed to acquire. Time-based measures, which track how long it takes a trainee to complete training tasks, a post-training test, or the entire training program, may also complement these assessments. However, it can be difficult and resource-intensive to assess the direct impact of specific training initiatives on job performance once trainees return to their typical job roles in the workplace, along with assess training's direct impact on organization-wide metrics such as turnover and organizational performance.

For the current meta-analysis, I broadly examined the relationship between age and training outcomes, where outcomes were based on the different types of training criteria commonly available in the literature in combination with Kirkpatrick's (1959) taxonomy, then I dissected the relationship according to various moderators rooted in theory. I was particularly interested in how training outcomes are conceptualized and measured, and whether the relationships between age and training outcomes differ based on various operationalizations of training criteria such as training reactions, mastery, or training times. Older adults have been found to experience differences in training performance depending on the particular outcome metrics that researchers use. Past literature has demonstrated that performance differences between younger and older adults exist when performance is measured by the amount of time taken to complete the training program, mastery of training material, along with time to complete the final training task; older adults tend to take longer and perform more poorly (i.e., master less material) than younger adults (Kubeck et al., 1996). Interestingly, even though older employees perform more poorly in training than younger adults, this does not seem to be reflected when employees are on the job; age is unrelated to job performance with no differences between younger and older adults (Ng & Feldman, 2008). This result may be

reflective of the incorrect assumption that increased training performance automatically translates to better job performance.

The particular outcome criteria I focused on were based on the degree of prevalence in the training literature research in combination with the importance of such criteria to practitioners; specifically, I examined trainee reactions, mastery of training material (i.e., knowledge), and the completion time for training activities. Though trainee reactions are not reflective of the amount of material a trainee has learned, they can provide insight on trainees' general affective experiences while progressing through the training program. Furthermore, specific moderators of the relationship between age and trainee reactions can inform training developers about how to create training experiences that will be well-received. More distal training outcomes pertaining to Kirkpatrick's (1959) third and fourth levels of evaluation (i.e., job performance and ROI respectively), were not evaluated due to how infrequently training is assessed at those levels, making it difficult to conduct a meta-analysis on these questions.

As one would expect, if a trainee experiences difficulties during training, this may translate into negative affective reactions about the program. Due to age-related declines in reasoning ability, older adults are expected to have a harder time learning novel material, which is present in many typical training programs. Repeated difficulty with novel material can potentially become frustrating and elicit negative emotions from trainees, which may be reflected in affective and training utility reaction measures.

Therefore, I expect that:

H1A: There will be a negative relationship between age and training reactions, such that older adults will perceive training more negatively than younger adults.

In terms of the amount of material learned during training, I also anticipate clear age differences. Oftentimes, when older workers and younger workers are exposed to training, they receive the same program, which leaves their unique motivational and cognitive needs unaccounted for. General cognitive slowing associated with age indicates that performance on cognitive tasks, such as training, are likely to suffer and result in slower and less accurate performance (Salthouse, 2010). To further exacerbate performance differences, older adults' increased levels of knowledge cannot completely compensate for declines in reasoning ability (Hambrick & Oswald, 2006); when collapsed across different types of training, the difference in performance is likely to be evident. Past literature has found empirical evidence supporting a negative relationship between age and training performance such that younger workers slightly outperform older workers (Callahan et al., 2003; Kubeck et al., 1996; Ng & Feldman, 2008). Furthermore, psychologists have found that manipulations designed to boost short-term training performance on motor and verbal tasks are actually harmful for long-term performance (Schmidt & Bjork, 1992). In other words, training techniques that slow down the speed of skill acquisition are more beneficial for achieving desired, long-term improvements in job performance. As such, I expect that:

H1B: There will be an overall negative relationship between age and training performance, such that older adults will master less training material than younger adults.

and

HIC: There will be an overall positive relationship between age and training times, such that older adults will take longer to complete training activities and programs than younger adults.

Focus of training. Older adults prioritize different goals relative to younger adults due to developmental changes in perceived amount of future time available, which in turn affects motivation (Carstensen, 1992, 1998). According to the industrial gerontology model (Sterns, 1986), older adults' motivation to engage in training may also be compounded by fear of negative consequences that can impact their self-efficacy; thus, training specialists should first focus on getting older adults to enroll in training. Once that occurs, Sterns (1986) suggests following up with continual encouragement to help older adults complete training. Because the possibility of continual encouragement is contingent on older adults enrolling in training, I focus on assessing differing training participation rates in the present study.

Different goal priorities can affect whether or not older adults decide to participate in training; people who perceive future time as limited (i.e., older adults) tend to prioritize emotionally meaningful goals while people who perceive future time as open-ended prioritize instrumental and knowledge-related goals (Lang & Carstensen, 2002). Consequently, different training programs may be perceived as more or less appealing to older adults depending on whether training focuses on furthering achievement-related goals or socioemotionally-related goals. The focus of training can be represented by the rewards trainees expect to receive as a result of participating in training. In laboratory settings, older adults typically elect to participate in studies for a variety of reasons, but those reasons may not be representative of real-world workplace

settings. Therefore, I concentrated on field studies and examined how participation is affected by the focus of various training programs offered to participants.

Some training programs may offer achievement-focused rewards related to skill development for employee marketability or other future work opportunities. According to Carstensen (1998), older adults will be less attracted to these types of opportunities than younger adults will, because they are not aligned with socioemotional goals. However, if training programs offer immediate, job-relevant, or emotionally-meaningful rewards (such as those that result from mentoring or coaching another employee), older adults will find those training programs to be attractive because they further socioemotional goals and allow older adults to optimize their shrinking pool of resources. Consequently, I anticipated the participation rate of older adults in field-based training studies to be affected such that:

H2: For training conducted in field settings, trainees who participate in programs with socioemotionally-focused goals will be older than trainees who participate in programs with achievement-focused goals.

Task complexity. Training involves teaching people tasks that can differ on a variety of dimensions such as content and difficulty. According to Wood (1986), task complexity describes the relationships between task inputs and is a determinant for performance due to the cognitive load it imposes on learners. All tasks are composed of three integral components by Wood: (1) information cues, (2) required acts, (3) and products (Wood, 1986); the relationships between these components can vary and differentially affect task complexity. Three different types of task complexity have been identified: (1) component complexity, (2) coordinative complexity, (3) and dynamic

complexity.

Component complexity refers to the demands imposed by information processing and memory storage (Naylor & Dickinson, 1969). Both required acts and information cues are inputs needed to execute the task and reach the product, or output. The amount of inputs a task has is particularly important for task complexity because the quantity sets the limit for how much knowledge, skills, and resources are needed to successfully complete that specific task. Typically, the greater the amount of required acts and information cues, the more knowledge, skills, and resources are needed for success. However, any redundancy amongst the task inputs will reduce the demand for knowledge, skills, and resources. Therefore, a task's component complexity is dependent upon the number of unique required acts and information cues needed to successfully complete. This makes a learner's performance dependent on how high or low this unique limit is set.

Coordinative complexity is a second type of task complexity that focuses on relationships between task inputs and task products, including specific requirements such as timing, frequency, intensity, location, and the order in which task inputs must be completed for successful task completion; the amount of knowledge and skill necessary to perform a task depends on the complexity between these elements (Wood, 1986). A task that requires an action to be performed once at any time throughout a training program will have less coordinative complexity than a task where the action must be completed immediately after a specific event in a certain location and sustained for set period of time. In other words, the more complex the relationships between specific requirements, the more knowledge and skills a person needs for success.

The third and final type of task complexity is dynamic complexity. This type of complexity refers to situations where people must adapt their performance due to changes in the environment that affect the steps one takes towards task completion (Wood, 1986). In order for a person to successfully navigate a changing environment and complete a training task successfully, he or she must have a thorough understanding of a task's component and coordinative complexities. Dynamic complexity is best represented as the total collective differences between component and coordinative complexity across the entire task period. As dynamic complexity is dependent on the other two types of task complexity, all three types of task complexity must be considered in order to obtain an accurate picture of exactly how complex a task is.

Task complexity is important in skill acquisition situations for a variety of reasons. First, in training situations, highly complex tasks are more difficult than low complexity tasks because they require greater amounts of task component knowledge and coordination between these task components to elicit the desired response, especially if task execution conditions are changing. As such, trainees are likely to formulate reactions to training pertaining to the difficulty of the task and the program itself. Past literature has demonstrated that task difficulty impacts learners such that difficult tasks elicit significantly more anxiety than easy tasks during learning (O'Neil, Spielberger, & Hansen, 1969). As a result, high complexity tasks are more likely to elicit stress (due to increased difficulty) compared to low complexity tasks. If stress persists over time, trainees may begin to feel negatively about the training program, which may also impact affective training outcomes. For older adults, who generally have less cognitive resources available for learning than younger adults and are therefore more likely to experience

stress as a result of cognitive overload, the impact of increased task complexity can further exacerbate negative feelings towards training.

Second, researchers know that task complexity affects training performance depending on the type of training method used. For example, behavioral modeling is more effective at yielding high performance than more traditional lecture-based training for computer training high in task complexity (Bolt, Killough, & Koh, 2001). Higher task complexity can also lead to less accurate performance and slower rates of accurate completion per minute when writing database queries (Topi, Valacich, & Hoffer, 2005). The underlying theoretical idea is that cognitive demands imposed by complex tasks are more strenuous on cognitive resources than simple tasks. Researchers have also theorized a “complexity effect,” which asserts that task complexity is related to performance differences on working memory tasks between younger and older adults; specifically, the higher the task complexity, the larger the performance gap (Oberauer & Kliegl, 2001). Accordingly, the industrial gerontology model and instructional design literature suggest that effective training for older adults arranges tasks in order of increasing complexity (Gagne & Briggs, 1974; Gagne, Mayor, & Paradise, 1962; Sterns, 1986), with basic skills leading into more difficult ones.

Third, high complexity tasks will likely take longer to master than low complexity tasks because there are more moving parts to understand and coordinate together (Wood, 1986). Consequently, training activity completion times should increase as tasks increase in complexity, affecting the speed at which trainees can complete the training program. In the current study, age was treated as a proxy for developmental changes in cognitive ability, an individual difference that can interact with task complexity and ultimately

affect performance. Task complexity was also examined holistically due to the dependent nature of its three facets. The nature of task complexity asserts that higher complexity tasks will require more knowledge, skills, and cognitive resources to successfully complete relative to lower complexity tasks. If someone does not have a sufficient amount of cognitive resources to handle the minimum requirements, performance is expected to suffer. As older adults tend to have lower capacities for cognitive resources, I anticipated that:

H3: Task complexity of training content will moderate the relationship between age and training outcomes, such that high complexity tasks will produce (a) stronger negative relationships between age and training reactions compared to low complexity tasks, (b) stronger negative relationships between age and training performance compared to low complexity tasks, and (c) stronger positive relationships between age and training times compared to low complexity tasks.

However, task complexity is a limited avenue for training designers to customize the learning experience for older adults. Depending on the needs of an organization, training employees on complex tasks may be unavoidable and a training specialist would therefore be unable to control task complexity. For situations where older adults must be trained on complex tasks, learners will be subject to a fixed amount of intrinsic cognitive load as a function of the task itself. Therefore, I examine structure as another component that training specialists can alter to make complex training more manageable.

Structure. Another component of training that can affect learner performance during training is structure, or the degree of instruction provided in a training programs. Structure is important because it can create a variety of learning environments that affect

how trainees acquire information; the degree of structure within a training program can be manipulated by adjusting the amount of instructions or guidance provided during the intervention (Bell & Kozlowski, 2008). High structure training can be created by giving trainees detailed step-by-step instructions for how to learn and complete a task. An example would be making a jigsaw puzzle with instructions that dictate where each piece goes. On the other hand, low structure training environments can be elicited by providing trainees with minimal instructions to complete a task, which forces them to explore the training environment and experiment with the different steps leading up to task completion. An example of low structure training would be building the same jigsaw puzzle, but only using the image of the finished puzzle on the box for reference. In the context of the industrial gerontology model, structure aligns with organization and program structure; Sterns (1986) recommends that training information should be arranged in a way that allows knowledge to be built up with each step in the program to support older learners. High structure in particular would address this recommendation directly by not only organizing information for learners but providing individual steps for older adults to build knowledge upon.

In addition to directly addressing the issues of organization and program structure, structure also ties into cognitive resource theories. Specifically, the amount of exploration required by different degrees of training structure impacts how much cognitive load is imposed on trainees during the learning process. High structure training elicits passive learning, where germane cognitive load is low because trainees are not required to actively participate in acquiring new information. Examples of passive learning environments include lectures, modeling, and instructor-led tutorial sessions. On the

other hand, low structure training creates active learning environments, where germane cognitive load is high because it requires trainees to participate in activities such as discussions or performing the task being learned. Active learning situations are also known as exploratory learning environments and have two important defining features that serve as the sources of cognitive load: an inductive learning process and learner control (Bell & Kozlowski, 2008).

These two key features of active learning are important because they explain how trainees learn and the pace at which they do so. The lack of guidance inherent in the inductive learning process necessitates exploration of the learning environment in order to acquire the relevant information trainees need to learn and succeed at the task they are given (Smith, Ford, & Kozlowski, 1997). During this process, trainees must also determine whether the information is important for the task, and whether or not it leads to the desired progress towards completing a task goal; this often involves cycles of trial and error before a trainee acquires the correct information and successfully completes the entire task (Smith et al., 1997). Passive learning situations on the other hand provide relevant information directly to the trainee; as such, passive methods do not require engaging in exploratory information-seeking behaviors and inductive learning is not needed for success during skill acquisition. Some examples of passive learning environments include traditional methods of learning (e.g., lecture, modeling), where a learner may simply need to watch a presentation to acquire the proper information.

In addition to inductive learning, active learning environments also have a high degree of learner control. Learner control refers to trainees directing their own training experiences; in training programs with learner control, they are tasked with the

responsibilities of monitoring their learning development and making important instructional decisions, such as when to progress to the next section of training content (DeRouin, Fritsche, & Salas, 2004). For passive learning environments, these learning aspects are externally managed through mechanisms such as a trainer or an automated computer program, whereas for active learning environments, trainees must manage the learning aspects internally.

The amount of structure that a training program has can affect the cognitive demands imposed on a trainee. For low structure training, there is a high cognitive demand imposed on trainees because the task is learned through direct experience. Learning a task through direct experience forces trainees to explore and infer information to establish relationships between different concepts in the training (Bell & Kozlowski, 2008), which can lead to a broad and deep understanding of the training materials. The caveat is that when combined with a novel training content, particularly on a complex task, low structure may exacerbate the degree of complexity and add to cognitive load (van Merriënboer, Kirschner, & Kester, 2003). In contrast, all relevant information including relationships between various concepts are conveyed to the trainee directly in high structure training and none of the cognitive demands that come with training environment exploration are imposed. Thus, high structure environments have less cognitive demand compared to low structure. This is particularly helpful in regulating cognitive load when learners must be trained on complex tasks or skills. Though training programs can vary on structure along a continuum, this distinction is particularly important when individual differences such as age are considered in the context of training performance.

For this study, I expected interactions between cognitive ability and structure to impact two types of training outcomes: trainee reactions and mastery performance. First, differences in the degree of cognitive demand imposed on trainees have implications for how learners may feel about training once they complete the program. If a learner with limited cognitive resources (as determined by cognitive ability) participates in training that imposes a high degree of cognitive load (e.g., low structure), he or she may experience cognitive overload, and physiological feelings of frustration or stress. If this happens repeatedly, a learner can even begin to feel negatively about the training program itself. Older adults may be subject to experiencing more negative emotions as a result of cognitive overload than younger adults because they tend to have lower reasoning ability levels, and it is easier to surpass lower amounts of cognitive capacity than higher amounts of cognitive capacity. This may be further exacerbated by low structure environments, which impose more germane cognitive load than high structure environments as a result of learner control and active learning processes.

Second, I anticipated training performance to be affected through by an interaction between cognitive ability and training structure, which has been discussed in the literature (Campbell & Kuncel, 2001; Snow, 1989). According to past research, for low structure environments where cognitive demands are high (i.e. active learning), older adults are anticipated to perform more poorly than younger adults because they may not have a sufficient amount of attentional resources to fulfill all of the imposed cognitive demands to succeed at the task. Thus, learning will be difficult for older adults in the early stages of training, and this effect is expected to carry over into the subsequent stages of skill acquisition. However, in high structure situations (i.e., lecture and

modeling), older adults may yield performance comparable to younger adults, as some of the cognitive demand burden is externally managed by the detailed instructions inherent in high structure training programs. In fact, researchers have recommended that older adults learn in a highly structured learning environment (Wolfson et al., 2014), through methods such as advanced organizers and worked examples (see Preiss & Gayle, 2006; Van Gerven, Paas, Van Merriënboer, & Schmidt, 2002). Therefore, I expected that:

H4: The degree of structure a training program has will moderate the relationship between age and training performance; such that low structure training programs will produce (a) a stronger negative relationship between age and training reactions compared to high structure training programs, and (b) a stronger negative relationship with training performance compared to high structure training programs.

Pacing. General cognitive slowing with age also has implications for how quickly older adults can process training information and complete training programs; specifically, cognitive slowing results in older adults needing more time to process information and complete training activities (Cerella, 1985; Salthouse, 2010). Traditional instructor-led training does not accommodate for the different time needs of various learners because the same amount of time is given to each person to work on a task. However, self-pacing, or allowing a learner to progress through training content at his or her own rate may help account for differences in time needs. Having learners determine a comfortable pace at which they can proceed through the training material can also help prevent occurrences of cognitive overload, which are sure to negatively impact performance.

The industrial gerontology model (Sterns, 1986) suggests that older adults should

be given enough time to optimize their performance and research suggests that self-pacing is an effective way to account for cognitive changes that come with aging, while allowing older adults enough time to master training content (Belbin & Belbin, 1968; Belbin & Belbin, 1972; Callahan et al., 2003). Though self-pacing accommodates for a wide range of individual differences in learning that arise from aging, in general, cognitive faculties are expected to slow down and lead to increased times for completing training tasks and programs. Therefore, I expected older adults to benefit more from self-pacing than fixed-pacing during training such that:

H5: The pacing of training programs will moderate the relationship between age and training outcomes, such that self-paced training will yield (a) a weaker negative relationship between age and training performance than fixed-pace training and (b) stronger positive relationships between age and training times compared to fixed pace training.

Training content. Reasoning ability and knowledge have different functions which allow people to navigate their environment. Training programs can either teach completely novel information (e.g., beginner's computer programming) or information related to a topic that someone has become familiar with (e.g., intermediate or advanced computer programming). Learning may become more difficult with age due to reliance on decreased levels of reasoning ability during early stages of skill acquisition, where reasoning ability is an important determinant of success (Ackerman, 1988). In particular, novel information requires deliberate processing by reasoning ability before a person can acquire knowledge and skills, and by its nature, all of the information is new. This means that learners cannot rely on acquired skills and knowledge to navigate the training

environment and need to rely on their decreased reasoning ability; for older adults, this has the possibility to make performance decrements more salient (Head, Raz, Gunning-Dixon, Williamson, & Acker, 2002; Salthouse, Atkinson, & Berish, 2003; Salthouse, 2010). Additionally, greater losses of reasoning ability are not completely offset by increases in knowledge (Hambrick & Oswald, 2005); so while older adults may attempt to compensate for reasoning ability losses with knowledge, they can still experience performance decrements.

However, if a learning situation is not completely novel, then a person has familiarity with the topic, and therefore prior domain knowledge available for recall or use during learning. As a result, performance on the domain knowledge task may be dependent not only on reasoning ability, but also on stores of prior knowledge. Though Ackerman (1988) delineated specific variables as determinants of performance for each stage of skill acquisition, different types of tasks can make those variables stronger or weaker determinants. For instance, performance on an arithmetic task would not rely as heavily on perceptual speed and psychomotor ability as performance associated with operating a car. This is because the arithmetic task depends more on one's prior math knowledge as opposed to how quickly one can react and physically move the controls within a car. Therefore, different determinants such as domain knowledge may be more predictive of performance on tasks that are less dependent on perceptual and psychomotor skills (Ackerman, 2007).

General and specific domain knowledge are important in learning situations because people can learn about topics related to what they know. Empirical evidence supports this notion, as prior domain knowledge is instrumental in learning success when

tasks build upon domain knowledge. For example, past research has found that people with prior knowledge about basketball acquired more new basketball knowledge independent of basketball exposure (Hambrick, 2003). Prior domain knowledge is useful because it helps learners acquire knowledge and skills quickly; the more a person knows about something, the easier it is to obtain more knowledge and skills in the same domain (Stolovitch & Keeps, 2004). This effect has been demonstrated in a variety of knowledge domains such as current events (Hambrick, Pink, Meinz, Pettibone, & Oswald, 2008), baseball (Hambrick & Oswald, 2005; Spilich, Vesonder, Chiese, & Voss, 1979), chess (Chase & Simon, 1973) and finance (Ackerman & Beier, 2006).

Older employees tend to have a lot of domain knowledge due to their accumulated life experiences (Horn & Cattell, 19867; Horn & Donaldson, 1980). Researchers have found that domain knowledge assists in memorizing and comprehending domain-relevant content ranging from baseball (Hambrick & Engle, 2002) to music (Meinz & Salthouse, 1998) and political science (Voss, Greene, Post, & Penner, 1983). Older adults also tend to score well on various domain knowledge tests (Ackerman, 2000). Unfortunately, domain knowledge cannot completely compensate for declines in reasoning ability and having higher levels of reasoning ability does not enhance one's usage of prior knowledge (Hambrick & Oswald, 2005). Therefore, in domain knowledge-related learning, performance decrements may not be as substantial because older adults' prior domain knowledge may compensate for difficulties experienced as a result of decreased reasoning ability (Ackerman & Kyllonen, 1991; Salthouse, 2010). However, these findings provide implications that some types of training content may help close the disparity in training performance between younger

and older adults.

Though the literature has not focused heavily on older and younger adult training performance differences for novel and domain knowledge training content, a strong parallel between the types of training given in laboratory settings and field settings can be drawn. Interestingly, Kubeck et al. (1996) found the largest age differences in performance represented in laboratory samples ($r = -.23$) but discovered that field samples showed limited evidence of such performance differences ($r = -.05$). This may be due to the types of tasks that tend to be administered in the different settings. Laboratory-based training tasks tend to contain material that people do not have prior knowledge about; they are often stripped of real-world context, making it more difficult for people to rely on their prior knowledge during training. In other words, laboratory training presents novel or abstract tasks to learners; consequently, successful performance on such tasks relies heavily on reasoning ability to process the novel information (Hambrick & Engle, 2002) and older adults do not have prior knowledge to fall back on in the face of difficulties.

By contrast, training administered in a field setting provides real-world context, thereby giving learners an opportunity to use prior domain knowledge. Thus field training tasks mirror domain knowledge tasks because people acquire job-related knowledge when they work. Per the industrial gerontology model (Sterns, 1986), field training task content has a basis of familiarity for older adults and they can rely on prior domain knowledge to compensate for decreased reasoning ability. Thus, field and lab studies serve as proxies for high and low familiarity with training content respectively.

Training based on job-related training content is potentially beneficial for older

adults because they have more domain knowledge than younger adults as a result of accumulated life experiences. In other words, the tendency for older adults to know more can assist in achieving higher levels of training performance in field settings and possibly perform at levels comparable to younger adults. I anticipated performance differences on novel and domain knowledge training to manifest in the data, such that:

H6: The content of training programs will moderate the relationship between age and training outcomes, such that job-related training content (most commonly found in field settings) will yield a weaker negative relationship between age and training performance than abstract training content (most commonly found in laboratory settings).

CHAPTER 3: Method

Literature Search

In order to conduct a holistic meta-analysis of past literature, I adopted a thorough protocol to obtain empirical research articles with pertinent data and then process the data using meta-analytic methods based in psychometrics. First, I identified relevant research conducted on the relationship between age and training outcomes by: (1) conducting an extensive literature search using research publication databases and journals, (2) contacting researchers who have authored papers on age and training (e.g., Kubeck et al., 1996, Callahan et al., 2003), and (3) using listservs to inquire about gray literature sources (i.e., conference presentations, dissertations, technical reports, etc.). Relevant studies from 1890 up to the present day were included.

For the first step of the literature search process, I used various keyword combinations pertaining to training and age (e.g., training with older, train and elderly, etc.; See Appendix A) to search electronic databases such as PsycINFO and ProQuest Dissertation & Theses. I also manually examined journals with relevant literature (i.e., *Personnel Psychology*, *Journal of Management*, and *Journal of Applied Psychology*, etc.). Any relevant materials that appeared from these searches pertaining to age and work-related training were combined with results obtained from contacting researchers and soliciting listservs. I contacted researchers who were experts in aging and/or skill acquisition research to inquire about unpublished studies. Listservs such as the HFES Technical Listserv and APA Division 20 were also solicited to expand my search radius.

Next, I reviewed the articles collected for relevancy against inclusion criteria in two stages. First, I assessed articles by examining information provided in individual

abstracts and seeing if the research met basic inclusion criteria. General inclusion criteria required that the research be empirical in nature and include training of healthy older adults at a minimum. All articles which met basic inclusion criteria were then reviewed a second time by looking at individual studies within the full text documents with more specific inclusion criteria.

Detailed inclusion criteria required that the study administer short-term (i.e., one month or less in duration), job-related training on non-physical tasks. Job-related tasks included training studies such as computer skill development, machinery simulators, and job performance-related response times. Studies pertaining to activities such as memory training, plasticity training for fluid intelligence, or studies that allowed practice only to familiarize participants with a task were excluded due to my interest in the natural development of psychological capabilities as opposed to interventions designed to prevent their decline. Furthermore, the study needed to have enough statistical information to compute an effect size. This included measuring age as a study variable and providing the mean age of participants who were recruited, along with a measurement of the degree of spread around the mean. Studies that did not provide such information or artificially categorized age into more than three groups were omitted. Additionally, studies that used only non-objective mastery performance metrics (i.e., self-rated performance) were excluded because scores may be affected by socially-desirable responding.

Variable Measurement

Moderators. The moderators of interest were assessed in different ways due to how the hypotheses were conceptualized. However, the manner in which these variables

were coded was dependent on information available in the research articles marked for inclusion. The following coding and measurement of the variables below were applied to the final iteration of the coding protocol.

Focus of training. The type of focus provided by a training program was evaluated by looking at the description of the training program given to participants from each relevant research article. Training focus was operationalized as a categorical, dichotomous variable with either an achievement or socioemotional focus. Achievement-focused training was characterized by qualities such as personal development goals and networking for future opportunities. On the other hand, socioemotionally-focused training was characterized by qualities such as emotion regulation, or present-oriented goals. Studies were evaluated on a 5-point scale demonstrating the degree to which the training was achievement-focused compared to socioemotionally-focused training. A 5-point Likert scale ranging from 1 = *all achievement-focused* to 5 = *all socioemotionally-focused* was used to evaluate training goals. For instance, a study that trained participants on aircraft maintenance was considered achievement-focused whereas a study that trained participants on assertiveness and expressing their point of view was considered socioemotionally-focused. If the focus of training was indiscernible, a rating was not provided.

Task complexity. Task complexity was assessed using the three dimensions delineated by Wood (1986) – component, coordinative, and dynamic. Descriptions of the training tasks from method sections of each included study were used to develop a rating of how complex the particular task was. Task information was evaluated by looking for details pertaining to individual dimensions types of complexity; for example, to identify

the degree of coordinative complexity, raters attempted to get a general sense of the amount of knowledge and skill needed to successfully complete the training task. Once they were able to obtain a general idea of the complexity levels where possible, raters assigned a value from a 5-point Likert scale (ranging from 1 = *low* to 5 = *high*) to represent the overall degree of task complexity they perceived for the training task. An example of a low complexity task would be basic text-editing (e.g., inserting and deleting words) whereas a high complexity task would be using an aircraft simulator. If tasks did not provide enough information to give raters a confident idea of the overall degree of task complexity, a rating was not given.

Structure. To code for structure, raters reviewed descriptions of the training programs used in each study and assessed the degree to of structure contained within the program. Ratings of structure were provided on a 5-point Likert scale ranging from 1 = *low* to 5 = *high*, where low structure tended to contain (i.e., provides minimal instructions or guidance) or high structure (i.e., leads the learner through the material nearly step-by-step) based on the amount of instruction provided to trainees. For example, a lecture-based training program with step-by-step worksheets would be classified as low structure whereas an active learning training program would be classified as high structure.

Pacing. Qualitative information about the individual training programs used in each study was used to determine how much control learners have over their speed of progression through a training program. Self-pacing was operationalized as a continuous variable anchored by two poles: self-pacing or fixed-pace. Training programs where learners were given unlimited time to progress through training will be classified as self-paced. On the other hand, training programs that regulated a learner's progression

through methods such as limited time to work on tasks or having a training instructor who is responsible for moving the learner through different training content topics were classified as fixed-pace. The 5-point Likert scale to rate the degree of pacing ranged from 1 = *all fixed pacing* to 5 = *all self-pacing*; studies that included elements of both fixed and self-paced training received intermediate ratings between the two poles depending on which elements were more dominant.

Training content. In the training literature, many researchers do not classify their training as based on novel content or domain knowledge. The research setting that training was delivered in could reasonably act as a proxy the type of training content that was delivered where laboratory and field studies would represent novel training and domain knowledge training respectively. However, this would disregard lab training tasks that are more job-related than abstract in nature. Thus, training content was made into a 5-point rating scale to assess the degree to which a training task was job-related, where abstract tasks represented the low pole of the scale and job-related tasks represented the high pole. Job-related tasks were those characterized by qualities that one would ostensibly see while working on the job (e.g., tools, environment, task to be performed, purpose of task) whereas abstract tasks were more removed from an actual job performance context. Descriptive information about the training task used in each study was used to inform these scale ratings.

Training outcomes. As training can be evaluated in various ways, I also gathered data on how training outcomes were operationalized in studies marked for inclusion. I was particularly interested in how usage of different levels of Kirkpatrick's (1959) framework affected the relationship between age and training. This moderator variable

was treated as a categorical variable with three levels, each of which represented a different way of measuring training performance. The different levels were: reactions to the training program, mastery score on training activities, and time taken to complete the final training task or overall training program. If mastery was represented by an error rate measure, the related effect size was reverse scored accordingly. Examples of each level were: instructional satisfaction, accuracy/percent correct on performance test, and amount of time taken to complete entire training.

Age of training participants. The average age of training participants were obtained for each individual study included in the meta-analysis; information was taken from the methods portion of the included study. I also obtained the age range of participants (or degree of spread about the mean if an exact range was not given) to determine whether or not artifact corrections were necessary prior to running analyses and compute effect sizes where needed.

Coding Procedure

A full coding protocol including moderators of interest (that have a sufficient number of articles for analysis) and effect sizes (e.g., mean differences, correlations, etc.) was used to gather raw data from studies marked for inclusion. The original protocol was piloted with 10% of the studies deemed appropriate for use in the present study before a finalized version was used for statistical analysis. All included studies were coded by two independent graduate student researchers because the use of single data extraction (e.g., one coder for meta-analysis articles) leads to greater error rates compared to double data extraction (Buscemi, Hartling, Vandermeer, Tjosvold, & Klassen, 2006). Coders engaged in consensus meetings to identify any rating discrepancies between them. Any coding

disagreements were resolved through discussion until an agreement was reached. Once coding was completed with the final protocol, reliability was computed using the percentage of agreement across all possible judgments that could have been made. The ratings between the two coders reached a reliability level of 0.95.

Treatment of Effect Sizes and Moderator Analyses

I used Schmidt and Hunter's (2015) psychometric approach to meta-analysis to analyze the data. This meta-analytic approach is a random-effects model rooted in the idea that there are different population parameters between studies, and between-studies variation is a product of artifacts as opposed to differences in the underlying population. Therefore, the goal of psychometric meta-analysis is to estimate results free of imperfections resulting from study methodology (true values). This assumption is important because studies included in a meta-analysis act as a random sample of the distribution of effect sizes; combining the estimates produces the mean effect of the distribution (Borenstein, Hedges, Higgins, & Rothstein, 2009). Furthermore, there is no theoretical reason to assume that the true effect size is exactly the same amongst all studies (Borenstein et al., 2009). The true effect size might be different due to qualities of the individual studies; for example, if participants were more educated, younger, or an effect was measured more reliably.

Once all effect sizes were collected from relevant studies, they were converted to the same effect size metric, either a standardized mean difference or correlation, based on the study design and treatment of age as the predictor variable. Conversions between effect sizes were made using Lipsey and Wilson's (2001) *Practical Meta-analysis* effect size calculator. Individual studies primarily used two types of research designs: extreme

groups design with a subgroup of younger participants compared to a subgroup of older participants, or continuous group design that sampled across all population age ranges or only older adults aged 40 or older. Standardized mean differences were collected for studies with an extreme groups design whereas correlations were obtained for studies with a continuous group design.

Ideally, all effect sizes would have been converted to correlations as age is a continuous variable by nature. However, when computing effect sizes, extreme groups designs function as a form of range restriction and can provide overestimations of the true effect that a meta-analysis strives to measure. Researchers have long recognized that range restriction poses an issue when estimating population correlations, particularly for extreme groups (Sackett & Yang, 2000; Taylor & Griess, 1976). A correction for extreme groups design to enable treatment of the effect size as a correlation was not attainable; this was due to the inability to estimate the standard deviation of the unrestricted sample size, which would be used to correct the direct range enhancement (over-estimation of r) resulting from use of an extreme groups design (Sackett & Yang, 2000; Taylor & Griess, 1976). Therefore, it would have been inappropriate to combine standardized mean difference effect sizes from extreme group designs with correlations from studies that sampled participants without range restriction. In addition, collapsing across different types of training outcomes is not theoretically interesting for the current study and would improperly confound the positive and negative poles of each outcome (i.e., a high degree of mastery is positively valued whereas a long training time is not). As such, separate meta-analyses were conducted for each effect size type and within different training outcomes during the analysis process.

Prior to conducting analyses, effect sizes were sorted into three different categories based on the study design in order to apply appropriate corrections: standardized mean differences for studies examining age and training outcomes with an extreme groups design, correlations between a continuous age variable and training outcomes, and correlations between a continuous age variable that had been dichotomized and training outcomes. According to psychometric meta-analysis, variation in studies results from artifacts such as sampling or measurement error as opposed to underlying differences in the population (Schmidt & Hunter, 2015). These artifacts can inflate or reduce effect sizes from their true values. As a result, I have applied artifact adjustments during the analysis process and accounted for measurement unreliability, range restriction, and artificial dichotomization. For this study, I assumed operational validity, where age has perfect reliability but training outcomes were corrected for artifacts. All training outcomes except for time (i.e., reactions and mastery) were corrected for unreliability. No reliabilities were available for time training outcomes and perfect reliability was assumed due to its nature as an objective metric. However, this makes the effect sizes collected between age and time outcomes underestimations of true population values. For all other training outcomes, if reliabilities were available, they were used as corrections. Missing reliabilities for reaction or performance outcomes were imputed with a value of .80, which is the average of all attainable reliabilities for these two outcome types. A specific imputation value was chosen because the high frequency of missing reliability estimates did not allow for mean computations of existing reliabilities in every analysis.

Each of the three categories of effect sizes required separate sets of corrections to account for differences in study design and sampling error. For the standardized mean difference d , effect sizes were treated as the best estimate of the true difference in performance across extreme groups. However, when sample sizes are small, d can become an upwardly biased estimator; therefore, a small sample size bias correction (Lipsey & Wilson, 2001) was applied to account for extreme groups designs. There were also cases of range restriction and artificial dichotomization for correlation effect sizes.

Range restriction refers to limiting a variable's full degree of variation in a research study – either through sampling, measurement procedures, or experimental design – to a narrow subset of scores. For the current study, the type of limitation was *direct* and imposed on a predictor variable (i.e., age) directly (Schmidt & Hunter, 2015). Direct range restriction reduces the true unrestricted correlation and can end up downplaying age differences in training outcomes or the degree to which a moderator helps diminish those age differences. In the event of range restriction, researchers account for artifacts by applying corrections for disattenuation (Lord & Novick, 1968; Sackett & Yang, 2000; Thorndike, 1949). The current meta-analysis was corrected for direct range restriction because some studies measured age as a continuous variable but only recruited older adults, limiting the variation of age as a predictor variable. Effect sizes from such studies were adjusted using Thorndike's (1949) Case II correction for direct range restriction.

Additionally, there were studies where age was measured as a continuous variable and then artificially dichotomized into younger and older adult groups using a specific cut score. Artificial dichotomization of age into a categorical variable essentially changes

what would have been a Pearson product moment correlation between two continuous variables into a special case of the correlation coefficient called the point biserial correlation. By categorizing age, a variable which is not a true dichotomy, one simultaneously discards and distorts information about individual differences on the predictor variable, which can lead to effect size misrepresentation (MacCallum, Zhang, Preacher, & Rucker, 2002). Thus, I applied Schmidt and Hunter's (2015) correction in order to account for the artifacts introduced as a result of this dichotomization.

Once all corrections were applied, dependent effects obtained from the same study were averaged within each training outcome type. Effect sizes were also evaluated for outliers. A Fisher's z transformation was applied to all correlation effect sizes prior to examination for outliers. Any studies with effect sizes greater than three standard deviations from the mean were carefully examined for soundness of research design before a decision was made to omit or retain the study. Only one outlier was identified and retained because upon closer examination, the statistical results were conducted appropriately given the research question and methodological approach. All meta-analytic analyses included computations of observed and corrected meta-analytic effect sizes, 95% confidence intervals to estimate statistical accuracy, and 95% confidence intervals to estimate heterogeneity of effect sizes. Q -statistics were used to test for proposed moderators by examining the change in heterogeneity for effect sizes.

CHAPTER 4: Results

Descriptive Analyses

Initial searches in article databases and journals yielded over 9500 results to examine for relevance to the current study. After reviewing abstracts, a total of 442 articles from the search results met the basic inclusion criteria for full-text review. Research contacts and solicitations yielded an additional five articles to examine for relevancy. A total of 46 studies from 43 articles were obtained for inclusion in the meta-analysis.

After I identified studies that met all inclusion criteria, I assessed the likelihood that they could be included in moderator analyses by reviewing information provided in individual methods sections. Past psychometric meta-analyses have used minimum guidelines of at least two effect sizes per level of moderator before subgroup analyses can be run (Arthur, Bennett, Edens, & Bell, 2003). Scholars also note that meta-regression techniques can capitalize on chance, and one should be sensitive to meeting criteria in order for regression weights to be better estimates than equal weights. For the present study's six predictors, Schmidt (1971) recommends a total N of at least 100 studies. Any moderators that did not yield the minimum number of effect sizes needed for a subgroup comparison were not analyzed. Furthermore, if there were an insufficient number of studies for meta-regression, the moderator was dichotomized at the median point and subgroup analyses were applied instead (Steel & Kammeyer-Mueller, 2002); values which were rated as a 3 or higher on a 5-point scale were categorized with the higher pole on the scale whereas values rated as lower than 3 were categorized with the lower pole. Studies which did not provide enough details to code for a particular moderator were

excluded from that specific moderator analysis.

Descriptive data for the primary studies are presented in Table 1, including a breakdown by sample size and whether the study was included in specific moderator analyses.

Table 1

Basic Properties of Included Studies and Usage in Moderator Analyses

Study	N	Training Task	Setting	Reactions	Mastery	Timed	Complexity	Structure	Pacing
Beier et al. (2008)	161	database management system	lab	yes	yes	no	yes	no	yes
Beres & Baron (1981)	24	digit symbol substitution	lab	no	yes	no	yes	no	yes
Bretz & Thompsett (1992)	184	manufacturing resource planning	field	yes	yes	no	yes	yes	yes
Carter & Beier (2010)	161	database management system	lab	yes	yes	yes	yes	yes	yes
Charness et al. (1992)	32	word processing	lab	no	yes	yes	yes	yes	yes
<i>Sample 2</i>	60	word processing	lab	no	yes	yes	yes	yes	yes
Charness et al. (2001)	72	word processing	lab	no	yes	yes	yes	yes	yes
<i>Sample 2</i>	48	word processing	lab	no	yes	yes	yes	yes	yes
Chillarege et al. (2003)	67	word processing	lab	no	yes	no	yes	yes	yes
Czaja et al. (1989)	135	text editing	lab	yes	yes	no	yes	no	yes
Delgoulet & Marquie (2002)	43	magnetoscopy	field	no	yes	no	yes	no	yes
Dijkstra et al. (2014)	227	webcam & personal digital assistant technologies	lab	no	yes	no	yes	yes	yes
Echt et al. (1998)	92	basic computer skills	lab	no	yes	yes	yes	yes	no
Egan & Gomez (1985)	33	text editing	lab	no	yes	yes	yes	no	no

Elias et al. (1987)	45	word processing	lab	no	yes	yes	yes	yes	yes
Gegenfurtner et al. (2009)	444	occupational and safety training	field	yes	no	no	yes	yes	yes
Giannetto (1995)	352	public assistance program eligibility training	field	yes	yes	no	no	no	no
Gist et al. (1988)	146	spreadsheet software	field	no	yes	no	yes	yes	yes
Gomez et al. (1983)	40	text editing	lab	no	yes	yes	yes	yes	yes
Harada et al. (2010)	64	mobile application diet program	lab	no	yes	no	no	no	yes
Hickman et al. (2007)	63	basic computer skills	lab	no	yes	yes	yes	yes	yes
Hoyer et al. (1979)	30	text editing	lab	no	yes	no	yes	no	no
Jamieson & Rogers (2000)	80	ATM simulator	lab	no	yes	no	yes	yes	yes
Kehoe et al. (2009)	78	word processing	lab	no	yes	yes	yes	yes	yes
Korsgaard et al. (1998)	41	assertiveness training	field	no	yes	no	yes	yes	yes
Kurzman (1998)	59	word processing	lab	no	yes	yes	yes	yes	yes
Laier (1993)	197	word processing	lab	yes	yes	yes	yes	no	yes
Martocchio & Webster (1992)	68	word processing	field	yes	yes	no	yes	no	no
McCausland (2014)	251	aircraft maintenance	field	yes	yes	no	yes	yes	yes
Mead & Fisk (1998)	71	ATM simulator	lab	no	yes	no	yes	yes	yes
Morrow et al. (1993)	31	flight simulator	lab	no	yes	no	yes	yes	yes

Mykityshyn et al. (2002)	60	blood glucose monitor	lab	yes	yes	no	yes	yes	yes
Rebok et al. (1988)	52	implication-assertion discrimination	lab	no	yes	yes	yes	yes	yes
Reed (1998)	109	word processing, spreadsheets & internet	lab	no	yes	no	yes	yes	yes
Sanchez et al. (2014)	120	agricultural combine simulator	lab	no	yes	no	yes	yes	yes
Sanders et al. (2002)	116	arithmetic	lab	no	yes	yes	yes	yes	yes
Siemen (1976)	60	anatomy & physiology	lab	no	yes	yes	yes	yes	yes
Valasek (1989)	124	basic computer skills	lab	no	yes	yes	yes	no	yes
Van Gerven et al. (2002)	54	problem solving	lab	no	yes	yes	yes	yes	no
Van Gerven et al. (2006)	80	problem solving	lab	no	yes	yes	yes	yes	yes
Warr & Bunce (1995)	106	manager training	lab	yes	yes	no	yes	no	yes
Webster & Martocchio (1993)	68	word processing	field	yes	yes	no	yes	yes	yes
Wiker et al. (2009)	66	manual assembly task	lab	no	yes	no	yes	yes	yes
Wolfson (2014)	104	communication	lab	no	yes	no	yes	yes	yes
<i>Sample 2</i>	177	communication	lab	yes	yes	no	yes	yes	yes
Zandri & Charness (1989)	46	basic computer skills	lab	no	yes	yes	yes	yes	yes

Main Effect Analyses

Main effect results for the overall meta-analytic relationship between age and training outcomes using standardized mean differences and correlations are shown in Tables 2 and 3 respectively.

Table 2

Main Effect Results for Standardized Mean Differences Between Age and Training Outcomes

Relationship	<i>N</i>	<i>k</i>	<i>d</i>	δ	SD(δ)	95% CI	95% CrI
Age - Reactions	348	3	-0.11	-0.12	0.38	[-0.61, 0.36]	[-0.86, 0.62]
Age - Perf	1595	21	-0.41	-0.51	0.49	[-0.74, -0.27]	[-1.46, 0.44]
Age - Time	883	12	0.52	0.52	0.56	[0.18, 0.87]	[-0.57, 1.61]

Note. *N* = total sample size; *k* = number of independent effects (including averaged dependent effects); *d* = mean *N*-weighted standardized mean difference; δ = unreliability-corrected standardized mean difference; SD(δ) = standard deviation of δ ; CI = confidence interval of δ ; CrI = credibility interval of δ .

Table 3

Main Effect Results for Correlations Between Age and Training Outcomes

Relationship	<i>N</i>	<i>k</i>	<i>r</i>	ρ	SD(ρ)	95% CI	95% CrI
Age - Reactions	1730	10	.01	.01	.23	[-.15, .16]	[-.45, .46]
Age - Perf	2442	24	-.26	-.28	.18	[-.37, -.19]	[-.63, .07]
Age - Time	694	10	.49	.49	.25	[.33, .65]	[-.01, .98]

Note. *N* = total sample size; *k* = number of independent effects (including averaged dependent effects); *r* = mean *N*-weighted correlation; ρ = unreliability-corrected mean correlation; SD(ρ) = standard deviation of ρ ; CI = confidence interval of ρ ; CrI = credibility interval of ρ .

Hypothesis 1. Though weighted meta-analytic estimates seem to show a non-zero relationship between age and training reactions for both standardized mean difference ($k = 3$, $\delta = -0.12$, 95% CI [-0.61, 0.36]) and correlation analyses ($k = 10$, $\rho = .01$, 95% CI [-.15, .16]), both of the 95% confidence intervals include zero, indicating that the estimates

do not significantly differ from zero. Thus age does not impact people's general reactions toward training and Hypothesis 1A is unsupported.

When training outcomes are operationalized as mastery performance on training material, older adults generally obtained lower scores on training performance than their younger adult counterparts, regardless of whether the studies used extreme groups ($k = 21$, $\delta = -0.51$, 95% CI [-0.74, -0.27]) or continuous group ($k = 24$, $\rho = -.28$, 95% CI [-.37, -.19]) research designs. Results are significant as shown by the exclusion of zero in each of the 95% confidence intervals. Thus, there is a negative meta-analytic relationship between age and training performance, which supports Hypothesis 1B. From a substantive standpoint, this means that in extreme groups, when younger adults were scoring at the 50th percentile of training performance, older adults were scoring at approximately the 35th percentile.

In support of Hypothesis 1C, results show that when looking at studies with extreme groups designs, older adults took more time than younger adults to complete training activities/programs ($k = 12$, $\delta = 0.52$, 95% CI [0.18, 0.87]), such that when younger adults were at the 50th percentile for training time, older adults were at the 30th percentile. Meta-analytic results from the correlation analyses further corroborate this evidence ($k = 10$, $\rho = .49$, 95% CI [.33, .65]). To sum up, Hypothesis 1A was not supported while Hypotheses 1B and 1C were supported. The wide 95% credibility intervals for these three meta-analytic relationships suggest that moderators may be present, thus I proceeded with evaluating each relationship with the proposed moderators.

Moderator Analyses

Moderator analyses for the standardized mean difference meta-analysis and

correlation meta-analysis are shown in Tables 4 and 5 respectively.

Table 4

Moderator Analyses for Standardized Mean Differences Between Age and Training Outcomes

Variable	<i>N</i>	<i>k</i>	<i>d</i>	δ	SD(δ)	95% CI	95% CrI
<i>Performance</i>							
Task Complexity							
Low	788	14	-0.61	-0.69	0.45	[-0.97, -0.40]	[-1.56, 0.19]
High	743	6	-0.15	-0.23	0.41	[-0.60, 0.14]	[-1.03, 0.57]
Structure							
Low	356	6	-0.58	-0.64	0.73	[-1.28, -0.01]	[-2.08, 0.79]
High	898	12	-0.51	-0.56	0.44	[-0.85, -0.27]	[-1.43, 0.31]
Pacing							
Fixed	374	5	-0.28	-0.31	0	[-0.52, -0.09]	[-0.31, -0.31]
Self	1126	13	-0.42	-0.55	0.51	[-0.85, -0.23]	[-1.54, 0.44]
Content							
Novel	207	5	-0.71	-0.80	0.69	[-1.49, -0.11]	[-2.15, 0.56]
Domain	1388	16	-0.36	-0.46	0.43	[-0.70, -0.22]	[-1.29, 0.38]
<i>Time</i>							
Task Complexity							
Low	478	8	0.38	0.38	0.16	[0.16, 0.60]	[0.06, 0.70]
High	405	4	0.69	0.69	0.77	[-0.09, 1.47]	[-0.81, 2.20]
Structure							
Low	180	3	0.87	0.87	0.99	[-0.29, 2.03]	[-1.06, 2.80]
High	374	6	1.03	1.03	0.94	[0.25, 1.82]	[-0.81, 2.87]
Content							
Novel	166	3	0.74	0.74	0.94	[-0.37, 1.85]	[-1.10, 2.58]
Domain	717	9	0.47	0.47	0.40	[0.17, 0.78]	[-0.32, 1.26]

Note. *N* = total sample size; *k* = number of independent effects (including averaged dependent effects); *d* = mean *N*-weighted standardized mean difference; δ = unreliability-corrected standardized mean difference; SD(δ) = standard deviation of δ ; CI = confidence interval of δ ; CrI = credibility interval of δ .

Table 5

Moderator Analyses for Correlations Between Age and Training Outcomes

Variable	<i>N</i>	<i>k</i>	<i>r</i>	ρ	SD(ρ)	95% CI	95% CrI
<i>Reactions</i>							
Task Complexity							
Low	241	2	.16	.18	.19	[-.11, .47]	[-.19, .56]
High	893	6	-.14	-.15	0	[-.22, -.08]	[-.15, -.15]
Pacing							
Fixed	596	3	-.10	-.11	0	[-.18, -.03]	[-.11, -.11]
Self	470	4	-.02	-.02	.23	[-.26, .22]	[-.46, .42]
<i>Performance</i>							
Task Complexity							
Low	627	8	-.24	-.26	.34	[-.52, 0]	[-.92, .41]
High	1463	15	-.29	-.32	0	[-.39, -.25]	[-.32, -.32]
Structure							
Low	253	3	-.22	-.23	.12	[-.44, -.03]	[-.47, 0]
High	1363	16	-.33	-.35	.20	[-.48, -.23]	[-.75, .04]
Pacing							
Fixed	653	5	-.21	-.23	0	[-.27, -.19]	[-.23, -.23]
Self	1244	15	-.30	-.34	.25	[-.49, -.18]	[-.84, .16]
Content							
Novel	213	2	-.45	-.50	0	[-.67, -.33]	[-.50, -.50]
Domain	2229	22	-.24	-.26	.17	[-.35, -.17]	[-.60, .08]
<i>Time</i>							
Task Complexity							
Low	210	4	.52	.52	0.38	[.14, .90]	[-.22, 1.0]
High	484	6	.47	.47	0.33	[.33, .61]	[.15, .80]

Note. *N* = total sample size; *k* = number of independent effects (including averaged dependent effects); *r* = mean *N*-weighted correlation; ρ = unreliability-corrected mean correlation; SD(ρ) = standard deviation of ρ ; CI = confidence interval of ρ ; CrI = credibility interval of ρ .

Though some moderators were originally defined as continuous variables, the number of studies available for each level of each moderator, nested within different training outcomes, were insufficient for a meta-regression (Schmidt, 1971). Consequently, each moderator was dichotomized into high and low levels and subgroup analyses were

conducted for the individual moderators. Furthermore, studies that confounded moderator properties by providing only effect size measurements of the main effect of age on training outcomes, as opposed to effect sizes for individual conditions, were excluded from moderator analyses. Additionally, not all moderator analyses could be conducted due to differences in the amount of methodological detail provided in individual research articles (leading to an inability to make a rating on a moderator), and separation of extreme groups and continuous group designs.

Hypothesis 2. No moderator analyses for goal type were conducted for correlations and standardized mean differences due to the low incidence of field studies (a total of 9 studies) (Arthur et al., 2003). In addition, the exact training program goals were often difficult to infer from the methodology information provided by each study, making missing data a common issue; this further reduced the number of studies eligible for the goal type moderator analysis. Due to insufficient information from original studies, Hypothesis 2 could not be tested and I could not determine whether or not older adults' participation rates in training programs differ by the type of training program goal.

Hypothesis 3. Analyses for the remaining moderators were conducted where possible; each level of a moderator needed at least two studies before analyses could be performed to avoid comparison of the average effect size of multiple studies against a single study's results, which would defeat the purpose of a meta-analysis. Task complexity accounted for a significant reduction in heterogeneity of the age and training reactions meta-analytic relationship ($Q(B) = 15.21, p < .001$) when examining studies with continuous group designs. The relationship was moderated such that high

complexity tasks received poorer reactions from trainees than low complexity tasks, supporting Hypothesis 3A. In fact, older adults responded to low complexity tasks more positively than younger older adults ($\rho = .18$), but the opposite effect occurred for high complexity tasks ($\rho = -.15$). Too few studies were available to run task complexity moderator analyses on training reactions with standardized mean difference effect sizes.

Task complexity also significantly moderated the age and training performance meta-analytic relationship for standardized mean difference ($Q(B) = 40.45, p < .001$) and correlation analyses ($Q(B) = 7.16, p = .007$). Age-related decrements in training performance were diminished with high complexity training tasks ($\delta = -0.23$) relative to low complexity tasks ($\delta = -0.69$) for standardized mean differences, demonstrating an effect in the opposite direction of what was predicted. When looking at the subset of continuous group studies, this relationship changed so that low complexity tasks ($\rho = -.26$) had smaller age-related performance decrements than high complexity tasks ($\rho = -.32$). Consequently, Hypothesis 3B had mixed support because the subset of extreme groups studies show that low complexity tasks lead to smaller age difference in performance compared to high complexity tasks, however the subset of correlational studies show an opposite effect.

Lastly, task complexity moderated the meta-analytic relationship between age and training times (standardized mean difference: $Q(B) = 21.83, p < .001$, correlation: $Q(B) = 55.83, p < .001$); studies with extreme groups designs showed that older adults took more time with high complexity training tasks ($\delta = 0.69$) than low complexity tasks ($\delta = 0.38$), yet effects were found in the opposite direction when studies did not use an extreme groups research design ($\rho_{\text{low}} = .52, \rho_{\text{high}} = 0.47$), providing mixed support for Hypothesis

3C. In sum, task complexity was found to be an effective moderator for training reactions, mastery performance, and timed training outcomes; but low complexity only led to consistent diminished age differences for training reactions.

Hypothesis 4. Hypothesis 4A could not be tested as too few studies were available to assess structure's effect on the age and training reactions relationship. But structure did significantly moderate the relationship between age and training performance for continuous group studies ($Q(B) = 5.76, p = .02$). Results indicate that compared to younger adults, older adults experienced greater age decrements in performance with high structure tasks ($\rho = -.35$) than low structure tasks ($\rho = -.23$), providing evidence that does not support Hypothesis 4B, which asserted that low structure tasks would best diminish age differences in performance. The data furthered this conclusion in extreme groups studies, where structure was not found to be a significant moderator ($Q(B) = 1.03, p = .31$).

Hypothesis 5. The pacing of training programs did affect the training outcomes by significantly moderating the age and training performance relationship when looking at the subset of continuous group studies ($Q(B) = 15.76, p < .001$) and extreme groups studies ($Q(B) = 10.78, p = .001$). Interestingly though, the moderation effect was in the opposite direction of what was hypothesized, such that self-paced training ($\delta = 0.69, \rho = -.34$) led to larger age differences in performance than fixed-pace training ($\delta = 0.38, \rho = -.23$). Thus Hypothesis 5A was unsupported and self-pacing does not benefit older adult performance. Hypothesis 5B could not be tested because there were not enough studies at each moderator level to examine how pacing moderates the relationship between age and training times.

Hypothesis 6. Finally, meta-analytic support was found for training content as a moderator in extreme groups ($Q(B) = 12.03, p < .001$) and continuous group studies ($Q(B) = 5.12, p = .02$). Across both types of study designs, abstract training tasks ($\delta = -0.80, \rho = -.50$) yielded stronger negative relationships between age and training performance than job-related training tasks ($\delta = -0.46, \rho = -.26$). Thus, Hypothesis 6 is supported and job-related training can provide context for older adults to rely on previously acquired job knowledge to perform well during training.

Additional Analyses

Publication bias. Ensuring that meta-analyses are representative of the total population of both published and unpublished literature for the relationship of interest is a critical concern for researchers. Publication bias, also known as the file drawer problem, arose from the selective nature of publications and represents the tendency to publish positive results rather than negative results or ones that do not confirm previous findings (McDaniel, Rothstein, & Whetzel, 2006; Rosenthal, 1979). Meta-analyses of solely published literature are subject to misrepresenting the true underlying relationship of interest that exists in the real world, in this case, the relationship between age and training outcomes. Efforts were made to minimize publication bias by using a variety of sources (i.e., published literature, gray literature, and research experts) to find relevant research for inclusion in the meta-analysis. Out of all studies selected for inclusion in the current meta-analysis, 10 studies were unpublished and the remaining 36 studies were published; looking more closely at the effect size level, this translates into 18 unpublished effect sizes and 63 published effect sizes.

Though the large proportion of unpublished effect sizes implies that publication

bias may not be an issue, additional efforts were taken to examine its extent in the current study. To do so, I compared the meta-analytic effect sizes for each main effect, splitting studies into groups of published or unpublished studies. See Tables 6 and 7.

Table 6

Publication Bias Analyses for Main Effect Standardized Mean Differences

Relationship	<i>N</i>	<i>k</i>	<i>d</i>	δ	SD(δ)	95% CI	95% CrI
Age-Performance							
Published	912	16	-0.55	-0.60	0.49	[-0.87, -0.31]	[-1.56, 0.37]
Unpublished	683	5	-0.23	-0.36	0.44	[-0.78, 0.07]	[-1.21, 0.50]
Age-Time							
Published	562	10	0.66	0.66	0.67	[0.21, 1.11]	[-0.65, 1.97]
Unpublished	321	2	0.28	0.28	0.00	[0.21, 0.35]	[0.28, 0.28]

Note. *N* = total sample size; *k* = number of effects; *r* = mean *N*-weighted correlation; ρ = unreliability-corrected mean correlation; SD(ρ) = standard deviation of ρ ; CI = confidence interval of ρ ; CrI = credibility interval of ρ .

Table 7

Publication Bias Analyses for Main Effect Correlations

Relationship	<i>N</i>	<i>k</i>	<i>r</i>	ρ	SD(ρ)	95% CI	95% CrI
Age-Reactions							
Published	1166	7	.04	.04	.15	[-.09, .17]	[-.26, .34]
Unpublished	564	3	-.18	-.21	.00	[-.24, -.17]	[-.21, -.21]
Age-Performance							
Published	1485	18	-.30	-.33	.21	[-.45, -.21]	[-.75, .09]
Unpublished	957	6	-.19	-.21	.02	[-.29, -.12]	[-.24, -.17]
Age-Time							
Published	595	8	.53	.53	.23	[.37, .70]	[.07, .99]
Unpublished	99	2	.21	.21	.15	[-.04, .47]	[-.07, .50]

Note. *N* = total sample size; *k* = number of effects; *r* = mean *N*-weighted correlation; ρ = unreliability-corrected mean correlation; SD(ρ) = standard deviation of ρ ; CI = confidence interval of ρ ; CrI = credibility interval of ρ .

Results indicate that generally, unpublished studies tend to yield weaker effects in the same direction as published studies. However, there is one exception with age and trainee reactions in correlational studies; in unpublished studies, older adults react more

negatively to training than younger adults ($\rho = -.21$), but published studies appear to indicate that the age difference in reactions is negligible ($\rho = .04$). Moderator analyses confirm that effect sizes between unpublished and published studies differ for all the main effects examined in both extreme groups (Age-Perf: $Q(B) = 10.71, p = .001$; Age-Time: $Q(B) = 29.52, p < .001$) and continuous group (Age-Reaction: $Q(B) = 14.94, p < .001$; Age-Perf: $Q(B) = 22.02, p < .001$; Age-Time: $Q(B) = 31.54, p < .001$) designs. As such, there is evidence of publication bias present in the current meta-analysis; and despite a thorough search of the gray literature, results from this meta-analysis should be interpreted cautiously.

Main effects and moderators. As training outcomes can be operationalized in a variety of ways, additional analyses were undertaken as follow-up to provide additional information to compare and contrast results against past literature. See Appendix B. First, analyses were undertaken to examine whether the effect differed by the dimension(s) of training reactions assessed in the training outcome measure. Thus training reactions were separated into three types as delineated in Alliger et al. (1997): (1) *affective* reactions about how much learners liked training, (2) *utility* reactions about how useful learners found the training, and (3) a *combination* of both affect and utility reactions because not all studied separated these two dimensions when computing effect sizes.

Due to the training reaction outcome measures used, only the combination of affect and utility reactions could be examined across all studies regardless of research design. Interestingly, age had a significant negative relationship with combined training reactions for studies using extreme groups ($k = 2, \delta = -0.68, 95\% \text{ CI } [-1.15, -0.25]$) and continuous group ($k = 6, \rho = -.16, 95\% \text{ CI } [-.30, -.02]$) research designs. Furthermore, age

was positively and significantly related to utility reactions in studies using extreme groups ($k = 2$, $\delta = 0.10$, 95% CI [0.04, 0.16]), as indicated by the exclusion of zero in the confidence interval. However, age was not significantly related to affective training reactions for correlation effect sizes ($k = 4$, $\rho = .02$, 95% CI [-.11, .15]), providing mixed results for the relationship between age and different types of training reactions.

Second, I re-operationalized two moderators – training content and self-pacing – in an effort to capture more nuanced distinctions between the true individual moderator levels I wanted to assess. Though there was a support for training content as a moderator of the age and training performance relationship, the training content construct space can be examined in a variety of ways. According to the 2016 ATD State of the Industry Report, 41% of training was delivered through technological means and the three top training content areas were: managerial/supervisory; mandatory/compliance; and processes, procedures, and business practices. With technology advancing at a rapid pace, computers and related devices have become a common and important part of working environments. However, computer-based technology can potentially act as an additional hurdle to learning for older workers, as the workplace has changed since these older adults originally entered the workforce (Baldi, 1997). Consequently, I used Kubeck et al.'s (1996) taxonomy of training content to compare computer-based training (e.g., software use) to training of other job-related skills.

There was no support for a moderator effect of training content (i.e., computer-based vs. other job-related skills) on the age and performance relationship in extreme groups studies ($Q(B) = 0.45$, $p = .50$), however, training content was a significant moderator for continuous group studies ($Q(B) = 25.86$, $p = .50$). Computer-based training

yielded larger age differences in performance than job-related training ($\rho_{\text{computer}} = -.34$, $\rho_{\text{job}} = -.18$); these findings partially support the age difference found by Kubeck and colleagues.

Lastly, due the lack of support for self-pacing as an intervention that supports older adults, I attempted to measure the degree of learner control in the included studies instead. I used the definition of learner control described previously by DeRouin, Fritzche, and Salas (2004), which is characterized by elements such as control of content, learning context, sequence, presentation method, incentives, etc. All included studies were double-coded for the learner control variable; if insufficient information was provided in the study methodology to give a rating, no value was assigned. Reliability between raters was 0.90, and consensus meetings were used to rectify any discrepancies in ratings and reach an agreement.

Learner control was not a significant moderator of the age and training reactions relationship in studies with a continuous group design ($Q(B) = 3.43$, $p = .06$); too few studies were available to evaluate studies with extreme groups. There was also no support for a moderator effect of learner control on the age and performance relationship in extreme groups studies ($Q(B) = 0.11$, $p = .74$) or continuous group studies ($Q(B) = 1.55$, $p = .21$). However, the age and training time relationship was affected by the degree of learner control (extreme groups: $Q(B) = 179.28$, $p < .01$; continuous group: $Q(B) = 26.52$, $p < .01$). In extreme groups studies, studies with high learner control had longer training times than low learner control ($\delta_{\text{low}} = 0.61$, $\delta_{\text{high}} = 1.87$) whereas the opposite occurred for continuous group studies ($\rho_{\text{low}} = .54$, $\rho_{\text{high}} = .48$), providing mixed results for learner control as a moderator.

CHAPTER 5: Discussion

Overview of Aims

Training and development have been reviewed multiple times in the published literature, and researchers have begun noting the increasing advancements being made with each passing decade (Aguinis & Kraiger, 2009; Campbell, 1971; Goldstein, 1980; Wexley, 1984; Latham, 1988; Salas & Cannon-Bowers, 2001; Tannenbaum & Yukl 1992). The most recent review by Aguinis and Kraiger (2009) summed up research conducted since 2000, mentioning that the researchers have found several interventions that are effective at amplifying the benefits of training. Intriguing developments from annual reviews, in combination with meta-analyses (Kubeck et al., 1996; Callahan et al., 2003), which are becoming increasingly outdated, has led to the need for an updated perspective on aging and training. The goals of the current study were to (1) use a theoretically-based approach to examine how age affects training outcomes as a proxy for motivation and cognitive ability, (2) update the age and training literature by meta-analytically assessing studies using younger and older workers, (3) adopt a scientist-practitioner approach by examining a range of training outcomes used in academia and industry, and (4) identify ways to help support older employees in the workplace. By integrating theory with literature, this meta-analytic study provides both a holistic view of the research and highlights evidence-driven avenues for researchers and practitioners to support older workers.

Meta-analytic Findings & Implications

Results from the present study illustrate a clear difference between younger and older adults on different training outcomes, except for training reactions. Interestingly,

when the types of training reactions were further split into specific dimensions, there was mixed evidence that the type of reaction information gathered could potentially lead to age differences in affective receptivity to training. From a substantive standpoint, even though younger and older adults feel about the same towards training after completing a program, older adults master less learning material and take longer to complete training activities compared to younger adults. In other words, skill acquisition is less efficient for older employees. Compared to previous work by Kubeck and colleagues (1996), a greater number of studies (46 vs. 32 studies) were included, indicating that researchers are continuing to examine the impact of age on training in the workforce. Additionally, results of the present study replicated results of the main effect relationship between age and training outcomes found in previous meta-analyses, supporting existing empirical results (Callahan et al., 2003; Kubeck et al., 1996).

In addition to looking at the overall effects between the variables of interest, I examined specific moderators of the age and training outcomes relationship, in the hopes of identifying ways to adjust training interventions that would help diminish the age differences in training outcomes. Wide confidence intervals for the main effects provided evidence suggesting that a moderating variable may be producing large amounts of variation in the effect sizes. The moderator analyses illustrate a muddled picture where some factors are consistent moderators of training outcomes and others vary by the specific subset of data being analyzed.

One of the most consistent moderators that arose from the data was training content. Compared to abstract training tasks, job-related training tasks diminished age differences for training performance across studies with extreme groups and single group

correlational designs, making it a good candidate to help support older employees in the workplace. There was also preliminary evidence among studies with extreme group designs that job-related training tasks helped diminish age differences in training time. Results about job-related content as an effective way to support older workers align with the industrial gerontology model's assertion that older workers perform better when training content builds off past knowledge and abilities (Sterns, 1986; Sterns & Miklos, 1995); it also further supports similar empirical results about prior knowledge (Beier & Ackerman, 2005) and training strategies that focus on the expansion of learners' domain knowledge bases (Taconis, Ferguson-Hessler, & Broekkamp, 2001) as determinants of new domain knowledge acquisition. Furthermore, when training content was delineated as a difference between job-related and computer-based content, results found by Kubeck et al. (1996) were replicated, such that computer-based training yielded poorer results for older adults relative to job-related training. This empirical evidence further indicates that even though training is shifting towards greater computer technology usage, researchers and practitioners should still be cognizant of the impact that technology can have on training success for different age groups.

The three remaining moderators had mixed support or partial evidence due to the extent that analyses could be conducted. For instance, the moderation effect for task complexity varied depending on how the training outcome was operationalized. High complexity tasks drew more negative reactions from older adults than low complexity tasks, which aligns with the idea that high complexity tasks are more frustrating. But oddly enough, high complexity tasks also led to smaller training performance age differences than low complexity tasks. In other words, high complexity tasks are not

perceived pleasantly, even though they yield diminished performance differences, which seems contradictory.

One potential explanation is that recruited participants have become accustomed to a specific degree of complexity involved in performing their typical job tasks. Thus, when the degree of task complexity during training differs from typical task exposure on the job, the difference could potentially impact performance negatively. One way to examine this possibility would be to compare the complexity of jobs held by sampled participants – obtained through an objective resource like the O-NET – with the complexity of the training task. A closer examination of this information revealed that information gleaned from individual studies are too convoluted to arrive at a clear conclusion; participants' jobs often go unreported or are mixed together from several industries or job complexity levels. Thus, further research is needed to examine what mechanism(s) may be leading to this particular effect.

There was also mixed evidence for Hypothesis 4, which asserted that high structure is more beneficial for reducing age differences in performance. Though this evidence was only present in single group correlational studies, it may be indicative of differences that occur in the active versus passive learning processes people are exposed to in low structure and high structure training respectively. Specifically, low structure training encourages broad, in-depth acquisition of training materials because learners must explore the training environment to succeed; however, high structure encourages more passive acquisition of training materials because external sources such as a training facilitator or computer program dictate the task elements involved in completing the task, along with making the correct decisions that lead up to successful task completion (Bell

& Kozlowski, 2008).

Initially, I expected that low structure would amplify age differences because it creates more cognitive load during the skill acquisition process, which can make it harder for older adults to learn. Furthermore, most training manipulations try to maximize short-term performance that occurs during or immediately after training (Schmidt & Bjork, 1992) and the benefits of structure typically manifest in transfer performance situations (Keith, Richter, & Naumann, 2010), which are more long-term in nature. However, if learners are trained using high structure and stumble onto unfamiliar task situations (either as a function of the training test or deviating from the correct set of steps for task completion), they can potentially experience performance decrements because they are less likely to hold knowledge of the corrective measures needed to put them back on a familiar path to success. In the context of the industrial gerontology model, the support for program structure is still undetermined as Sterns (1986) uses structure to refer to the sequencing of training tasks increasing in difficulty within an intervention, rather than the degree of instruction one receives during skill acquisition.

Results about training pace also went against empirical findings from past literature that reported self-pacing as beneficial for training older adults (Callahan et al., 2003), and by association, the specific proposed cognitive load mechanism underlying self-paced learning was also unsupported. Though the industrial gerontology model asserts that training developers should cater to older adults' learning needs by allowing sufficient time to progress through and master training (Sterns, 1986; Sterns & Miklos, 1995), current study results suggest that moderation may be key. Self-paced training could possibly add more cognitive load to training situations as learners are tasked with

determining when they feel comfortable enough with current training material to progress to the next stage or module. This increased learner control may actually replace the extraneous cognitive load imposed by fixed pace activities and replace it with germane cognitive load associated with learner control. Though researchers have suggested that germane cognitive load is beneficial for learning (Kirschner, 2002; Paas & Van Gog, 2006), the cumulative amount of cognitive load may not change by much; therefore it could still be overwhelming and lead to older adults experiencing cognitive overload during training. Additional moderator analyses conducted on learner control show that while self-pacing is an aspect of learner control in training, it may not be truly representative of the overall amount of learner control given to trainees in skill acquisition situations; this is evidenced by the differences in the quantity of studies classified as low vs. high learner control compared to self vs. fixed pacing.

Despite the inconsistent nature of some of the current study's results, several practical takeaways emerge. First, there are consistent age differences between age and training outcomes that are commonly measured, namely performance and training times. With an increasing number of older employees in the workforce each passing year, this highlights a strong need for researchers and practitioners to tailor training for this specific population. Second, the relationship between age and training outcomes is moderated by several factors, and there may be additional undiscovered moderators. In particular, moderator levels that consistently result in a weaker negative relationship between age and training outcomes can provide avenues for tailoring training to older workers' needs in the workplace. For instance, people who create training could generate task content rooted in prior job knowledge to help boost performance and reduce training times for

older adults. Older adults may also need to be given more exposure to training programs that use prior job knowledge to reduce the chance of cognitive overload and promote successful training performance. However, for moderators where the benefits change by the operationalization of training outcomes, training specialists should use needs analysis to inform which features to implement in practice. Lastly, there is emerging support for cognitive load theory and the industrial gerontology model, which is encouraging for theory development and evidence-based practice.

Limitations and Future Directions

While results from this study help inform the current state of training and development literature, there are some limitations that impacted the results that could be obtained from the data. One key limitation is how the analyses were separated because there was no correction for extreme group range enhancement, a well-documented issue called the missing middle (Sackett & Yang, 2000; Taylor & Griess, 1976). Ideally, combining all effect sizes from the analyses would have provided the most holistic perspective of the current state of age and training literature findings; also, splitting up studies by different research designs made it difficult to test some analyses and decreased the number of studies included at each moderator level. Some moderator levels had only two studies – thereby limiting the utility of credibility intervals and estimates of heterogeneity. On a related note, the range enhancement that is inherent in extreme groups designs inflates the true underlying population effect. Thus, research results where only the subset of extreme groups studies yielded significant results should be interpreted carefully before practical application.

Until more methods to feasibly obtain the unrestricted sample standard deviation

are established, it will be difficult to combine the different types of research design without introducing large amounts of error, which would end up misrepresenting the results that researchers have truly obtained. One way to address this in the future is by creating a standard for the information detailed as part of a training study. Training programs are complex and can differ greatly from one another; consequently, endeavors to meta-analyze such work requires a good deal of researcher judgment without looking directly at the training materials or experiencing the program's protocol. Standardizing the reporting process would assist in reducing error inherent in rater judgments and provide richer information for future research synthesis.

Finally, future research could focus more on the function of motivation as a determinant of training outcomes. Though the developmental theory and motivation-related training suggestions could not be explored in the present study, motivation may serve as an additional avenue through which researchers and practitioners can impact the training experience. By focusing on training design techniques which address developmental changes in both cognitive ability and motivation, psychologists can support older workers throughout the whole skill acquisition process, as opposed to select portions of the training experience.

Conclusion

Organizations and researchers have recognized that aging brings on important changes that may affect training outcomes. Various theories and models have arisen in the literature in an attempt to identify needs that arise from those changes, explain the underlying operational mechanisms, and provide ways to address those issues while optimizing performance. Recent advancements have necessitated a big picture

perspective that incorporates a variety of theoretical perspectives and examines a broader variety of customizable training features. Though general trends regarding the relationship between age and training performance have been replicated from previous work, data from the present study show that there is more to be discovered; especially the impact that different nuanced training elements (e.g., training complexity, learner control, etc.) may have on the skill acquisition experiences and related outcomes. With results from the current study, employers and training developers can start becoming more aware of the different needs that older workers have and begin to support this population using specific techniques in applied contexts, and hopefully benefit organizations in the long term.

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Appendix A

Electronic Database Search Details

Search Limiters (as keywords, document titles, and publication titles): neural, fMRI, sport, sports, counseling, schizophrenia, clinical, psychiatry, animal, animals, social work (document title and publication title only)

Record Type: Journal, Journal Article, Peer-reviewed Journal, Dissertation, Dissertation Abstract

Date Range: 1890 through April 2016

Age Range: Adulthood (18 yrs & older), Young Adulthood (18-29 yrs), Thirties (30-39 yrs), Middle Age (40-64 yrs), Aged (65 yrs and older)

Seed Articles: Kubeck et al. (1996), Callahan, Kiker, & Cross (2003), Ng & Feldman (2008)

Notes:

- Combinations from Callahan (2003) with the words "old" and "older" were dropped → too broad; Training and Aging also excluded due to redundancy with Kubeck et al. (1996); Learning and Adult excluded due to redundancy with Adult Learning
- Age and Learning, and Age and Work from Kubeck et al. (1996) too broad. Used Age, Learning, and Work and Age, Work, and Training instead.
- Added Training and Work and Training and Work Skills to capture age and training research where the topic is not primary focus

Search Terms (keywords):

Adult Learning
 Adult Education
 Age and Ability Training
 Age and Evaluation
 Age and Retraining
 Age and Skill
 Age and Training
 Age, Learning, and Work
 Age, Work, and Training
 Learn and Adult
 Learn and Age
 Learn and Aging
 Learning and Elderly
 Learning and Age
 Learning and Aging
 Learning and Elderly
 Learning and Work

Learner and Adult
Learner and Age
Learner and Aging
Learner and Elderly
Older Worker Education
Train and Adult
Train and Age
Train and Aging
Train and Elderly
Training and Adult
Training and Aging
Training and Elderly
Training and Work
Training and Work Skills
Training Effects and Older Workers
Training Performance and Adult
Training Performance and Age
Training Performance and Aging
Training Performance and Elderly
Training Success and Adult
Training Success and Age
Training Success and Aging
Training Success and Elderly
Work and Training Older Adult
Worker and Adult
Worker and Age
Worker and Aging
Worker and Elderly

Appendix B

Additional Analyses Results for Main Effects and Moderators*Main Effect for Standardized Mean Differences Between Age and Training Reactions*

Relationship	<i>N</i>	<i>k</i>	<i>d</i>	δ	SD(δ)	95% CI	95% CrI
Age - Reactions	348	3	-0.11	-0.12	0.38	[-0.61, 0.36]	[-0.86, 0.62]
Utility	236	2	0.09	0.10	0	[0.04, 0.16]	[0.10, 0.10]
Affect & Utility	151	2	-0.62	-0.68	0.16	[-1.11, -0.25]	[-0.99, -0.37]

Note. *N* = total sample size; *k* = number of independent effects (including averaged dependent effects); *d* = mean *N*-weighted standardized mean difference; δ = unreliability-corrected standardized mean difference; SD(δ) = standard deviation of δ ; CI = confidence interval of δ ; CrI = credibility interval of δ .

Main Effect for Correlations Between Age and Training Reactions

Relationship	<i>N</i>	<i>k</i>	<i>r</i>	ρ	SD(ρ)	95% CI	95% CrI
Age - Reactions	1730	10	.01	.01	.23	[-.15, .16]	[-.45, .46]
Affect	869	4	.02	.02	.11	[-.11, .15]	[-.20, .23]
Affect & Utility	899	6	-.15	-.16	.14	[-.45, .12]	[-.31, -.02]

Note. *N* = total sample size; *k* = number of independent effects (including averaged dependent effects); *r* = mean *N*-weighted correlation; ρ = unreliability-corrected mean correlation; SD(ρ) = standard deviation of ρ ; CI = confidence interval of ρ ; CrI = credibility interval of ρ .

Moderator Analyses for Standardized Mean Differences Between Age and Training Outcomes

Variable	<i>N</i>	<i>k</i>	<i>d</i>	δ	SD(δ)	95% CI	95% CrI
<i>Performance</i>							
Learner Control							
Low	1169	16	-0.49	-0.63	0.59	[-0.95, -0.31]	[-1.78, 0.52]
High	556	8	-0.60	-0.67	0.64	[-1.16, -0.18]	[-1.93, 0.59]
Content							
Job-related	303	6	-0.43	-0.48	0.71	[-1.10, 0.15]	[-1.86, 0.91]
Computer	1292	15	-0.41	-0.51	0.41	[-0.76, -0.27]	[-1.32, 0.29]
<i>Time</i>							
Learner Control							
Low	774	9	0.61	0.61	0.69	[0.14, 1.08]	[-0.73, 1.95]
High	132	3	1.87	1.87	1.22	[0.43, 3.31]	[-0.52, 4.26]
Content							
Job-related	262	4	0.90	0.90	0.89	[-0.00, 1.81]	[-0.84, 2.64]
Computer	621	8	0.36	0.36	0.15	[0.17, 0.55]	[0.08, 0.65]

Note. N = total sample size; k = number of independent effects (including averaged dependent effects); d = mean N -weighted standardized mean difference; δ = unreliability-corrected standardized mean difference; $SD(\delta)$ = standard deviation of δ ; CI = confidence interval of δ ; CrI = credibility interval of δ .

Moderator Analyses for Correlations Between Age and Training Outcomes

Variable	N	k	r	ρ	$SD(\rho)$	95% CI	95% CrI
<i>Reactions</i>							
Learner Control							
Low	480	3	-.13	-.14	.02	[-.25, -.03]	[-.17, -.11]
High	1572	9	-.03	-.03	.18	[-.16, .10]	[-.38, .32]
<i>Performance</i>							
Learner Control							
Low	971	11	-.28	-.29	.22	[-.45, -.14]	[-.72, .13]
High	703	9	-.31	-.34	.14	[-.47, -.20]	[-.60, -.07]
Content							
Job-related	818	6	-.16	-.18	0	[-.22, -.13]	[-.18, -.18]
Computer	1624	18	-.31	-.34	.21	[-.46, -.22]	[-.74, .07]
<i>Time</i>							
Learner Control							
Low	255	4	.54	.54	.30	[.24, .84]	[-.04, 1.13]
High	245	4	.48	.48	.28	[.19, .77]	[-.08, 1.04]

Note. N = total sample size; k = number of independent effects (including averaged dependent effects); r = mean N -weighted correlation; ρ = unreliability-corrected mean correlation; $SD(\rho)$ = standard deviation of ρ ; CI = confidence interval of ρ ; CrI = credibility interval of ρ .