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A Meta-Analysis of the Interactive, Additive, and Relative Effects of Cognitive Ability and Motivation on Performance

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*We tested the longstanding belief that performance is a function of the interaction between cognitive ability and motivation. Using raw data or values obtained from primary study authors as input (*k *= 40 to 55;* N *= 8,507 to 11,283), we used meta-analysis to assess the strength and consistency of the multiplicative effects of ability and motivation on performance. A triangulation of evidence based on several types of analyses revealed that the effects of ability and motivation on performance are additive rather than multiplicative. For example, the additive effects of ability and motivation accounted for about 91% of the explained variance in job performance, whereas the ability-motivation interaction accounted for only about 9% of the explained variance. In addition, when there was an interaction, it did not consistently reflect the predicted form (i.e., a stronger ability-performance relation when motivation is higher). Other key findings*

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include that ability was relatively more important to training performance and to performance on work-related tasks in laboratory studies, whereas ability and motivation were similarly important to job performance. In addition, statelike measures of motivation were better predictors of performance than were traitlike measures. These findings have implications for theories about predictors of performance, state versus trait motivation, and maximal versus typical performance. They also have implications for talent management practices concerned with human capital acquisition and the prediction of employee performance.

Keywords: *ability; motivation; performance; interactions; relative importance; meta-analysis*

Individual performance is one of the most central and frequently studied constructs in management and related fields (Campbell & Wiernik, 2015; Cascio & Aguinis, 2008; Dalal, Bhave, & Fiset, 2014). Conceptual models and considerable empirical evidence suggest that two key determinants of performance are cognitive ability and motivation. Cognitive ability is the capacity to mentally process, understand, and learn information (Hunter & Schmidt, 1996). Ability relates to performance primarily through job knowledge, such that high-ability workers tend to demonstrate higher performance because they are better able to acquire and use job-relevant knowledge compared to those who possess lower levels of ability (F. L. Schmidt, Hunter, & Outerbridge, 1986).

Motivation is "an unobservable force that directs, energizes, and sustains behavior" (Diefendorff & Chandler, 2011: 66; see also Kanfer, Chen, & Pritchard, 2008; Mitchell & Daniels, 2003). Motivation relates to performance by influencing the direction, intensity, and persistence of effort (Blau, 1993; Campbell, 1990; Kanfer, 1990). Specifically, motivation is reflected in the choices workers make about whether to expend effort, the level of effort they expend, and how much they persist in that level of effort (Campbell, 1990). Furthermore, these choices can be enduring, such as individuals who generally work with great effort, or situation specific, such as workers who devote effort toward a specific task or in a particular context.

A longstanding belief exists that ability and motivation interact to affect performance, such that the relation between ability (motivation) and performance depends on, or is moderated by, motivation (ability; Maier, 1955; Murphy & Russell, in press; Vroom, 1964). Stated more formally, Performance = f(Ability × Motivation). This *multiplicative model* predicts that when individuals possess little or no motivation, they will demonstrate similarly low levels of performance regardless of their ability level. However, as individuals begin to exert some level of effort, differences in ability can play a role, and the relation between ability and performance becomes positive, such that high-ability individuals will outperform low-ability individuals. Thus, the multiplicative model is noncompensatory in that performance is predicted to be low whenever ability *or* motivation is low. This is different from an *additive model* in which the effects of ability and motivation on performance are independent and compensatory (Mount, Barrick, & Strauss, 1999; Sackett, Gruys, & Ellingson, 1998). For instance, in an additive model, individuals' level of motivation would not affect the relation between ability and performance. Moreover, individuals who possess a lower level of motivation could compensate for this deficit to some extent by demonstrating a higher level of ability.

The belief in the veracity of the multiplicative model seems justified given that many well-established theories predict or assume an interactive relation between ability and motivation. For example, expectancy theory posits that "the effects of ability and motivation on performance are not additive but interactive" (Vroom, 1964: 203). Another example is goal-setting theory (Locke & Latham, 1990), which predicts that ability and goals (as a motivating factor) interact to affect performance. Specifically, the effect of ability on performance is predicted to be stronger when people set difficult goals than when they set easy goals. Similarly, Lawler and Porter's (1967) model of managerial attitudes and performance posits that ability interacts with effort to affect performance. The idea that ability and motivation have an interactive effect on performance also is evident within theory and models on the antecedents and determinants of job performance. For example, Campbell's well-known theory (e.g., McCloy, Campbell, & Cudeck, 1994) predicts that declarative knowledge and procedural knowledge and skills (of which ability is an immediate precursor) interact with motivation to affect performance. Finally, propositions related to the multiplicative model can be found in theory and research on resource allocation (e.g., Hobfoll, 1989; Kanfer & Ackerman, 1989) that consider variables such as ability to be resources people can deploy to achieve a desired outcome.

In short, various theoretical bases exist to support the multiplicative model. Furthermore, researchers have suggested the idea that Performance = *f*(Ability × Motivation) is "empirically, logically, and psychologically convincing" (Porter & Lawler, 1968: 33) and have referred to it as a "well-accepted truism" (Bell & Kozlowski, 2002b: 497). This idea can be found in textbooks widely used in undergraduate, graduate, and executive courses (e.g., Bauer & Erdogan, 2010; Gómez-Mejía, Balkin, & Cardy, 2007; Landy & Conte, 2004). There even is anecdotal evidence that beliefs in the multiplicative model influence the advice consultants provide organizations (Cerasoli, 2014).

Despite the strong theoretical and logical basis for the multiplicative model, the number of direct tests of this model is surprisingly small. In addition, of the studies that have been conducted, some have reported evidence of an ability-motivation interaction on performance (e.g., Fleishman, 1958; French, 1957; Perry, Hunter, Witt, & Harris, 2010), whereas others have failed to find evidence of an interaction effect (e.g., Dachler & Mobley, 1973; Gavin, 1970; Terborg, 1977). Furthermore, some studies have found evidence of an interaction, but its form was not consistent with theory (e.g., Kanfer & Ackerman, 1989; Latham, Seijts, & Crim, 2008; Wright, Kacmar, McMahan, & Deleeuw, 1995). A related research stream has assessed whether ability interacts with personality variables to predict performance (e.g., Mount et al., 1999; Sackett et al., 1998).

Adding to the lack of clarity regarding the validity of the multiplicative model, the designs and measures used in many studies make it difficult to draw clear conclusions. For example, some studies (e.g., Fleishman, 1958) have assessed ability using measures with questionable construct validity, such as initial performance on an experimental task, self-ratings, or tenure. Other studies (e.g., Hollenbeck, Brief, Whitener, & Pauli, 1988) have measured motivation using variables that may not directly capture the underlying construct, such as self-esteem, integrity, or broad measures of conscientiousness. Other empirical work (e.g., Terborg, 1977) has included variables (i.e., statistical controls) in addition to ability, motivation, and performance, which complicates the interpretation and comparison of findings across studies (Bernerth & Aguinis, 2016). Finally, most research has tested the multiplicative hypothesis using significance tests of incremental variance explained. Thus, low or differential levels of statistical power, which are known problems in research that examines interaction effects (e.g., Aguinis, Beaty, Boik, & Pierce, 2005; Murphy & Russell, in press), often make it difficult to draw conclusions from tests of the multiplicative model.

Present Study

We conducted the present study to provide a comprehensive test of a longstanding hypothesis regarding how two of the most central and widely studied individual differences in management and related fields—ability and motivation—relate to performance. To do so, we engaged in a multistage data collection process that began by identifying published and unpublished studies that included measures of ability, motivation, and performance. Next, we requested raw data from the original authors, which we used to calculate the multiplicative effects of ability and motivation on performance for each study. We then used meta-analysis to assess the level and consistency of support for the multiplicative model across the primary studies. We also used meta-analysis to assess the relative importance of ability versus motivation for explaining variance in performance. Taken together, this methodology enabled us to test the multiplicative hypothesis in a way that overcomes many of the challenges and limitations of previous research.

Our study makes several contributions. First, the findings contribute to theory by testing a hypothesis that can be found in several highly influential theories. Although previous research has tested the Ability × Motivation hypothesis, the findings have been inconsistent and have failed to provide clear conclusions regarding the level of support for this model. By focusing on studies whose designs and measures reflect the constructs of interest, collecting previously unreported data obtained directly from authors, and cumulating results across a large number of studies, the present meta-analysis provides a direct test of the interactive effects of ability and motivation on performance.

Second, we extend existing research by investigating a number of potential boundary conditions of the multiplicative model. For example, it has been suggested that support for this model may be stronger in lab settings than in field settings and stronger for more complex jobs or tasks than for less complex ones (e.g., Sackett et al., 1998; Terborg, 1977). We test both of these possibilities. Researchers also have noted that motivation can be enduring (i.e., a trait) or situation specific (i.e., a state; e.g., Chen, Gully, Whiteman, & Kilcullen, 2000; Kanfer & Heggestad, 1997). We examine whether the trait versus state motivation affects support for the multiplicative model. In addition, we explore several other factors that could affect support for the multiplicative model, including publication status (published vs. unpublished studies), type of organization (civilian vs. military), study sample size, performance dimension (task vs. contextual performance), and the manner with which performance is operationalized (objective vs. subjective measures). An examination of these factors enabled us to explore situations when the multiplicative effects may be stronger or weaker, as well as to provide information to guide future research and make context-specific recommendations for practice.

Third, the present study also improves our understanding of the relative importance of ability and motivation. Although many primary and meta-analytic studies have examined how ability relates to performance *or* how motivation relates to performance, surprisingly few studies have directly compared the importance of these two predictors, particularly based on data from the same set of primary studies. Our results shed light on whether ability or motivation is relatively more important to performance in general, as well as in different contexts (e.g., during training vs. on the job). Furthermore, to our knowledge, we provide the first meta-analytic test of the trait versus state motivation distinction as it relates to the prediction of performance. Our findings regarding this distinction contribute to the literature on the prediction of performance, as well as to the vast body of work on motivation, by highlighting which operationalization of motivation is the best predictor of performance and when.

Finally, the present findings inform how organizations should use data on ability and motivation to facilitate staffing decisions. For example, if ability and motivation combine multiplicatively, this suggests that applicants may need to possess a high level of both variables to perform well on the job. This, in turn, could reduce the pool of potentially acceptable applicants. Conversely, if ability and motivation combine additively rather than multiplicatively to influence performance, it may be possible to select job applicants who possess a high level of one variable but a more moderate level of the other. The results also have implications for other human resources practices that attempt to affect, or are influenced by, ability and motivation, including training and incentive practices.

Hypotheses and Research Questions

Tests of the Multiplicative Model

As we mentioned, propositions concerning the multiplicative model can be found in several theories and models of job performance. The idea that ability and motivation interact to influence performance also has logical appeal. At the same time, empirical evidence for the Performance = f(Ability × Motivation) hypothesis is inconclusive and often difficult to interpret. As such, it was difficult to hypothesize what we expected to find. We did anticipate that any support we might find for the multiplicative model would be modest. For one, the likely strong main effects of ability and motivation may make it difficult for the interaction between the two variables to explain a large amount of additional variance in performance (Murphy & Russell, in press). Furthermore, the incremental contribution of interaction effects beyond first-order (i.e., "main") effects tends to be quite small (Aguinis et al., 2005).

Thus, the first goal of our study was to assess the level and consistency of support for the multiplicative model. The novel methodological approach we used enabled us to test the multiplicative hypothesis in a more valid and comprehensive manner than past research. First, we focused on studies that avoided the design and measurement limitations noted above (e.g., use of proxies to measure ability and/or motivation). Second, we obtained raw data or analysis output from the original authors. This was important because it helped to ensure all the data were treated in the same way and analyzed using a consistent approach. Third, in contrast to previous research that has tended to focus on the statistical significance of ability-motivation interactions, we focused on effect sizes. Specifically, we examined support for the multiplicative model by calculating the amount of change in the multiple correlation coefficient (R) between the additive and multiplicative models, as well as by assessing the relative importance of ability, motivation, and the ability-motivation interaction for explaining variance in performance.

In addition, prior studies that have found evidence of an ability-motivation interaction have not always interpreted the nature of the interaction. To address this omission, we calculated simple slopes for the ability-performance relationship across different levels of motivation. Fourth, we then used meta-analysis to assess the mean and variability of the multiplicative effect across studies, as well as the consistency of the magnitude and direction of differences between the simple slopes. This methodology avoids common problems in testing interaction effects, including low statistical power (i.e., we focused on effect sizes based on dozens of studies and thousands of observations) and low reliability of the product term (which we corrected for in our analyses). Finally, cumulating effects across primary studies also allowed us to investigate potential boundary conditions of the multiplicative model, as well as factors that may moderate the relative importance of ability and motivation to performance. We describe these boundary conditions next.

Boundary Conditions of the Multiplicative and Relative Effects of Ability and Motivation

Conceptualization of motivation. Work motivation is a broad construct that has been defined and measured in many ways. We reviewed existing definitions of work motivation and found that most of them share two common elements. First, they refer to "unobservable forces" that energize behavior. The forces that energize behavior are innumerable and originate both within and outside workers. For example, Diefendorff and Chandler noted that "motivation for a given activity at a particular point in time may be shaped by an infinite number of factors, including biological processes, needs, values, group norms, personality, emotions, job characteristics, cultural context, and many others" (2011: 66). Moreover, the factors that motivate workers are personal, and different workers have different needs and think different features of the work environment are important (Mitchell & Daniels, 2003).

Second, most definitions refer to the idea that work motivation directly affects the direction, intensity, and duration or persistence of effort. Motivation is reflected in the choices workers make about whether to expend effort, the level of effort they expend, and how much they persist in that level of effort (Campbell, 1990). Furthermore, these choices can be enduring, such as employees who generally exhibit high levels of effort, or situation specific, such as employees who devote effort toward a specific task. Following previous definitions, we define work motivation as an unobservable force that initiates work-related behavior and determines its direction, intensity, and duration.

Several theories and areas of research distinguish between traits and states (Steyer, Schmitt, & Eid, 1999). For example, researchers have identified differences between trait and state affect (e.g., D. Watson, Clark, & Tellegen, 1988), anger (e.g., Gibson & Callister, 2010), anxiety (Speilberger, Sydeman, Owen, & Marsh, 1999), and self-efficacy (Bandura, 1997). Similarly, motivation can be enduring (i.e., a trait) or situation specific (i.e., a state; e.g., Chen et al., 2000; Kanfer & Heggestad, 1997). Trait motivation reflects a relatively stable tendency to exert effort and demonstrate persistence on work tasks. Measures such as achievement motivation, achievement striving, and work drive are thought to capture trait motivation (Chen, Gully, & Eden, 2004; Kanfer & Heggestad, 1997; Perry et al., 2010). In contrast, state motivation reflects workers' level of motivation at a specific moment in time. Measures of state motivation typically assess the amount of time, effort, or attention devoted to a task (Chen et al., 2004). Goal-related measures also are thought to capture state motivation because goals help direct workers' effort toward specific tasks (Katerberg & Blau, 1983).

Results of previous research suggest that the way motivation is conceptualized may affect support for the multiplicative model. For example, Hirschfeld, Lawson, and Mossholder (2004) found that the ability-motivation interaction was stronger when the motivation measure was more task specific (i.e., academic motivation) than when it was more general (i.e., achievement motivation). Similarly, Perry et al. (2010) found greater support for the multiplicative model with a measure that focused more directly on motivation (i.e., achievement striving) than for measures that assessed less relevant constructs (e.g., other facets of conscientiousness). However, we are not aware of a theoretical basis to hypothesize that support for the multiplicative model will be stronger or weaker for any specific conceptualization of motivation. Thus, we pose the following research question:

Research Question 1: Does the way motivation is conceptualized (i.e., trait vs. state) affect the strength of the multiplicative effect of ability and motivation on performance?

We also examine whether the trait versus state distinction affects the relative importance of motivation to performance. Various theories and models propose that distal, traitlike motivational variables affect outcomes such as performance via more proximal, statelike variables. For example, cognitive choice theories of motivation (e.g., goal-setting theory, expectancy theory) propose that distal variables such as achievement motivation affect performance primarily by influencing more proximal variables such as goal choice and intended effort (Kanfer, 1990). In support of this idea, Phillips and Gully (1997) found evidence that traitlike variables such as locus of control and need for achievement relate to academic performance through statelike variables such as specific self-efficacy and self-set goals. Similarly, Chen et al. (2000) found that statelike variables such as goals and state anxiety were better predictors of academic performance than traitlike variables such as general self-efficacy and goal orientation.

Thus, theory and prior research suggest that statelike motivation will tend to have a strong, direct effect on outcomes such as performance. In contrast, traitlike motivation is thought to affect outcomes indirectly through their influence on more proximal variables and, thus, have a weaker effect on the outcomes. This leads to our first hypothesis:

Hypothesis 1: The relative importance of motivation to performance will be stronger for state motivation compared to trait motivation.

Study setting. Researchers have suggested that interaction effects are more likely to be found in laboratory settings than field settings (e.g., McClelland & Judd, 1993). The rationale is that laboratory studies enable researchers to measure variables more precisely and to control for extraneous sources of variance better than in field studies and thereby maximize the ability to detect interactions. Relative to field studies, laboratory studies also are more likely to use experimental designs and manipulations that enable researchers to induce a range of motivational levels. In contrast, motivation may be less varied in field settings where extremely low levels of motivation may not be present (i.e., because all employees need some minimum level of motivation to perform their jobs) and/or where extremely high levels of motivation may not be present over longer periods. Similarly, laboratory studies are less likely to include variables with nonoptimal distributions (e.g., low variance in measures of performance), which can lower the size of the parameter estimate for the interaction effect and statistical power to detect it (Aguinis, Edwards, & Bradley, in press). In sum, we hypothesize the following:

Hypothesis 2: The multiplicative effects of ability and motivation on performance will be stronger in laboratory studies than in field studies.

Study setting also may serve as a boundary condition for the relative importance of ability versus motivation. Laboratory studies typically are short-term and focus more on maximal performance than on typical performance. This is relevant because ability tends to be a better predictor of maximal performance, whereas noncognitive variables tend to be better predictors of typical performance (e.g., Beus & Whitman, 2012; DuBois, Sackett, Zedeck, & Fogli, 1993). Similarly, criteria in training studies (e.g., training test scores) tend to assess knowledge acquisition, of which ability is a key antecedent (e.g., F. L. Schmidt et al., 1986). In contrast, motivation may be more constrained (i.e., to be relatively high) in laboratory and training settings. For example, many training contexts (e.g., new hire training) may represent strong situations (Mischel, 1973), such that trainees tend to be highly motivated to learn job-relevant knowledge and skills. This, in turn, may constrain variability in motivation and attenuate relations between motivation and performance. Thus, we propose the following hypothesis:

Hypothesis 3: Ability will be more important than motivation to training performance and to performance in laboratory studies designed to simulate job performance.

The relative importance of ability and motivation to job performance seems less certain. Previous research suggests that general mental ability is one of the best predictors of job performance, particularly task performance (F. L. Schmidt & Hunter, 1998). At the same time, motivation is thought to be a key determinant of performance (e.g., Campbell, McCloy, Oppler, & Sager, 1993), and certain motivation-related variables (e.g., goal setting, incentives) have been found to demonstrate moderate to strong relations with performance (e.g., Guzzo, Jette, & Katzell, 1985; Locke, Feren, McCaleb, Shaw, & Denny, 1980; Tubbs, 1986). Furthermore, in contrast to laboratory and training studies, job performance studies tend to use measures that focus more on typical performance, of which motivation may be a better predictor than ability. Therefore, we explore the following research question:

Research Question 2: Is ability or motivation more important to job performance?

Operationalization of performance. We also examined whether the manner in which the criterion is operationalized influences conclusions regarding the effects of ability and motivation on performance. Specifically, we expected that ability will be relatively more important than motivation when performance is measured objectively, whereas motivation will be more important when performance is measured subjectively. This expectation was based on two factors. First, construct relations tend to be stronger when measures are aligned on factors such as type and specificity of measurement (e.g., Hogan & Holland, 2003). Therefore, it is possible that ability—an objectively measured predictor—will better predict objective performance measures, whereas motivation—a subjectively measured predictor—will better predict subjective performance measures. Second, objective performance measures (e.g., sales) tend to focus on task-related performance and, as noted, ability is thought to be a strong predictor of task performance. In contrast, subjective performance measures (e.g., supervisor ratings) tend to assess task performance, as well as nontask factors such as citizenship behaviors and counterproductive work behavior (CWB; Rotundo & Sackett, 2002). This is noteworthy because motivation-related variables are thought to predict nontask factors that often are considered in subjective performance measures. This leads us to hypothesize the following:

> *Hypothesis 4:* Ability will be more important than motivation when performance is measured objectively, whereas motivation will be more important than ability when performance is measured subjectively.

Additional factors. In addition to the aforementioned boundary conditions for which we had specific hypotheses or research questions, we explored six other variables that could affect support for the multiplicative model. We examined these particular variables given past theoretical and empirical interest in each of them.

First, studies with statistically significant findings are, in some situations, more likely to be published than studies whose results are not significant (e.g., Dalton, Aguinis, Dalton, Bosco, & Pierce, 2012). Although most of the studies in our meta-analysis did not focus on the multiplicative model, we explored whether support for this model differed between published and unpublished studies. Second, type of organization (i.e., civilian vs. military) is a commonly reported potential moderator in meta-analyses, and we examined the possible influence of this variable as well. For example, perhaps the structured environment of military organizations constrains the influence of individual differences (and their interactions) on performance.

Third, as discussed, many studies do not have sufficient sample sizes (and, in turn, statistical power) to detect interaction effects (Aguinis et al., in press; Murphy & Russell, in press). Thus, we also explore the influence of study sample size on support for the multiplicative model. Fourth, ability-motivation interactions could be stronger for more complex jobs or tasks (Sackett et al., 1998; Terborg, 1977). In these situations, individual differences in ability are likely to have a large effect on performance; thus, employees' motivation to deploy their abilities may be particularly important. Therefore, we explore the potential role of job complexity.

Fifth, as noted, prior research suggests that ability tends to be a better predictor of task performance, whereas noncognitive variables tend to be better predictors of other dimensions of performance, such as contextual performance and CWB (e.g., Hattrup, O'Connell, & Wingate, 1998; LePine & Van Dyne, 2001; Mount, Oh, & Burns, 2008). We therefore explore whether support for the multiplicative model varies based on whether the criterion reflects task versus contextual performance. Finally, when two variables have strong bivariate or additive effects on an outcome, there may not be much "room" for the interaction between the variables to explain additional variance in the outcome (e.g., Murphy & Russell, in press). For this reason, we also explore whether relations between ability and performance and between motivation and performance affect the strength of the ability-motivation interaction on performance.

Method

Literature Search

We began by searching online and electronic databases, including ABI/INFORM Collection, Academic Source Complete, Business Source Complete, Education Resources Information Center (ERIC), Google Scholar, JSTOR, ProQuest Dissertations & Theses, PsycINFO, and Web of Science, for studies that included measures of ability, motivation, and performance. We used many combinations of key terms in an attempt to be as comprehensive as possible. For ability, we used the following search terms: *ability*, *aptitude*, *cognitive ability*, *competence, GMA* (i.e., general mental ability), *intelligence*, *IQ*, and *mental ability*. For motivation, we used the following terms: *achievement* (to capture *achievement striving, need for achievement*, and related terms), *attentional focus/resources*, *diligence*, *effort*, *goal* (to capture *goals*, *goal setting*, *goal commitment*, and related terms), *hard work, intensity, mental effort/workload*, *motivation*, *on-task/off-task thoughts*, *persist/persistence*, *time spent*, *work ethic*, and *work orientation*. For performance, we used the following terms: *absence/absent, citizenship*, *contextual performance*, *counterproductive work behavior* (and *CWB*), *deviance*, *effectiveness*, *extra-role* (and *extra role* and *extrarole*), *lateness*, *organizational citizenship behavior* (and *OCB*), *performance*, *productivity*, *prosocial behavior*, *sales*, *supervisor ratings*, *tardiness*, *training*, and *withdrawal*.

In addition, we searched for studies that included particular measures of ability (e.g., Wonderlic Personnel Test; Wonderlic Associates, 1999), motivation (e.g., Kanfer, Ackerman, Murtha, Dugdale, & Nelson, 1994), or performance (e.g., Williams & Anderson, 1991). Finally, we reviewed the references sections of the studies we obtained to identify additional sources. Our searches yielded over 3,000 studies to review for possible inclusion in the meta-analysis.

Inclusion Criteria

We used nine criteria to determine whether to include the identified studies in the meta-analysis. We summarize the criteria below and provide further details about them online in Appendix A of the supplemental file. First, we included only studies that measured ability, motivation, *and* performance because we needed data on all three variables to create and test the ability-motivation interaction (as well as to directly compare the relative importance of ability and motivation). Second, we included only studies conducted (a) in field settings in which the criteria reflected job or training performance or (b) in laboratory settings designed to simulate job or training performance. Third, we included only studies that examined relations among ability, motivation, and performance at the individual level of analysis. Fourth, we included only studies in which the results were based on the full range of participants in the sample. We excluded studies in which the variance in the predictors, criteria, or both was intentionally enhanced. Fifth, we included only independent samples, and we used the method described by Wood (2008) to identify (and exclude) studies in which a sample appeared to overlap with a sample from another article authored by the same researchers. When possible, we tried to confirm apparent instances of sample overlap with the study authors.

Sixth, we included only studies that measured ability using objective tests that assessed one or more types of cognitive abilities, such as quantitative, verbal, or spatial ability. Seventh, consistent with how we defined work motivation, we included only motivation measures that assessed the tendency to demonstrate work effort (i.e., trait motivation) or the amount of effort devoted to a particular task (i.e., state motivation). Trait motivation was assessed by measures such as achievement motivation and work drive. Some researchers have suggested that conscientiousness captures overall motivation tendencies (e.g., Chen et al., 2000; Diefendorff & Chandler, 2011; F. L. Schmidt & Hunter, 1992). However, conscientiousness is a broad, multifaceted construct, and some of its subfacets (achievement striving in particular) are more closely linked to motivation and effort than other subfacets (e.g., dependability, order). Therefore, we did not include conscientiousness as a proxy for trait motivation. Studies assessed state motivation using measures such as task-specific effort, amount of time spent on a task (e.g., time spent studying training materials), and goals.

Eighth, we included studies in which the performance measure(s) reflected one or more of the following: task performance, contextual performance, CWB, or overall performance. Furthermore, we included only studies that measured job performance using supervisor ratings, peer ratings, or some objective criterion (e.g., sales). The one exception is that, consistent with previous meta-analyses (e.g., Gonzalez-Mulé, Mount, & Oh, 2014), our meta-analysis included self-reports of CWB. For studies that measured training performance, the criteria reflected exam scores, grades, or instructor ratings. Also, for laboratory studies, performance was measured with scores on simulated work tasks or by observer ratings of performance. Finally, we included only studies for which we or the original authors (see below) could estimate effects for a model that included ability, motivation, and the interaction between the two as predictors of performance without any other variables in the model (e.g., statistical controls).

We found 57 studies that appeared to meet all the criteria. However, none of the studies included all the statistics needed for the meta-analysis, especially correlations between the ability-motivation product term and the other variables. Therefore, we had to attempt to locate and contact the authors of every study to request the relevant results or the raw data so that we could perform the analyses. We located contact information for authors of 56 studies, and 48 (85.7%) responded to our request for data. Of the authors who responded, 33 sent us the raw data, or they ran the analyses using IBM SPSS syntax we provided and sent us the output (we provide this syntax in Appendix B in the online supplemental file). Of the authors who did not provide us data, most indicated that they no longer had the data or could not locate them. A few authors indicated that they could not make time to look for the data or that they did not want to share their data.

The data collection process yielded 56 independent samples, which comprised 39 journal articles, 16 dissertations and theses, and 1 conference paper. Two of the authors independently coded 50% of the studies. Before analyzing the data, we determined the percentage of times the two coders recorded the same sample size, reliability estimates, correlations, and regression coefficients. The level of rater agreement ranged from 98.3% to 100% across the coded variables. Considering the high level of intercoder agreement, the first author coded the remaining primary studies.[1]

Data-Analytic Approach

We used Hunter and Schmidt's (2004) psychometric meta-analysis procedures to analyze the data. We provide an overview of the analyses below and describe further details in

Appendix C of the online supplemental file. First, we recorded zero-order correlations among ability, motivation, and performance. To estimate the multiplicative model, we also needed correlations between the ability-motivation product term and the other variables. Although correlations for the product term were not reported in any of the original primary studies, we obtained them (or the raw data to compute the correlations) from many of the original authors. For these studies, we (or the original authors) standardized scores for the ability and motivation measures and computed a new variable that reflected the product of the two components. We then recorded the zero-order correlations between the product term and ability, motivation, and performance.

Second, we computed composite variables for primary studies that included multiple measures of ability, motivation, and/or performance. Third, because we were interested primarily in relations at the construct level and not at the measure level (Hunter & Schmidt, 2004; Le, Schmidt, & Putka, 2009), we corrected the observed correlations for measurement error in all the variables. We also report relations corrected for both measurement error and range restriction. Fourth, we used the observed and corrected correlations among ability, motivation, and performance to estimate the additive effects of ability and motivation on performance. This analysis yielded observed and corrected *R*s and standardized regression coefficients for each study. We used the same observed and corrected correlations, plus the correlations involving the ability-motivation product term, to estimate the multiplicative effects of ability and motivation.

Fifth, we computed relative weight statistics (*RW*s) for both the multiplicative and additive model. Relative weight analysis (Johnson, 2000) assesses the contribution each predictor makes to the regression model, considering each predictor's individual effect and its effect when combined with the other predictors (LeBreton, Hargis, Griepentrog, Oswald, & Ployhart, 2007). The resulting relative weights indicate the percentage of variance in the criterion each predictor explains. These analyses were ideally suited for our purposes because they focus on effect sizes and, thus, minimize concerns about low or differential levels of statistical power across the primary studies. Finally, we conducted a simple slopes analysis for each study to interpret the nature of any ability-motivation interactions we might find.

Each of the above sets of results is based on different sets of primary studies. First, zero-order correlations among ability, motivation, and performance, as well as the additive and relative effects of ability and motivation on performance, are based on 55 independent samples (N = 11,283).[2] Second, tests of the interactive effects of ability and motivation are based on 40 samples (N = 8,507) for which we had information concerning the multiplicative model. Third, the simple slopes analyses are based on 39 samples (N = 7,499) for which the primary authors shared the raw data needed to conduct these analyses.

Results

Correlations Among Ability, Motivation, and Performance

Zero-order correlations among the variables are shown in Table 1. For this and subsequent tables, we report observed estimates, estimates corrected for measurement error, and estimates corrected for measurement error and range restriction. When discussing the results, we focus on the last set of estimates (which we refer to as the "corrected" estimates). The first line shows results based on data from all the primary studies combined (i.e., "Overall"). The mean

Table 1

Meta-Analytic Estimates of Correlations Among Ability, Motivation, and Performance

			Ability and motivation					Ability and performance					Motivation and performance				
Analysis	k	N	r	ρ_1	ρ_2	95% CI	$SD_{\rho 2}$	r	ρ_1	ρ_2	95% CI	$SD_{\rho 2}$	r	ρ_1	ρ_2	95% CI	$SD_{\rho 2}$
Overall	55	11,283	.04	.05	.07	.03, .11	.13	.26	.33	.44	.38, .50	.22	.21	.29	.29	.24, .35	.19
Motivation construct																	
Trait motivation	39	7,779	.02	.03	.04	.00, .08	.11	.22	.30	.39	.32, .47	.24	.15	.23	.23	.17, .47	.19
State motivation	19	4,303	.07	.08	.12	.05, .19	.15	.34	.40	.55	.47, .61	.14	.30	.37	.37	.30, .44	.15
Performance context																	
Job performance	28	4,718	.03	.04	.06	.01, .12	.13	.18	.26	.31	.23, .40	.23	.21	.33	.33	.26, .40	.17
Training performance	15	3,720	.01	.01	.02	–.03, .07	.07	.27	.33	.45	.35, .55	.20	.11	.15	.15	.09, .21	.09
Laboratory study performance	17	3,602	.07	.08	.12	.04, .20	.16	.37	.44	.59	.53, .64	.11	.30	.36	.37	.27, .47	.20
Performance measure																	
Subjective	32	5,520	.02	.03	.04	–.02, .09	.13	.17	.25	.32	.23, .40	.24	.20	.31	.31	.24, .37	.17
Objective	29	6,810	.05	.06	.09	.03, .14	.14	.33	.38	.51	.45, .58	.17	.21	.26	.26	.19, .34	.19
Publication status																	
Published	38	7,842	.04	.05	.07	.02, .12	.13	.25	.32	.42	.34, .50	.24	.19	.27	.27	.21, .34	.18
Unpublished	17	3,443	.04	.04	.07	–.01, .14	.14	.29	.37	.48	.39, .57	.18	.27	.35	.34	.25, .44	.19
Type of organization																	
Civilian	31	5,340	.02	.03	.04	–.11, .18	.11	.24	.31	.40	.31, .49	.25	.16	.23	.23	.17, .29	.16
Military	7	2,341	.03	.04	.06	–.03, .14	.10	.16	.21	.31	.17, .44	.18	.22	.33	.33	.20, .46	.17
Performance dimension																	
Task performance	8	1,364	.02	.03	.05	–.04, .15	.11	.12	.17	.18	.01, .35	.23	.18	.26	.25	.18, .33	.08
Contextual performance	5	1,067	.01	.01	.02	–.09, .13	.11	.13	.19	.23	.05, .40	.19	.21	.32	.32	.21, .44	.12

Note: k = number of correlations from independent samples; N = total number of participants across samples; r = sample size–weighted mean observed correlation; ρ_1 = correlation corrected for measurement error in the predictor and criterion; ρ_2 = correlation corrected for range restriction in the predictor and measurement error in the predictor and criterion; 95% CI = lower and upper bounds of the 95% confidence interval for ρ_2; $SD_{\rho 2}$ = standard deviation of ρ_2.

corrected correlation between ability and motivation was .07, the mean corrected correlation between ability and performance was .44, and the mean corrected correlation between motivation and performance was .29. These results suggest that (a) ability and motivation are independent of one another and (b) both variables were related to performance.

Tests of the Multiplicative Model

We assessed support for the multiplicative model in four ways. First, we examined the change in R between the additive model and the multiplicative model. We focused on R, rather than on R^2, so readers can more easily compare the effects to those typically reported in the literature (e.g., Bosco, Aguinis, Singh, Field, & Pierce, 2015). Second, we examined the relative importance of ability, motivation, and the ability-motivation interaction to performance.

Table 2 displays results for the first two sets of analyses. The overall corrected change in R from the additive model to the multiplicative model was .02. Thus, inclusion of the ability-motivation interaction resulted in only a slight increase in the prediction of performance beyond the additive effects of ability and motivation. As shown on the first row and last three columns of Table 2, the overall corrected relative weight percentages for ability, motivation, and the ability-motivation interaction were 60.1%, 30.5%, and 9.4%, respectively. Thus, the additive effects of ability and motivation accounted for about 91% of the explained variance in job performance, whereas the ability-motivation interaction accounted for only about 9% of the explained variance.

The third way we assessed support for the multiplicative model was to compute simple slopes for the ability-performance relationship across different levels of motivation. Results of the simple slopes analyses are shown in Table 3. We conducted these analyses using the SPSS macros developed by O'Connor (1998) that estimate the direction and strength of the relation between ability and performance at three levels of motivation: 1 *SD* below the mean, the mean, and 1 *SD* above the mean. Because these analyses are based on raw data, results reflect the observed (i.e., uncorrected) relations among the variables. Overall, relations between ability and performance tended to increase slightly as motivation increased from low (.22) to moderate (.24) to high (.25). This small, positive trend was fairly consistent across the different sets of analyses.

Finally, as an additional way to interpret the results, we examined the strength and direction of the multiplicative effect in one other way. Specifically, there were 67 individual analyses with available data to calculate the simple slopes (i.e., some of the 39 independent samples included multiple motivation measures and/or criterion measures). In 23 cases (34.3%), the change in slopes (i.e., from low motivation to high motivation) was positive and .10 or higher in magnitude. In 27 cases (40.3%), the change in slopes was trivial, that is, between .00 and +/–.09. And in 17 cases (25.4%), the change in slopes was negative and –.10 or lower in magnitude. These findings are consistent with earlier results and suggest that, in most cases, the ability-motivation interaction was very small. Furthermore, when the interaction was larger, in some cases it was positive (i.e., the ability-performance relation increased as motivation increased) and in some cases it was negative (i.e., the ability-performance relation decreased as motivation increased).

Table 2

Meta-Analytic Estimates of the Additive and Multiplicative Effects of Ability and Motivation on Performance

			Observed estimates						Estimates corrected for measurement error						Estimates corrected for measurement error and range restriction					
Analysis	k	N	R_1	R_2	ΔR	RW_A	RW_M	RW_I	R_1	R_2	ΔR	RW_A	RW_M	RW_I	R_1	R_2	ΔR	RW_A	RW_M	RW_I
Overall	40	8,507	.37	.38	.01	54.0	36.7	9.3	.48	.50	.02	51.7	37.7	10.6	.56	.58	.02	60.1	30.5	9.4
Motivation construct																				
Trait motivation	30	5,767	.30	.32	.02	58.4	29.6	12.0	.42	.45	.03	55.9	30.3	13.8	.51	.54	.03	61.0	27.1	11.9
State motivation	13	3,539	.44	.45	.01	56.1	40.3	3.7	.54	.54	.00	54.4	41.5	4.1	.63	.64	.01	66.9	29.3	3.7
Performance context																				
Job performance	19	2,964	.30	.32	.02	32.5	50.3	17.2	.44	.49	.05	29.7	51.2	19.1	.48	.52	.04	36.1	46.9	17.0
Training performance	13	3,256	.31	.32	.01	72.1	17.7	10.2	.39	.41	.02	70.0	18.2	11.8	.50	.52	.02	76.5	13.2	10.3
Laboratory performance	13	3,044	.48	.48	.00	59.5	38.5	2.0	.58	.59	.01	57.6	40.0	2.5	.68	.68	.00	69.0	28.7	2.3
Performance measure																				
Subjective	23	3,701	.29	.31	.02	32.8	49.6	17.6	.43	.48	.05	29.7	50.7	19.6	.48	.52	.04	36.4	45.7	17.9
Objective	22	5,762	.40	.41	.01	68.0	27.5	4.5	.48	.49	.01	66.3	28.5	5.2	.58	.59	.01	75.6	19.9	4.5
Publication status																				
Published	29	6,219	.33	.35	.02	55.0	32.7	12.4	.45	.48	.03	52.2	33.8	14.0	.53	.56	.03	58.8	29.0	12.2
Unpublished	11	2,288	.45	.45	.00	51.2	47.7	1.1	.57	.57	.00	50.5	48.3	1.3	.65	.65	.00	63.6	34.4	2.0
Type of organization																				
Civilian	22	2,876	.30	.33	.03	42.6	36.3	21.0	.45	.51	.06	38.9	37.2	24.0	.50	.55	.05	45.5	33.1	21.5
Military	4	1,579	.28	.28	.00	36.3	55.8	7.8	.38	.39	.01	34.9	56.7	8.4	.44	.45	.01	45.2	47.8	7.0
Performance dimension																				
Task performance	5	700	.23	.26	.03	29.3	42.7	28.0	.33	.39	.05	26.5	43.2	30.4	.35	.41	.06	37.9	34.5	27.6
Contextual performance	4	609	.25	.26	.02	28.0	59.4	12.6	.38	.41	.03	26.9	59.3	13.8	.43	.48	.05	37.3	48.5	14.2

Note: Some of the ΔR values are .01 larger or smaller than the differences between R_1 and R_2 because of rounding. Similarly, some of the RW values do not sum to exactly 100 due to rounding. k = number of correlations from independent samples; N = total number of participants across samples; R_1 = sample size–weighted mean multiple correlation for the additive model; R_2 = sample size–weighted mean multiple correlation for the multiplicative model; ΔR = change in R from the additive model to the multiplicative model; RW_A = sample size–weighted mean relative weight for ability, expressed as the percentage of explained variance in performance for which ability accounts; RW_M = sample size–weighted mean relative weight for motivation; RW_I = sample size–weighted mean relative weight for the ability-motivation interaction.

Table 3
Sample Size–Weighted Mean Standardized Simple Slopes for Ability-Performance Relations at Different Levels of Motivation

			–1 *SD*		*M*		+1 *SD*	
Analysis	*k*	*N*	Slope	95% CI	Slope	95% CI	Slope	95% CI
Overall	39	7,499	0.22	0.16, 0.28	0.24	0.19, 0.29	0.25	0.19, 0.30
Motivation construct								
Trait motivation	29	4,759	0.17	0.09, 0.24	0.18	0.12, 0.24	0.19	0.13, 0.26
State motivation	13	3,539	0.31	0.23, 0.39	0.31	0.25, 0.37	0.32	0.26, 0.37
Performance context								
Job performance	19	2,964	0.12	0.03, 0.21	0.14	0.07, 0.21	0.15	0.07, 0.24
Training performance	12	2,248	0.22	0.12, 0.32	0.24	0.16, 0.40	0.26	0.18, 0.35
Laboratory study performance	13	3,044	0.34	0.28, 0.41	0.34	0.29, 0.39	0.34	0.28, 0.39
Performance measure								
Subjective	23	3,701	0.12	0.04, 0.20	0.14	0.08, 0.20	0.16	0.08, 0.24
Objective	21	4,754	0.30	0.22, 0.37	0.30	0.24, 0.36	0.31	0.26, 0.36
Publication status								
Published	28	5,211	0.20	0.12, 0.27	0.21	0.02, 0.40	0.23	0.01, 0.44
Unpublished	11	2,288	0.28	0.20, 0.36	0.29	0.21, 0.37	0.30	0.21, 0.39
Type of organization								
Civilian	22	2,876	0.15	0.05, 0.24	0.19	0.11, 0.26	0.22	0.13, 0.31
Military	4	1,579	0.13	0.01, 0.25	0.13	0.02, 0.23	0.12	0.01, 0.24
Performance dimension								
Task performance	5	700	0.02	–0.21, 0.25	0.07	–0.12, 0.25	0.12	–0.05, 0.29
Contextual performance	4	609	–0.01	–0.10, 0.09	0.04	–0.04, 0.13	0.10	–0.06, 0.26

Note: *k* = number of correlations from independent samples; *N* = total number of participants across samples; 95% CI = lower and upper bounds of the 95% confidence interval. Simple slopes reflect (uncorrected) standardized regression coefficients for ability and performance at low (–1 *SD*), moderate (mean), and high (+1 *SD*) levels of motivation.

In sum, evidence from these analyses converges to suggest a lack of support for the multiplicative model. The ability-motivation interaction provided little incremental prediction beyond the additive effects of ability and motivation and accounted for only a small percentage of the explained variance in performance. Moreover, when there was an interaction, sometimes it reflected the predicted form (i.e., a stronger ability-performance relation when motivation is higher) and sometimes it did not.

Boundary Conditions of Multiplicative and Relative Effects

Conceptualization of motivation. Research Question 1 asked whether the way motivation is conceptualized—as a trait or as a state—would affect the strength of the multiplicative effects of ability and motivation on performance. Table 2 shows that the mean corrected relative weight percentage for the ability-motivation interaction was 11.9% for measures of trait motivation and 3.7% for measures of state motivation. This suggests that evidence of an ability-motivation interaction was somewhat stronger when motivation was conceptualized as a trait than when it was conceptualized as a state. However, in both cases, the multiplicative effect was small.

Hypothesis 1 predicted that state motivation would be relatively more important to performance compared to trait motivation. Mean corrected correlations for trait and state measures and performance were .23 versus .37, respectively (see Table 1). This provides support for Hypothesis 1 and suggests that statelike motivation measures are better predictors of performance than traitlike measures.

Study setting. Hypothesis 2 predicted that the multiplicative effects of ability and motivation on performance would be stronger in laboratory settings compared to field settings. Results in Table 2 suggest an opposite pattern. Specifically, the overall corrected relative weight for the ability-motivation interaction was larger for job performance (17.0%) and training performance (10.3%) than for laboratory study performance (2.3%). Thus, Hypothesis 2 was not supported.

Hypothesis 3 predicted that ability would be relatively more important than motivation to performance during training, as well as in laboratory studies designed to simulate work tasks. Table 4 provides estimates of the additive and relative effects of ability and motivation on performance. We found that ability was indeed a much stronger predictor than motivation of both training performance (corrected *RW*s = 83.0% vs. 17.0%) and laboratory study performance (corrected *RW*s = 70.8% vs. 29.2%). Thus, Hypothesis 3 was supported.

Research Question 2 addressed whether ability or motivation would be relatively more important to job performance. Interestingly, the results reported in Table 4 revealed that ability and motivation contributed equally to the explained variance in job performance (both *RW*s = 50.0%). This suggests that the two variables are similarly important to how well employees perform their jobs.

Operationalization of performance. Hypothesis 4 predicted that ability would be more important when performance is measured objectively, whereas motivation would be more important when performance is measured subjectively. Table 4 shows that ability was indeed a better predictor of objective performance measures (corrected *RW*s = 77.7% for ability vs. 22.3% for motivation). In contrast, ability and motivation contributed about equally to the variance explained in subjective performance measures (both corrected *RW*s = 50.0%). These results provide partial support for Hypothesis 4 and suggest that the relative importance of ability versus motivation depends on how job performance is measured.

One complicating factor is that study setting and performance measure covaried in our data set. Specifically, job performance studies tended to measure performance subjectively (e.g., using supervisor ratings), whereas laboratory studies tended to measure performance objectively (e.g., with scores on simulated job tasks). Training performance studies used a mix of subjective and objective criterion measures.

To explore the relative influence of study setting and performance measure on the size of the ability-performance relation, we conducted a weighted least squares (WLS) multiple regression analysis (Steel & Kammeyer-Mueller, 2002) with performance context (job vs. training vs. lab) and performance measure (objective vs. subjective) as independent variables and ability-performance correlations as the dependent variable. To represent the three performance contexts, we created two dummy variables: one for job performance (coded as 1) versus training and laboratory study performance (coded as 0) and another for laboratory performance (coded as 1) versus job and training performance (coded as 0). In addition, we

Table 4

Meta-Analytic Estimates of the Additive and Relative Effects of Ability and Motivation on Performance

	Additive effects				Relative effects of ability							Relative effects of motivation						
Analysis	R	R_{c1}	R_{c2}	$SD\ R_{c2}$	β	RW	β_{c1}	RW_1	β_{c2}	$SD\ \beta_{c2}$	RW_2	β	RW	β_{c1}	RW_1	β_{c2}	$SD\ \beta_{c2}$	RW_2
Overall	.36	.48	.56	.17	0.25	58.1	.32	56.2	.41	.22	65.1	0.20	41.9	.28	43.8	.26	.16	34.9
Motivation construct																		
Trait motivation	.30	.43	.51	.16	0.22	62.3	.29	60.8	.38	.23	66.7	0.14	37.7	.22	39.2	.21	.17	33.3
State motivation	.45	.54	.63	.15	0.32	58.1	.37	55.8	.50	.14	68.5	0.27	41.9	.33	44.2	.31	.13	31.5
Performance context																		
Job performance	.30	.45	.49	.16	0.17	44.3	.24	42.2	.29	.21	50.0	0.20	55.7	.31	57.8	.30	.16	50.0
Training performance	.31	.38	.49	.16	0.27	78.3	.33	76.3	.45	.19	83.0	0.11	21.7	.15	23.7	.14	.07	17.0
Laboratory performance	.48	.58	.68	.12	0.34	60.9	.41	59.4	.54	.12	70.8	0.26	39.1	.33	40.6	.31	.17	29.2
Performance measure																		
Subjective	.30	.46	.49	.16	0.17	44.6	.24	42.5	.30	.20	50.0	0.20	55.4	.31	57.5	.30	.16	50.0
Objective	.41	.48	.59	.16	0.31	69.7	.37	67.8	.49	.17	77.7	0.19	30.3	.24	32.2	.22	.15	22.3
Publication status																		
Published	.34	.46	.54	.16	0.24	58.1	.30	56.1	.40	.23	64.2	0.17	41.9	.25	43.9	.24	.15	35.8
Unpublished	.41	.52	.60	.19	0.28	58.2	.35	56.3	.46	.18	67.1	0.25	41.8	.34	43.7	.31	.16	32.9
Type of organization																		
Civilian	.31	.44	.51	.17	0.23	63.1	.31	61.4	.39	.24	67.5	0.15	36.9	.22	38.6	.21	.14	32.5
Military	.29	.41	.47	.15	0.15	42.6	.19	39.4	.28	.16	50.9	0.21	57.4	.32	60.6	.31	.15	49.1
Performance dimension																		
Task performance	.25	.35	.37	.13	0.12	44.5	.16	42.3	.16	.24	53.3	0.18	55.5	.26	57.7	.25	.07	46.7
Contextual performance	.26	.41	.44	.11	0.12	40.6	.18	39.1	.21	.19	46.9	0.20	59.4	.32	60.9	.31	.12	53.1

Note: See Table 1 for k and N for each set of estimates. R = sample size–weighted mean multiple correlation; R_{c1} = sample size–weighted mean multiple correlation corrected for measurement error in all the variables; R_{c2} = sample size–weighted mean multiple correlation corrected for range restriction in the predictors and measurement error in all the variables; $SD\ R_{c2}$ = standard deviation of R_{c2}; β = sample size–weighted mean standardized regression coefficient; β_{c1} = sample size–weighted mean standardized regression coefficient correlation corrected for measurement error in predictor and criterion variables; $SD\ \beta_{c1}$ = standardized deviation of β_{c1}; β_{c2} = sample size–weighted mean standardized regression coefficient correlation corrected for range restriction in the predictor and measurement error in the predictor and criterion; $SD\ \beta_{c2}$ = standardized deviation of β_{c2}; RW = sample size–weighted mean relative weight expressed as the percentage of explained variance in performance for which the predictor (ability or motivation) accounts; RW_1 = sample size–weighted mean relative weight based on correlations corrected for measurement error in the predictor and criterion; RW_2 = sample size–weighted mean relative weight based on correlations corrected for range restriction in the predictor and measurement error in the predictor and criterion.

weighted each study by the inverse of the sampling error variance, such that studies with less sampling error received greater weight than studies with more sampling error (Hedges & Olkin, 1985; Steel & Kammeyer-Mueller, 2002).

Interestingly, results revealed that the dummy code representing the two types of performance measure was significant ($\beta = 0.52$, $p = .02$), whereas the performance context dummy codes were not ($\beta = -0.08$ and -0.02, both $p > .05$). This suggests that relations between ability and performance were stronger when performance was measured objectively, regardless of the performance context (e.g., on the job vs. during training). We then conducted this same analysis using motivation-performance correlations as the dependent variable. We found the opposite pattern of results this time, such that performance context (i.e., laboratory performance vs. job and training performance) was significant ($\beta = 0.50$, $p < .01$), whereas performance measure was not ($\beta = -0.03$, $p = .90$). Job performance versus training and laboratory performance also was nonsignificant ($\beta = 0.30$, $p = .20$). In other words, relations between motivation and performance were stronger in laboratory settings than in job and training settings, regardless of whether performance was measured objectively or subjectively.

Additional factors. In these analyses, we explored additional factors that might affect support for the multiplicative model. Table 2 displays results for the categorical factors (and Table 3 presents the corresponding simple slopes results). Regarding publication status, the corrected relative weight for the ability-motivation interaction was 12.2% among published studies and 2.0% among unpublished studies. This suggests a tendency for published studies to find stronger support for the multiplicative model, although even in published studies, support for the model was quite weak. We discovered a similar trend for type of organization, such that the interaction effect was stronger among studies conducted in civilian organizations (RW = 21.5%) compared to military organizations (RW = 7.0%). However, we caution that only four military samples were available for this analysis. Regarding performance dimension, the strongest support for the multiplicative model (across all the analyses we conducted) came from several studies in which the criterion reflected task performance (RW = 27.6%). In contrast, the multiplicative model explained less variance when the criterion reflected contextual performance (RW = 14.2%).[3]

The other three factors are continuous, so we calculated zero-order correlations between these factors and the corrected relative weights for the ability-motivation interaction (please note that the correlations in this paragraph are not reported in any of the tables). The correlation for study sample size was –.27 ($p = .07$). This suggests that the interactive effect was stronger in smaller samples than in larger samples. To measure job complexity, we used O*NET data regarding two generalized work activities (processing information and analyzing data or information) that reflect the description of job complexity provided by Morgeson and Humphrey (2006). For each job, we recorded scores for these two variables and then averaged the scores to create a measure of job complexity ($\alpha = .87$). The correlation for job complexity was .06 ($p = .80$), which indicates that the complexity of the job did not affect support for the multiplicative model. The last analysis explored whether relations between ability and performance and between motivation and performance affected the strength of the ability-motivation interaction on performance. The ability-performance relation correlated –.47 ($p < .01$) with the interaction effect, and the motivation-performance relation correlated

Table 5
Correlations Between Boundary Condition Variables and the Ability-Motivation Interaction

Variable	1	2	3	4	5	6	7
1. Corrected relative weight for ability-motivation interaction							
2. Publication status	.36**						
3. Study setting	–.43**	–.50**					
4. Sample size	–.42**	.02	–.01				
5. Motivation construct	–.35**	–.48**	.57**	.11			
6. Performance measure	–.55**	–.46**	.57**	.46**	.60**		
7. Ability-performance correlation	–.68**	–.34**	.46**	.36**	.41**	.60**	
8. Motivation-performance correlation	–.32*	–.19†	.22†	–.08	.43**	–.06	.19

Note: Ns ranged from 46 to 49 independent samples. Publication status was coded 0 = unpublished study and 1 = published study. Study setting was coded 0 = field setting and 1 = laboratory setting. Motivation construct was coded 0 = trait motivation and 1 = state motivation. Performance measure was coded 0 = subjective measure and 1 = objective measure.
†$p < .10$.
*$p < .05$.
**$p < .01$.

–.21 ($p = .14$) with the interaction effect. These results suggest that support for the multiplicative model was stronger when the relation between ability and performance was weaker.

Multivariate analyses of boundary conditions. Finally, we conducted a WLS regression analysis to explore the relative influence of all the potential boundary conditions. In this analysis, the cases were the independent samples for which we had data for the multiplicative model. The dependent variable was the corrected relative weight for the ability-motivation interaction for each study.[4] The independent variables included the following binary-coded (0 vs. 1) variables: publication status (published vs. unpublished), study setting (field vs. laboratory), motivation construct (trait vs. state), and performance measure (subjective vs. objective). The model also included three continuous independent variables: sample size, the corrected correlation between ability and performance, and the corrected correlation between motivation and performance.[5]

Tables 5 and 6 present correlations among the variables and WLS regression results, respectively. It is interesting that all of the primary study characteristics correlated significantly with the ability-motivation interaction. Specifically, the interaction was stronger when the study was published, when the study was conducted in a field setting, when the sample size was smaller, when trait motivation was measured, when performance was measured subjectively, and when ability-performance and motivation-performance relations were weaker. The WLS regression model with these variables as predictors of the ability-motivation interaction was significant ($F_{7, 45} = 8.55$, $p < .001$, adjusted $R^2 = .54$). Three variables remained significant when variance due to the other variables was controlled within this analysis: sample size ($b = -0.22$, $p = .09$), the ability-performance correlation ($b = -0.39$, $p = .01$), and the motivation-performance correlation ($b = -0.34$, $p = .02$). We also conducted

Table 6
Weighted Least Squares Regression Results for Boundary Conditions as Predictors of the Ability-Motivation Interaction

Predictor	*b*	*SE*	β	*t*	*RW* (%)
Publication status	7.42	8.56	0.11	0.87	6.73
Study setting	–7.80	9.15	–0.12	–0.85	9.54
Sample size	–0.03	0.02	–0.22	–1.71†	16.23
Motivation construct	16.55	10.76	0.25	1.54	3.62
Performance measure	–15.12	11.85	–0.26	–1.28	15.96
Ability-performance correlation	–42.09	14.52	–0.39	–2.90**	35.13
Motivation-performance correlation	–52.32	20.57	–0.34	–2.54*	12.79

*Note: N*s ranged from 46 to 49 independent samples. Publication status was coded 0 = unpublished study and 1 = published study. Study setting was coded 0 = field setting and 1 = laboratory setting. Motivation construct was coded 0 = trait motivation and 1 = state motivation. Performance measure was coded 0 = subjective measure and 1 = objective measure. Analyses are based on a random-effects model. *b* = unstandardized regression coefficient; *SE* = standard error; β = standardized regression coefficient; *t* = *t* statistic; *RW* = relative weight.
†$p < .10$.
*$p < .05$.
**$p < .01$.

a relative weight analysis. The results in Table 6 show that the ability-performance correlation was the most important predictor (*RW* = 35.13%), followed by sample size (*RW* = 16.23%) and performance measure (*RW* = 15.96%).

Discussion

We addressed a foundational question in management and other fields concerned with employee performance: What is the functional form of the joint effects of cognitive ability and motivation on performance? Given the centrality of performance to theory and practice, and the abundant conceptual and empirical work on ability and motivation as key predictors of performance, our results have implications for management theory, future research, and practice.

Implications for Theory and Research

A key finding is that available evidence does not provide strong or consistent support for the hypothesis that Performance = f(Ability × Motivation). This conclusion is based on a triangulation of evidence based on raw data from dozens of primary studies that did not suffer from some of the problems that have limited prior research on the multiplicative model. First, moderated multiple regression analyses revealed that the overall corrected change in R from the additive model to the multiplicative model is .02. Thus, the ability-motivation interaction tends to provide very little incremental prediction beyond the additive effects of ability and motivation. Second, relative importance analyses showed that ability, motivation, and the ability-motivation interaction account for an average of 60.1%, 30.5%, and 9.4% (respectively) of the explained variance in performance. This suggests that in most cases, the interactive effect is relatively unimportant to performance. Third, simple slopes analyses suggested that the ability-performance relationship remains fairly consistent across levels of motivation. And fourth, even in cases where the interactive effect appears nontrivial, the direction of the effect is not consistent. That is, in some cases the ability-performance relation is stronger when motivation is higher, and in other cases, the ability-performance relation is weaker when motivation is higher.

The lack of support for the multiplicative model is particularly noteworthy because we focused on effect sizes and applied corrections for statistical and methodological artifacts. As such, the lack of evidence for the multiplicative model cannot be attributed to common problems with testing interaction effects, such as low statistical power and low reliability of the product term (Aguinis et al., in press). In addition, interactions can be difficult to detect when the two predictors are highly correlated, which decreases the likelihood that the interaction between the two variables will provide unique information (Murphy & Russell, in press). This also was not an issue in the present study because correlations between ability and motivation tend to be very small.

An additional contribution is our examination of situations when the multiplicative model may be more viable. Results reveal that the interactive effects of ability and motivation on performance generally are small in both published and unpublished studies, in both laboratory and field settings, in both civilian and military organizations, in both complex and less complex jobs, for both trait and state motivation measures, and for both objective and subjective performance measures. The two situations that appear most conducive to finding an ability-motivation interaction are (a) when the sample size is smaller and (b) when the bivariate effects of ability and motivation on performance (particularly ability) are weaker. The finding that small-sample studies are more likely to find support for the multiplicative model is counterintuitive given that small samples often lack sufficient statistical power to detect interaction effects (Aguinis, 1995). However, we focused on the size of ability-motivation interactions rather than on their statistical significance. The fact that interactive effects are stronger in smaller samples suggests that even when an interaction is evident, it may be “driven” by a small subset of cases (e.g., individual employees who possess particularly low or high levels of ability and/or motivation) that has an inordinate influence on results within smaller samples.

Overall, the present findings suggest quite clearly that the effects of ability and motivation on performance are additive rather than multiplicative. The lack of support for the multiplicative hypothesis suggests the need to revisit theories and models that predict or imply an interactive relation between ability and motivation. For example, job performance theories and models should specify that ability and motivation exert independent effects on performance rather than interactive effects. In addition, ability may not be a resource that only highly motivated individuals allocate towards tasks. Similarly, it appears that goals—and individuals’ commitment to those goals—demonstrate independent effects on performance and do not help higher-ability individuals more than lower-ability individuals. This conclusion also has implications for the types of designs required in future research. For example, a priori estimates of statistical power can focus on additive effects rather than on interactive effects. This, in turn, can substantially reduce sample size requirements and make future research more practically feasible.

The present findings also have implications for understanding the relative importance of ability and motivation. For example, we found that relations between motivation and performance (as well as the importance of motivation relative to ability) are stronger when measures reflect state motivation (e.g., time spent on a task) than when they reflect trait motivation (e.g., achievement motivation). This finding provides support for the trait versus state distinction (Chen et al., 2000; Kanfer & Heggestad, 1997) and addresses calls for meta-analytic research to directly compare the predictive validity of different motivational constructs (e.g., Diefendorff & Chandler, 2011).

Our results also provide support for the maximal-typical performance distinction (DuBois et al., 1993) by showing that ability is relatively more important than motivation to training performance and to performance on simulated job tasks in laboratory studies, both of which tend to focus on maximal performance (e.g., they are short-term). The fact that ability appears to be much more important than motivation to training performance is intriguing. One possibility is that training—particularly new hire training—represents a strong situation (Mischel, 1973), such that trainees tend to be highly motivated to learn job-relevant knowledge and skills. This, in turn, may constrain the variance in motivation and attenuate relations between motivation and performance. In contrast, ability and motivation appear to be approximately equally important to job performance, the measures of which tend to assess typical performance over long periods. This discovery was somewhat unexpected given the strong track record of ability as a predictor of performance (e.g., F. L. Schmidt & Hunter, 1998) and suggests that motivation may be just as important to job performance as ability.

Implications for Talent Management Practices

The present findings also point to actionable steps organizations can take to improve how they acquire and manage talent. First, our results reveal that ability and motivation are weakly correlated. The fact that ability and motivation largely are independent, and that both variables tend to demonstrate relations with performance, suggests that organizations should measure both variables to predict future performance. In other words, talent management systems that emphasize ability at the expense of motivation, or vice versa, are likely to be suboptimal for influencing or predicting future performance.

Second, the general lack of support for the multiplicative model suggests that job applicants should be allowed to compensate for lower scores on ability measures with higher scores on motivation measures and vice versa. For instance, instead of requiring a minimum score on a cognitive ability test and a minimum score on a motivation measure (i.e., a multiple cutoffs or hurdles approach), it may be more effective to set a minimum total score for the two measures combined. Third, if ability and motivation interact to influence performance, this would suggest that interventions designed to increase motivation (e.g., incentive plans) should target employees who possess a high level of ability. The present results challenge this idea and suggest that interventions should focus on employees of all ability levels.

Fourth, our findings suggest that compared to motivation, ability is much more important to performance during training and in laboratory studies designed to simulate job performance. Thus, practitioners should be aware that findings from training and laboratory studies may overestimate the importance of ability and underestimate the importance of motivation to on-the-job performance. Fifth, we found that ability is a better predictor of objective performance measures. The implication is that the type of performance organizations would most like to influence should inform the individual differences they assess during the selection process or try to influence through training and development or incentive programs. For instance, the present findings suggest that if outcomes such as sales or productivity are more strategically critical than supervisor evaluations of employee performance, organizations should focus on ability. On the other hand, if an organization is particularly interested in improving supervisor evaluations, then it should focus on motivation.

Limitations and Directions for Future Research

We acknowledge several potential limitations of our research. First, despite an extensive search for primary studies, the number of independent samples available for some analyses was small. For example, most studies that met the inclusion criteria used traitlike measures of motivation; fewer studies have included ability, performance, and statelike measures of motivation. In particular, surprisingly little research has measured effort directly, particularly in field settings. Given the theoretical importance of effort to work motivation, we encourage more research on this key construct. For example, we found that measures of various constructs contain items about the amount or duration of effort devoted to work tasks, including measures of conscientiousness, engagement, work involvement, and organizational citizenship behavior. It would be helpful for future research to delineate the similarities and differences among these constructs and measures to bring the measurement of effort into clearer focus. Our study also points to the need for additional research concerning how to best measure effort, including measures that can be used in high-stakes settings in which issues such as response distortion may be a concern.

Second, a requirement of the present meta-analysis was that all studies had to include measures of ability, motivation, *and* performance. As discussed, focusing on studies that measured all three constructs enabled us to (a) calculate the ability-motivation interaction and estimate its effects on performance and (b) directly compare the relative importance of ability and motivation to performance. A potential limitation of this approach was that the meta-analysis includes only a portion of studies that have measured ability and performance (but not motivation) and studies that have measured motivation and performance (but not ability). As a result, some of the correlations may differ from what we might have found had our results been based on a larger set of primary studies. For example, although the mean correlations we found between ability and performance are in line with ability-performance correlations from several previous meta-analyses, these correlations are somewhat different (i.e., smaller) than correlations reported in some other meta-analyses. For example, our mean observed correlation of .18 between ability and job performance is very similar to observed correlations of .14 to .20 reported in studies such as Berry, Clark, and McClure (2011), Bertua, Anderson, and Salgado (2005), Gonzalez-Mulé et al. (2014), and Nathan and Alexander (1988). In contrast, the .18 correlation is smaller than the observed correlation of .25 from Hunter (1983), whose values have been used in subsequent meta-analyses (e.g., F. L. Schmidt & Hunter, 1998).

Several factors may contribute to the somewhat lower ability-performance relations we observed compared to some previous meta-analyses. For example, some studies were based solely or primarily on studies designed to validate a particular ability test, such as Hunter's (1983) meta-analysis of the General Aptitude Test Battery. In contrast, a variety of ability tests are represented in the present meta-analysis, and the ability-performance relation was not the primary focus of most of the studies we cumulated. In fact, in the present study, corrected correlations between ability and performance were slightly larger in unpublished studies than in published studies (rs = .48 vs. .42; see Table 1). Furthermore, some ability meta-analyses have included job knowledge and/or work sample tests as measures of job performance, whereas we did not include such criteria because they do not assess on-the-job performance. This is relevant because ability tends to correlate more strongly with job knowledge and work sample tests than with performance ratings and productivity records (e.g., Nathan & Alexander, 1988). Finally, some of the artifact corrections we used also may be different from the corrections used in some previous meta-analyses. For example, range restriction values (u) for ability in some of the subsets of studies in our meta-analysis appear to be somewhat larger (and, thus, more conservative) than values used by several previous meta-analyses (e.g., Hunter, 1983; Salgado, Anderson, Moscoso, Bertua, & de Fruyt, 2003).

Regardless of the reason(s), we do not believe relations involving ability are systematically different (e.g., lower) than relations involving motivation because both sets of estimates were taken from the same studies. Thus, we have no reason to believe the sometimes smaller ability-performance relations we observed compared to some previous meta-analyses should affect conclusions regarding the relative importance of ability versus motivation or the validity of the additive versus multiplicative models.

Third, although we made extra efforts to try to understand and correct for the effects of range restriction (please see Appendix C in the online supplemental file), this proved to be a challenging endeavor. For example, many studies did not report enough information for us to determine whether range restriction may be relevant, and if so, the specific nature of the restriction (e.g., direct vs. indirect). Furthermore, studies were more likely to provide information concerning whether and how ability scores were restricted, whereas there tended to be less information about possible restriction on motivation. Thus, in some instances, the range restriction–corrected results may underestimate the magnitude of relations involving motivation. Finally, even when we could be reasonably confident about the range restriction mechanism(s) within particular samples, we often did not have all the information needed to implement the most appropriate corrections. Thus, we sometimes had to make assumptions and/or use values from other studies in the data set. In spite of these considerations, given the consistency of results across types of analyses, it is unlikely that implementing additional or alternative range restriction corrections would have changed our substantive conclusions.

Fourth, we found several variables that appear to moderate the relative importance of ability and motivation to performance, such as the study setting (laboratory vs. field) and how performance was measured (objectively vs. subjectively). However, even after accounting for these variables, there sometimes was considerable variance in estimates across primary studies that was not due to the moderators or statistical artifacts. Thus, future research could examine additional potential moderators. For example, there is evidence that ability is relatively more important when individuals first start a job, whereas motivation is relatively more important later on (e.g., Zyphur, Bradley, Landis, & Thoreson, 2008). Relatedly, most of the research we reviewed was cross-sectional and examined relations between individuals. Future research might adopt an intraindividual approach to examine whether relations among ability, motivation, and performance change within individuals over time (for examples, see Kanfer & Ackerman, 1989; Yeo & Neal, 2008).

Finally, the present study used meta-analysis to cumulate interaction effects. As such, we hope our study will serve as a model for researchers who wish to understand the magnitude and consistency of interactive effects in other domains. However, our experience suggests that meta-analyzing interactions can be quite challenging. For example, primary studies very rarely include the exact same variables in their analyses or report all the statistics researchers need to estimate interactive relations. Thus, meta-analysts must be willing to devote substantial time and effort to obtain the relevant data or statistics from the primary study authors. We urge primary researchers who study interactions to report correlations among all the variables, including the product terms, so that the results can be included in future meta-analyses.

Conclusions

The results of the present study have the potential to "change the conversation" regarding theories that predict that Performance = *f*(Ability × Motivation), as well as how these theories are disseminated to students in classrooms, to decision makers in organizations, and in the media and public discourse. Overall, our findings suggest that including ability-motivation interactions in future theoretical explanations or empirical models will add complexity to theories and models but not necessarily increase understanding or prediction of performance. Instead, our findings suggest that, in most cases, researchers and practitioners can focus on the more parsimonious additive effects of ability and motivation on performance. In addition, we hope our study will serve as a catalyst for future research to use meta-analysis to better understand interactive relations in other domains. Finally, we hope some of our findings about the compensatory contributions of ability and motivation will be useful to practitioners when they design talent management systems and interventions aimed at predicting and improving employee performance.

Notes

1. The main codes and values for each primary study are available from the first author upon request.
2. One of the 56 primary studies we found was a large-sample study conducted in a military training context (Carretta, Teachout, Ree, Barto, King, & Michaels, 2014; N = 9,396). Although the multiplicative model results from this study generally were consistent with the overall results from the other 55 studies, the magnitude of the correlations and additive effects were notably different (i.e., lower) than the average of the other studies in the data set. As such, this study emerged as a strong influential case in many of the analyses. Rather than reporting results with and without this study each time, we decided to exclude this study from the meta-analysis.
3. To avoid the potentially confounding effects of performance dimension (task vs. contextual) and performance measure (objective vs. subjective), we limited these analyses to subjective measures of task and contextual performance.
4. We found highly similar results using other measures that reflect the strength of the ability-motivation interaction, such as the percentage of change in R (from the additive model to the multiplicative model) and the change in simple slopes.
5. The WLS regression analysis did not include organizational context, job complexity, or performance dimension because these factors were not relevant to laboratory studies. However, neither organizational context nor job complexity was a significant predictor of the ability-motivation interaction when we limited the analysis to field studies. In addition, the small number of task versus contextual performance studies prevented us from including this factor in multivariate analyses.

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