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Performance, incentives, and needs for autonomy, competence, and relatedness: a meta-analysis

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Abstract Although self-determination theory (SDT) is one of the most widely cited theories of human motivation and function, critics have questioned the practical utility of its three needs (i.e., autonomy, competence, and relatedness) in performance contexts. We conduct a meta-analysis ($k = 108$, $N = 30{,}648$) to explore the magnitude and boundary conditions of need satisfaction and performance. As expected, autonomy ($\rho = .28$), competence ($\rho = .37$), and relatedness ($\rho = .25$) predict performance. Incentivization per se has little impact on need-satisfaction: instead, the need satisfaction → performance relationship is moderated by incentive salience. Consistent with a crowding-out hypothesis, need satisfaction matters less to performance when incentives are directly salient ($\rho = .22$) and more when indirectly salient ($\rho = .45$). Our meta-analysis demonstrates that indirectly salient incentives and need-satisfaction are indeed compatible, providing a direct response to criticisms of SDT in performance contexts. Additional unexpected findings and future directions are discussed.

Keywords Productivity · Academic achievement · Literature review · Employee motivation · Rewards

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Introduction

> If intrinsic motivation is largely wiped out as Deci has claimed (Deci and Ryan 1985) by such factors as salient incentives and rewards; competition; imposed goals, standards, and deadlines; pressure; anxiety; self-doubt; conflict; instrumental task consequences; feelings of obligation to others; appraisals of performance by others; negative feedback; surveillance; ego involvement, and the like, then *it is doubtful that it has much application to real life…*
> …It seems incongruous that the need for self-determination and competence are considered to be…the wellsprings of all human motivation and at the same time so fragile that their effects can be negated by the most common of life's exigencies.–Edwin Locke and Gary Latham (1990), p. 56, emphasis added)

Self-determination theory (SDT; Ryan and Deci 2000) is one of the most widely cited theories of human motivation (Boggiano 1998; Deci and Ryan 2000; Rose 2011). It argues that human function depends on satisfaction of three basic psychological needs: the needs for autonomy, competence, and relatedness. The importance of these fundamental needs, theorized to be critical across life domains (Deci and Ryan 2000), has been empirically documented in hundreds of primary studies. A wealth of data has shown that satisfaction of the three needs is critical for everything from personal healthcare (Williams et al. 2000) to mental health (Sheldon et al. 2008) to interpersonal relationships (LaGuardia and Patrick 2008), public service (Park and Rainey 2008), and even helping others (Grant 2008). Yet, despite the theoretical importance of the three needs across multiple life domains, the role of need satisfaction in performance contexts such as work and school continues to be viewed with skepticism.

A review of the literature is needed to respond to critics of the theory. Two decades of research have largely been dedicated to demonstrating that provision of incentives and external control erode need satisfaction and intrinsic motivation (e.g., Deci et al. 1999). If it is true that foundational characteristics of performance such as external control or incentives are incompatible with need satisfaction, the relevance of need satisfaction in organizations is difficult to demonstrate (cf., Donovan 2001; Locke and Latham 1990). This critique is not without merit. However, it does necessitate a review that can provide a defensible response.

A review is also needed because the theoretical links between need satisfaction and performance are typically underdeveloped ("why should need satisfaction matter to performance?"). Although the need satisfaction—performance link is mentioned in several places (e.g., Deci et al. 1989; Gagné and Deci 2005; Gagné and Forest 2008), the mechanisms that link need satisfaction to performance are infrequently explored at length due to conflicting premises or findings. The inability to reconcile several premises has led to something of a theoretical dead-end, which some have termed the *uncomfortable conclusion* (Cerasoli et al. 2014). Although not insurmountable (as we explore later), the uncomfortable conclusion provides a strong disincentive for researchers to focus on the need satisfaction-performance relationship.

A review could also answer a number of empirical questions about the existing literature. Although over a hundred studies have empirically examined the link, the need satisfaction—performance link is typically reported as an ancillary analysis. A meta-analysis could aggregate and demonstrate the effect with greater confidence ("does need satisfaction actually predict performance?"). Further, a review could explore relationships among moderators and related factors that cannot be readily assessed in primary studies ("when does need satisfaction matter more to performance?"). Many of these moderators are factors that are critical to assess under SDT, such as incentive type, incentive saliency, performance criteria, and context, all of which cannot readily be assessed in a single primary study.

Finally, a review is needed because the question remains as to whether there is a business case to be made for fostering psychological needs (Baard et al. 2004). Performance is a fundamental concern of many researchers and practitioners (Cascio and Aguinis 2008), and understanding the need satisfaction-performance link at school and at work is critical. Although adults spend over a third of their waking lives at work (Bureau of Labor Statistics 2014), for many, work is simply not enjoyable. For instance, a 2013 Gallup Poll indicates that over 70 % of U.S workers are unhappy or unfulfilled at their jobs (Gallup 2013), which is associated with lower levels of performance (Cropanzano and Wright 2001; Judge et al. 2001). A review and meta-analysis of the literature can demonstrate empirical links that schools and organizations would need to justify initiatives that bolster need satisfaction among students and employees.

Therefore, this paper reflects an attempt to expand and advance the theoretical and practical utility of SDT in performance contexts. In order to achieve this goal, we first discuss SDT and the three needs posited, establishing a conceptual link with performance quality and with performance quantity (an important but often overlooked distinction made in the literature). Second, we reexamine the impact of incentives on need satisfaction. Finally, we focus on the impact of incentives on the need satisfaction—performance link. This is our core focus, given that there have been conflicting findings on the joint role of incentives and need satisfaction in performance contexts. We conduct a meta-analysis to explore three general hypotheses derived from theory and previous research and conclude with a discussion of several unexpected findings and their practical implications.

Need satisfaction and performance

Self-determination theory brings a unique perspective to performance contexts (Pinder 2011). In contrast to other theories of work motivation, such as the Job Characteristics Model (JCM; Hackman and Oldham 1976), valence-expectancy theory (VIE; Van Eerde and Thierry 1996; Vroom 1964), or control theory (Carver and Scheier 1981), SDT is a humanistic theory that takes a very positivist standpoint. It is not based on the extent to which individuals vary in the strength of certain needs, such as need for achievement (Atkinson 1957), nor is it based in the notion of "drive reduction," perhaps to satiate a desire for hunger or success (e.g., Hull 1943). It is also neither based on the idea that behavior is driven by Freudian subconscious desires, nor purely by the observable consequences of behavior (Skinner 1953).

Instead, all individuals have three psychological needs which must be satisfied for optimal function. These needs do not vary in the extent to which individuals *possess* them (as need-for-achievement is posited to), but instead vary in the extent to which the surrounding environment facilitates their *satisfaction*. The theory, with its roots in reaction to the dominant operant paradigm of the mid-20th century, reflects the ongoing evolution and integration of five or six mini theories of human function (Vansteenkiste et al. 2010), which each emerged to solve a particular motivational problem and explain its underlying mechanisms. These theories have helped explain how the environment and social context impact the degree to

which needs are satisfied and how behavior regulation becomes internalized.[1] However, they have not explored in much detail the extent to which the needs in turn impact certain behaviors. Because our focus in the current paper is on performance, we turn here to explore the need satisfaction—performance link for the three needs posited under the theory, namely autonomy, competence, and relatedness needs.

The *need for autonomy* reflects the most basic desire humans possess to be the causal agents of their environment. More formally, the need for autonomy refers to the psychological need to experience self-determination and endorse the cause of a behavior as one's own (Deci and Ryan 1987). If individuals are forced or manipulated to engage a task (thwarting autonomy), they lose the intrinsic desire to subsequently do so. Behaviors are perceived as autonomous when they are freely initiated and maintained; behaviors will be perceived as autonomous to the extent that they impart a subjective sense of freedom and lack imposed constraints. In contrast, behaviors are not perceived as autonomous when their initiation and regulation is coerced or pressured. Controlled behaviors are perceived to be maintained by forces outside the self and range in degree of perception from completely external (in the case of absolute coercion) to mostly internal (willful compliance). When external forces are even partially attributed as the cause of one's behavior initiation/regulation, full autonomy will not be experienced, and according to organismic integration theory (OIT), such behaviors may fail to internalize (Ryan and Connell 1989).

Three psychological components (Reeve 2009) can explain why autonomy should predict performance. First, an *internal perceived locus of causality* should be associated with performance because it allows the individual to take ownership of an action/circumstance. Perceived autonomy should predict performance outcomes because increasing (versus decreasing) performance affirms that the environment is within the person's control. Second, *perceived volition* (the perception that a behavior is self-initiated and free of coercion; Deci et al. 1995) links autonomy to performance because individuals will not expend effort if they believe their efforts will be thwarted or ineffective. This link is supported by research on learned helplessness, which indicates that individuals perform less effectively when constraints are imposed (Kane 1997) or when employees have more of a learned-helplessness orientation (Silvester et al. 2003). And third, when individuals perceive they have the *freedom of choice* whether or not they engage a performance task, performance should improve. For example, meta-analytic work confirms that providing non-controlling choices has positive motivational consequences (Patall et al. 2008). Thus, we predict:

Hypothesis 1 Perceived autonomy is positively related to performance.

The *need for competence* refers to the desire to demonstrate and improve one's abilities. In performance contexts, when an individual's performance criteria cannot be evaluated, effort and performance stagnate (presumably due to lack of competence-relevant feedback; Karau and Williams 1993). Satisfaction of competence needs predict performance outcomes because demonstrating and improving one's abilities is fundamentally satisfying (Deci and Ryan 1985; Harter 1978). The earliest conceptualizations of competence needs can be dated back to White (1959). White's concept of effectance motivation described the inborn need of an individual to affect and manipulate his or her environment, as well as to obtain desired outcomes within it. More specifically, White posited that individuals have an "intrinsic need to deal with the environment" (White 1959, p. 318), suggesting that a minimal perceived level of competence is a fundamental need. In the time since, multiple theories of human motivation have posited competence or efficacy needs as foundational, including social cognitive theory (Bandura 1986), goal setting theory (Locke and Latham 1990), achievement goal orientation theory (Elliot and Dweck 2005), and even OIT (Ryan and Connell 1989) to name a few.

Although satisfaction of competence needs predict performance because demonstrating and improving one's abilities is fundamentally satisfying (Deci and Ryan 2000; Harter 1978), two competence-relevant components may clarify the link between competence satisfaction and performance. First, competence perceptions depend on a mix of *challenge and skill:* individuals must experience both a challenge and possess the skills necessary to meet that

[1] First, cognitive evaluation theory (CET; Deci 1972) was developed in response to Skinnerian behaviorists (e.g., Skinner 1953) to explain how rewards might actually *reduce* intrinsic motivation (and perhaps subsequent performance). Second, organismic integration theory (OIT; Ryan and Connell 1989) was articulated to show how the motive behind some behaviors changes over time, moving from externally driven to various degrees of internal identification and enjoyment. Third, causality orientations theory (COT; Deci and Ryan 1985) identified individual differences in the extent to which individuals attribute the cause of their actions to themselves or externally. Fourth, and perhaps most germane to our research here, basic psychological need theory (BPNS; Ryan and Deci 2002) calls out the importance of the three psychological needs (autonomy, competence, and relatedness), or fundamental nutriments, that when met, pave the road for individuals to seek meaningful and intrinsically enjoyable tasks. Fifth, goal content theory (GCT; Kasser and Ryan 1996) explains how the pursuit of intrinsic or extrinsic goals relates to satisfaction of basic psychological needs. Finally, Relationships Motivation Theory (RMT; Deci and Ryan 2014) helps explain the nature of supportive relationships. For a review, see Vansteenkiste et al. (2010). We thank an anonymous reviewer for helping us focus this point.

challenge. Individuals who feel unchallenged will not boost their sense of competence because there is no work involved in meeting the demand (even if the task was self-endorsed). On the other hand, individuals who feel over-challenged may see a loss in competence, as the task is overwhelming. Generally speaking, successful performance on challenging (yet attainable) tasks will be satisfying when it serves to boost levels of perceived competence. Second, competence perceptions also depend on *performance feedback*. Individuals must feel they are responsible for the behavior to which the feedback refers (Fisher 1978; Kluger and DeNisi 1996) and the feedback must come from a trusted source (Snyder et al. 1984). Of course, feedback (and subsequently perceived competence) will impact performance to the extent that environmental feedback is perceived as valid and properly internalized. Therefore, we predict:

Hypothesis 2 Perceived competence is positively related to performance.

Relatedness needs reflect the universal human desire to be valued, respected, and desired by important others. The importance of interpersonal relationships appears in some form in many theories of human motivation, such as Maslow's (1943) hierarchy of needs theory and Alderfer's existence-relatedness-growth (ERG; 1969) theory. Under SDT, relatedness needs capture the desire to have meaningful relationships with others (Deci and Ryan 2000) and impact the degree to which individuals actualize innate tendencies for growth and exploration. Relatedness needs are important to self-determination theory (and the underlying organismic integration theory) because they provide the affective foundation for natural growth tendencies to emerge and behavior regulations to internalize (Ryan and Connell 1989). These needs include the desire to connect with others, to give affection, and to receive love and care in return (Baumeister and Leary 1995; Bowlby 1958; Deci and Ryan 2000; Harlow 1958; Ryan 1993). Individuals need to establish emotional bonds, relationships, and attachments with others (Guisinger and Blatt 1994; Ryan and Powelson 1991). Thus, individuals will gravitate towards those who help meet these needs and away from those who thwart them (Reeve 2009).

Deliberate attempts to impose controlling attachments (Moss and St-Laurent 2001) or witnessing acts of rudeness by an authority figure/peer (Porath and Erez 2007, 2009) have been found to reduce performance. Conversely, meeting relatedness needs boosts performance, in part because it improves well-being. Fostering secure emotional attachments is associated with holistic, integrated functioning such as fostering pro-social orientations and promotion of healthy relationships with others (Marcus and Sanders-Reio 2001). Or, this may occur through its positive impact on intrinsic motivation, which in turn has been shown to predict performance (Cerasoli et al. 2014). Therefore, we expect:

Hypothesis 3 Perceived relatedness is positively related to performance.

At this point, it is important to make a few clarifications on what we mean by "performance." Performance is often the central focus or "gold standard" criterion in many areas of the behavioral and management sciences (Cascio and Aguinis 2008). Yet, historically, the conceptualization and measurement of performance often lacks validity. The frequent oversimplification and deficient operationalization of performance, referred to as the "criterion problem," is an issue for any predictive enterprise (Campbell et al. 1993). In simple terms, the criterion problem states that if performance is operationalized as a homogenous, unidimensional construct, prediction will be less accurate because performance is rarely a singular construct. Because performance is not uniform within or between contexts, it must be broken down and defined more carefully (Guion 1998).

There are a number of taxonomies for performance; our main focus here is on the quality vs. quantity distinction because it serves theoretical purposes, is highly actionable for practitioners, and has been used for many years (e.g., Cerasoli et al. 2014). *Quality-type* tasks require attention to detail, personalization, and prideful, careful craftsmanship (Rich 2006). These tasks are fostered through intense personal involvement, enjoyment of the task, and perceived meaningfulness of the work. For example, indicators of a quality-type task may include creativity, lack of errors, artistic value, originality, and so forth. In contrast, *quantity-type* tasks are often repetitive, depend on rote skill, and tend to require less personal investment and creativity (Gilliland and Landis 1992). Such tasks can be driven by task familiarity or presence of others, as shown in the large body of research on social facilitation (Zajonc 1965). They typically do not lend themselves to high degrees of autonomy and interpersonal valuation. For example, indicators of a quantity type task can include assembly time, quantity of boxes assembled, word processing tasks, and number of sales made.

Although we admit this is something of an oversimplification of the performance domain, it is a practical one and consistent with thinking in this context (Gagné and Deci 2005). It is consistent with the arguments of previous theorists that more autonomous motives better predict heuristic-type tasks (e.g., Vansteenkiste et al. 2004). Previous research has shown that quantity-type tasks tend to be better predicted by incentives, while quality-type tasks tend to be better predicted by factors such as intrinsic

motivation and enjoyment (Cerasoli et al. 2014; Jenkins et al. 1998). Therefore, we expect that:

Hypothesis 4 The relationship between perceived need satisfaction and performance is stronger for quality tasks than quantity tasks.

Incentives and need satisfaction

Examining the relationship between incentives and need satisfaction is critical because the topic all but consumed SDT research for a decade or more through the late 1990's. Self-determination theory, and its core mini-theory cognitive evaluation theory (CET; Deci 1972), were borne out of the need to explain an observation that operant psychology (the dominant paradigm of psychology in the mid 1900's) could not. An emerging body of research in the early 1970 s suggested that in some cases, contrary to operant theory, incentives could have detrimental impacts on motivation and behavior (e.g., Deci 1972). Out of these findings sprung one of the biggest controversies to date in psychology.

A series of nine meta-analyses debated whether incentives erode need satisfaction (see Deci et al. 1999), relying on experimental research. Experimental research lends itself to higher internal validity, so the experimental data showed indirectly whether incentives *could* erode need satisfaction; however, non-experimental data are needed to show whether the provision of incentives *actually does* erode need satisfaction outside laboratory contexts. Perhaps more importantly, the meta-analyses never directly assessed the relationship between incentives and need satisfaction. From a theoretical standpoint, the provision of incentives is thought to reduce intrinsic motivation by thwarting needs for competence and autonomy, but this was never empirically captured. Non-experimental data, combined with applied operationalizations of incentive contingency are needed to show whether the provision of incentives *actually do* erode need satisfaction in practice.

Incentivization per se will not have an impact on need satisfaction because the way the incentive is provided and interpreted determines whether the effect will be positive or negative. Specifically, incentives can impart messages of external control (thought to thwart autonomy) and in some cases performance feedback (thought to boost competence). Traditionally, four types of incentive contingencies have been thought to capture this; whether the incentive contingency was (a) engagement contingent, (b) completion contingent, (c) performance contingent, or (d) non-contingent (Deci et al. 1999). Although this research is informative, this way of framing incentive contingency may not occur frequently outside the lab. For example, it is uncommon to find any employer who provides salary for merely participating in work tasks, an engagement-contingent incentive.

Recent work by Cerasoli et al. (2014) proposed *performance saliency* as an applied way of operationalizing incentives and whether incentives had negative motivational effects in applied contexts. *Directly salient incentives* set up a clear link between a behavior and receipt of an incentive ("if I perform X, it's clear I'll get the incentive"). Because they set up a very clear expectation of control, they will have a negative impact on need satisfaction through substantially undermined autonomy. In contrast, *indirectly salient incentives* set up a very vague link between a particular behavior and the provision of an incentive ("if I perform X, I may get some incentive"). As such, indirect incentives should have a positive impact on need satisfaction because they are not controlling enough to reduce autonomy, yet are linked closely enough to boost competence. Therefore, we hypothesize that:

Hypothesis 5 In the presence of incentives, overall need satisfaction is lower when incentives are directly (versus indirectly) performance salient.

Incentives, need satisfaction, and performance

What was frequently lost in the entire incentive debate was the ultimate implication for performance. Although the ultimate implications for performance were frequently invoked as a strong rationale for exploring whether incentives erode need satisfaction (Tang and Hall 1995), once the research findings were reported, performance implications were typically treated only as an afterthought in discussions. Further, critics of these meta-analyses have called into question the ecological validity of their findings: findings based on laboratory data are used to draw the conclusion that incentives should not be used in a controlling manner. However, outside laboratory settings in applied contexts, incentives are deliberately used to control employees and it would be overreaching to suggest that incentives erode intrinsic motivation in all of these cases (Donovan 2001; Locke and Latham 1990). We suggest this gap in the literature can be addressed with meta-analytic data examining the relationship among incentives, need satisfaction, and performance.

We have argued that overall need satisfaction is related to higher performance, and we also now argue that the presence of incentives influences this relationship. Our rationale hinges on a notion of leveraging, also referred to as the "crowding out hypothesis" (Frey and Oberholzer-Gee 1997). For practical purposes, motives to perform can be intrinsic or extrinsic. Under many circumstances, both

intrinsic and extrinsic motives are likely to be operational, which would suggest both have some non-zero unique predictive validity for performance. However, in some cases, extrinsic motives (i.e., incentives) become more salient (and thereby more dominant), and will thus be more strongly linked to performance. This salience is easy to observe for extrinsic incentive contingencies. When valued incentives are directly salient to performance, they leave little room for intrinsic motives, such as need satisfaction. Thus, when there is an abundantly clear, explicit link between performance of a behavior and receipt of a valued incentive, extrinsic motives take center-stage, and need satisfaction becomes far less relevant to performance.

The opposite is true when incentives are less salient to performance. When incentives are indirectly salient or not at all salient to performance, extrinsic motives will be reduced. This is because there is no clear "if–then;" the explicit link between performance of a behavior and the receipt of an incentive disappears. A similar argument is at the foundation of the "crowding out" hypothesis (c.f., Frey and Osterloh 2005; Gagné and Forest 2008); when incentives are not tied to performance, they have no leverage over motivation, and thus cannot crowd out the naturally occurring desire to fulfill needs for autonomy, competence, and relatedness surrounding the task. Under these circumstances, the predictive validity of need satisfaction will be magnified. Thus, we hypothesize the following:

Hypothesis 6 In the presence of incentives, the predictive validity of need satisfaction is attenuated for directly-salient incentives and augmented for indirectly-salient incentives.

Method

Literature search

A number of databases were searched for published studies through 2015, including psycINFO, ERIC, PubMed, Scopus, and Dissertation Abstracts International. We queried any combination of the three needs (i.e., *autonomy, competence, relatedness*) coupled with a defensible measure of performance (i.e., *performance, productivity, effectiveness, OCB, CWB, citizenship, counter-productive*). In addition, a call was placed for unpublished research using e-mail subscription lists, such as Academy of Management's Organizational Behavior listserv, the Self-Determination Theory's listserv, the Society for the Study of Motivation's listserv, and the American Educational Research Association Motivation Special Interest Group's listserv.

In order to be included, an article had to report a quantitative estimate of the relationship between need satisfaction (i.e., competence, autonomy, or relatedness need satisfaction as defined in the introduction) and performance. Any article had to publish sufficient data to unambiguously calculate effect sizes, usually in the form of Pearson correlations, but occasionally with simple *t*-tests or means and standard deviations. Importantly, we restricted our research to studies that explicitly examined one or more of the three psychological needs. To maintain a targeted focus and prevent the "apples and oranges" problem (Cortina 2003) of meta-analysis (i.e., to preserve construct homogeneity), we excluded potentially related constructs such as self-efficacy, attachment needs, or need for achievement. Need satisfaction was predominantly assessed through standardized multi-item self-report surveys, many of which were validated scales appearing in multiple studies. The operationalization of the construct had to be consistent with the definition of the three needs under self-determination theory (Ryan and Deci 2000). Examples include the Basic Psychological Need Satisfaction Scale (BPNS; LaGuardia et al. 2000), Basic Need Satisfaction at Work Scale (Deci et al. 2001), and the Intrinsic Need Satisfaction Scale (INS; Leone 1995).

Perceived autonomy was coded and defined as the extent to which individuals perceived they were capable of making independent, volitional choices in their environment or that the environment supported their autonomy[2] (e.g., perceived autonomy, perceived autonomy satisfaction, autonomy, perceived autonomy support). Perceived competence was coded and defined as the perception of individual ability and capacity to effect change upon the environment (e.g., perceived competence, competence satisfaction, performance expectations). Perceived relatedness was coded and defined as the perception that individuals felt connected to, supported by, or emotionally bonded to other individuals in their environment (e.g., perceived relatedness, relatedness satisfaction, feelings of relatedness).

Performance was coded as quality when output was compared with some non-quantitative evaluative performance standard (e.g., creativity, building quality, software ingenuity). Criteria were coded as quantity when performance was evaluated by the number of discrete units of output (e.g., number of problems solved, dollar sales, percent of goal). Finally, any criterion that was not clearly

[2] It should be noted that a conceptual distinction can be made between perceived *support* of the need (e.g., flexible work hours, an understanding supervisor) and the perceived *satisfaction* of the need (e.g., actual feelings and perceptions of autonomy or relatedness). Although it sometimes makes sense to differentiate between the two, we do not do so here because the two have been found to be highly correlated (Gagne and Bargmann 2003) and the distinction doesn't appear in empirical studies containing performance data. We thank an anonymous reviewer for helping us clarify this.

either quality or quantity was considered to have elements of both (e.g., academic performance, general job performance ratings, teamwork performance), and not included in quality or quantity breakdowns.

Incentive contingency was coded in line with recent work by Cerasoli et al. (2014). Incentives were coded as present when there was any explicit reference to an incentive being provided. Incentives were coded as directly-performance salient when it was clear that an expectation or psychological contract established a direct link between effort expended and the performance outcome measured (e.g., incentive for number of problems solved). Incentives were coded as indirectly-performance salient when the incentive offered had a relationship to the performance criteria measured that was somewhat ambiguous, instrumental, or distal (e.g., incentive to engage in a particular task, which in turn had some contribution to performance later on).

Finally, we also coded for and analyzed an exploratory list of theoretically and/or methodologically relevant categorical and continuous moderating variables (see Tables 4 and 5). In addition to those listed earlier, these included additional criterion dimensions (task vs. contextual; speed vs. accuracy; typical vs. max), context (school, work, physical [physically-demanding performance criteria such as exercise, sports, games]), age (child, adolescent, college, adult), criterion measurement (objective vs. subjective), criterion source (self vs. non-self), temporal separation (cross-sectional, lagged, recursive), study location (field vs. lab), research methodology (correlational measurement of need satisfaction vs. experimental manipulation), publication status (published vs unpublished), sample size, need satisfaction reliability, performance reliability, publication year, mean age, percent white, percent female, time lag between measurements in days, and response rate.

In total, we coded data on the main need satisfaction performance link alongside 30 moderating factors. Every individual data point included in the meta-analysis (31 variables X 253 effect sizes = 7843) was coded by at least two authors independently, yielding a Cohen's *kappa* of $\kappa = .79$. Initial disagreements that arose from independent coding were then discussed and consensus reached.

Analyses

We calculated effect sizes from Pearson product-moment correlations, exact p-values, group means/standard deviations, and t-values. In many cases, a study reported more than one effect size for a core construct of interest. To ensure that a sample only counted once toward a given effect size calculation, it was necessary to combine these effect sizes by creating composite effect sizes (Hunter and Schmidt 2004, p. 433) and composite reliabilities (Mosier 1943). These provided a single sample estimate that maintains assumptions of independence. Corrections were made for statistical artifacts, including sample size, construct measurement unreliability, and artificial dichotomization. We employed two general meta-analytic strategies, one geared toward categorical moderators, one toward continuous ones.

Our first analytic strategy, common to meta-analysis, was to treat moderator variables as *categorical*. For example, the need satisfaction → performance relationship would be calculated separately for incentives present versus absent, then the two effect sizes would be compared with respect to overlapping confidence intervals. For these traditional between-study categorical analyses, we used the random effects meta-analytic methods of Hunter and Schmidt (2004), which assume that variability in effect size estimates is due to both study artifacts and potential moderators. In comparison to fixed effects models, random effects models are designed *for generalizability.* Under random-effects models, the assumption is that even the most comprehensive collection of samples that comprise a meta-analysis are at best a representative sample of the unobservable larger population one wishes to make inferences about. In part, this assumption is because it is unlikely that any meta-analysis includes all studies ever conducted on a particular effect. By comparison, fixed effects models are designed to *describe the current sample.* Fixed effects models assume that after correcting for artifactual error, the same effect size is at the foundation of all studies (Hunter and Schmidt 2004).

There are several ways to assess the presence of moderators in meta-analysis. In line with Hunter and Schmidt, we do not advocate the use of significance testing. For gauging the heterogeneity of effect sizes (i.e., the presence of moderators), one can follow Hunter and Schmidt's recommendation concerning the use of 80 % credibility intervals. One can also infer, as Hunter and Schmidt do, that less than 75 percent-variance accounted for by statistical artifacts may suggest presence of additional moderators. Finally, we also provide 95 % confidence intervals (CIs) to infer whether an observed effect is significantly different from zero or from another effect (see Whitener 1990).

We favored random-effects over fixed-effects models for several additional reasons. First, admitting the broad research on motivation, it is altogether unlikely we have located every study ever conducted. Second, it would be overreaching to suggest that we have accounted for all potential moderators: such an attempt would be beyond our scope both practically and theoretically. Finally, we utilize random-effects models for statistical reasons; fixed-effects models usually test statistical significance through Chi square significance tests, which have low power (Schmidt

and Hunter 2001), as well as inflated Type I and Type II error rates (Hunter and Schmidt 2004; National Research Council 1992). Given these reasons, we follow the path of previous researchers to employ random effects models (Erez et al. 1996).

Our second analytic strategy was to treat moderators as *continuous* variables. Some meta-analyses have looked at relationships among continuous moderators in a limited fashion; for example, it is common to take a moderator that is naturally continuous (e.g., publication year, percent of sample that is female) and correlate this with the observed effect size. Recent research (Cerasoli et al. 2014) has called for meta-analysts to extend this approach to *all* data in a meta-analysis. By rescaling all data, interrelationships among study moderators and study main effects can be explored. For categorical moderators, data are dummy-coded (i.e., 0 and 1) to indicate membership in a group (e.g., adult vs. college) or dichotomy (e.g., incentive present vs. absent).

For continuous variables, it is important that they are placed on the same scale across all studies (Cerasoli et al. 2014). This approach is somewhat common for variables that naturally fall on a common scale across studies, such as age (Ng and Feldman 2012) and year of publication (Smith and Glass 1977). However, when continuously measured variables do not fall naturally on the same scale across studies, rescaling using the percent of maximum possible method (POMP) pioneered by Cohen et al. (1999) is necessary. For example, measures of need satisfaction are measured with a 5-point scale in some studies, while others use a 7-point. By taking the average level of need satisfaction in a given study, and dividing it by the maximum possible value the measurement scale used in that study can take, a number out of 100 is derived. This number can then be directly compared with rescaled results from other studies. In the current case, we used the POMP method only for levels of need satisfaction and levels of performance (and of particular note, coupled this with incentive contingency to explore Hypothesis 5, whether need satisfaction was associated with direct vs. indirect incentives).

Results

Our electronic search returned a total of 4862 non-duplicated unique articles. Out of this, 1048 articles, conference papers, and dissertations were selected for ordering. In total, we selected for inclusion and coded 96 sources (18 unpublished), reporting effect sizes from 108 independent samples and 30,648 respondents. We computed composite correlations and/or effect sizes from 253 raw data points, resulting in a final 108 independent effect sizes. Table 1 reports sources and data used for studies in the meta-analysis; Table 2 includes main hypothesized relationships, Table 3 and Table 4 contain categorical methodological moderator analyses; and Table 5 contains between-study analyses covering continuous moderators. Note that since some studies may have contributed to multiple moderator breakdowns, the k in subordinate categories may not always add up to the k in a superordinate one (e.g., Table 2, autonomy + competence + relatedness does not equal the Overall k). To ensure independence of observations, each sample counted only once toward any given meta-analytic estimate.

Hypothesis 1 (perceived autonomy predicts performance) received support. As reported in Table 2 under Overall, perceived autonomy emerged as a moderate predictor of performance ($k = 46$, $N = 11{,}937$, $\rho = .28$), and the absence of zero in the 95 % confidence interval indicates the population relationship between the two is positive (95 % CI = .23–.33). Hypothesis 2 (perceived competence predicts performance) received support. Perceived competence emerged as the strongest need satisfaction predictor of performance ($k = 70$, $N = 20{,}924$, $\rho = .37$), and the absence of overlapping confidence intervals with both autonomy and relatedness needs indicates the effect is significantly larger than both (95 % CI = .34–.40). Hypothesis 3 (perceived relatedness predicts performance) received support as well. Perceived relatedness emerged as the weakest need-satisfaction predictor of performance out of the three theorized needs ($k = 19$, $N = 6180$, $\rho = .25$), although the presence of overlapping confidence intervals suggests it is not significantly weaker than autonomy needs (95 % CI = .19–.31). A relatively small percentage of variance in effect sizes accounted for by artifacts (< 25.00 % for all three) suggests additional factors, as hypothesized.

Results were consistent with Hypothesis 4, that need satisfaction is a stronger predictor of performance quality than of performance quantity. As reported in Table 2 under Performance Type, performance quality ($k = 15$, $N = 3311$, $\rho = .40$; 95 % CI = .32–.48) and quantity ($k = 44$, $N = 13{,}290$, $\rho = .30$; 95 % CI = .26–.34) both showed non-zero predictive validity coefficients. However, the overlapping of the two 95 % confidence intervals indicate that while consistent with hypothesis, the difference is not statistically significant.

Hypothesis 5 (that in the presence of incentives, overall need satisfaction is lower when incentives are directly, versus indirectly, performance salient) received support. For a comparative baseline, as reported in Table 5, the mere fact that an incentive was present (variable # 7 in the table) was unrelated to levels of overall need satisfaction (variable # 2 in the table), $r = .08$: incentivization per se did not impact need satisfaction. Instead, the *salience* of the

Table 1 Sources included in the meta-analysis

1 Source	2 Year	3 *r*	4 n	5 α IV	6 α DV	7 $?	8 need	9 qual vs quan	10 spd vs acc	11 typ vs max	12 slf vs oth	13 objvs sub	14 crs vs lng	15 fld vs lab	16 cor vs exp	17 pub?	18 dom
Abuhamdeh et al.	2015	.40	72			Y-I	C	quan		max	oth	obj	crs	fld	exp	yes	othr
Aelterman	2014	.41	31	.51	.73	N	A				slf	sub	lng	fld	exp	yes	work
Almagro	2009	.35	248			N		quan		max	oth	obj	crs	fld	cor	yes	phys
Amorose	2015	.30	301	.89	.95	N	C				oth	sub	crs	fld	cor	yes	phys
Amorose	2015	.53	301	.76	.95	N	A				oth	sub	crs	fld	cor	yes	phys
Amorose	2015	.62	301	.90	.95	N	R				oth	sub	crs	fld	cor	yes	phys
Amoura	2015	.26	127		.95	N	R				oth	obj	lng	fld	cor	yes	acad
Amoura	2015	.18	127		.95	N	C				oth	obj	lng	fld	cor	yes	acad
Anderman	1997	.19	341	.66			C			max	oth	obj	lng	fld	cor	yes	acad
Anderman	1997	.10	341	.66			C			max	oth	obj	lng	fld	cor	yes	acad
Anderman	1997	−.22	341	.65			C			max	oth	obj	lng	fld	cor	yes	acad
Anderman	1997	−.14	341	.83			C			max	oth	obj	lng	fld	cor	yes	acad
Arkes	1979	.46	60			N	C	quan		max	oth	obj	crs	lab	exp	yes	othr
Arnold	1985	.37	42				C	quan		max	oth	obj	lng	lab	exp	yes	othr
Avila	2012	.40	32	.72		N	C	quan			oth	obj	crs	fld	cor	yes	phys
Axler	2009	.52	225				C				oth	obj	lng	fld	cor	no	acad
Baard	2004	.20	528				A			typ	oth	obj	lng	fld	cor	yes	work
Baard	2004	.17	528				C			typ	oth	obj	lng	fld	cor	yes	work
Baard	2004	.20	528				R			typ	oth	obj	lng	fld	cor	yes	work
Baard	2004	.27	35				A			typ	oth	obj	lng	fld	cor	yes	work
Baard	2004	.19	35				C			typ	oth	obj	lng	fld	cor	yes	work
Baard	2004	.34	35				R			typ	oth	obj	lng	fld	cor	yes	work
Baena	2015	.40	758	.75	.86	N		quan			slf	sub	crs	fld	cor	yes	phys
Barkoukis	2013	.20	170	.73		N	A	quan			slf	sub	lng	fld	cor	yes	phys
Becker	1993	−.03	89				C	quan	acc	max	oth	obj	crs	fld	cor	no	work
Beiser	1998	.18	945	.72	.95		C				oth	sub	lng	fld	cor	yes	acad
Beiser	1998	.19	945	.72	.95		C				oth	sub	lng	fld	cor	yes	acad
Beiser	1998	.38	388	.72	.95		C				oth	sub	lng	fld	cor	yes	Acad
Beiser	1998	.45	388	.72	.95		C				oth	sub	lng	fld	cor	yes	acad
Bemenutty	2013	.20	133	.86		N					oth	obj	crs	fld	cor	yes	acad
Bodla	2014	.54	688			N		qual			slf	sub	crs	fld	cor	yes	work
Boggiano et al.	1982	.34	13			N	C	quan		max	oth	obj	crs	lab	exp	yes	othr
Boggiano et al.	1982	.18	13			N	C	quan		max	oth	obj	crs	lab	exp	yes	othr
Boggiano et al.	1982	.49	13			N	C	quan		max	oth	obj	crs	lab	exp	yes	othr
Boggiano et al.	1982	.62	13			Y-I	C	quan		max	oth	obj	crs	lab	exp	yes	othr

Table 1 continued

1 Source	2 Year	3 *r*	4 n	5 α IV	6 α DV	7 $?	8 need	9 qual vs quan	10 spd vs acc	11 typ vs max	12 slf vs oth	13 objvs sub	14 crs vs lng	15 fld vs lab	16 cor vs exp	17 pub?	18 dom
Boggiano et al.	1982	.67	13			Y-I	C	quan		max	oth	obj	crs	lab	exp	yes	othr
Boggiano et al.	1982	.53	13			Y-I	C	quan		max	oth	obj	crs	lab	exp	yes	othr
Boggiano	1979	.29	12			Y-D	C	quan			oth	sub	crs	lab	exp	yes	othr
Boggiano	1979	.20	12			Y-I	C	quan			oth	sub	crs	lab	exp	yes	othr
Boggiano	1979	.49	12			Y-D	C	quan			oth	sub	crs	lab	exp	yes	othr
Boggiano	1979	.50	12			Y-I	C	quan			oth	sub	crs	lab	exp	yes	othr
Bouchey	2005	.35	215	.80		Y	C				oth	obj	lng	fld	cor	yes	acad
Bouffard	1998	.45	173	.82			C				oth	obj	lng	fld	cor	yes	acad
Bouffard	1998	.56	173	.82			C				oth	obj	lng	fld	cor	yes	acad
Bouffard	1998	.04	173	.82			C				oth	obj	lng	fld	cor	yes	acad
Bouffard	1998	.46	173	.82			C				oth	obj	lng	fld	cor	yes	acad
Bouffard	1998	.18	173	.82			C				oth	obj	lng	fld	cor	yes	acad
Bouffard	1998	.50	173	.82			C				oth	obj	lng	fld	cor	yes	acad
Bouffard	1998	.13	153	.88			C				oth	obj	lng	fld	cor	yes	acad
Bouffard	1998	.52	153	.88			C				oth	obj	lng	fld	cor	yes	acad
Bouffard	1998	.46	185	.88			C				oth	obj	lng	fld	cor	yes	acad
Bouffard	1998	.55	185	.88			C				oth	obj	lng	fld	cor	yes	acad
Brein	2012	.54	380	.87	.79	N	C	qual			slf	sub	crs	fld	cor	yes	work
Brein	2012	.43	380	.81	.79	N	A	qual			slf	sub	crs	fld	cor	yes	work
Brein	2012	.21	380	.90	.79	N	R	qual			slf	sub	crs	fld	cor	yes	work
Burkhalter	1998	.30	242	.70			C			typ	oth	obj	crs	fld	cor	no	phys
Burkhalter	1998	.45	242	.70			C			max	oth	obj	crs	fld	cor	no	phys
Burleigh	1976	.18	65				C	quan	spd	max	oth	obj	crs	lab	cor	no	work
Burleigh	1976	.23	65				C	quan	spd	max	oth	obj	crs	lab	cor	no	work
Burleigh	1976	.14	65				C	quan	spd	max	oth	obj	crs	lab	cor	no	work
Burleigh	1976	.15	65				C	quan	spd	max	oth	obj	crs	lab	cor	no	work
Carpentier	2013	.35	58	.71	.86	N	C	qual			oth	sub	crs	fld	cor	yes	phys
Cassidy	2009	.13	235	.78		N					oth	obj	lng	fld	cor	yes	acad
Cho	2006	.38	151	.83		Y-I	C				oth	obj	lng		cor	no	acad
Cho	2011	.38	151	.83		N	C				oth	obj	crs	fld	cor	yes	acad
Choi	2012	.31	331	.81	.70	N	C	qual			oth	sub	lng	fld	cor	yes	acad
Collins	2010	.40	999				A						crs	fld	cor	yes	work
Corrigan	1998	.15	198			N	A			typ	oth	sub	lng	fld	cor	no	work
Corrigan	1998	−.02	198			N	C			typ	oth	sub	lng	fld	cor	no	work

Table 1 continued

1 Source	2 Year	3 *r*	4 n	5 α IV	6 α DV	7 $?	8 need	9 qual vs quan	10 spd vs acc	11 typ vs max	12 slf vs oth	13 objvs sub	14 crs vs lng	15 fld vs lab	16 cor vs exp	17 pub?	18 dom
Dinger	2013	.47	524	.82	.82	N	C				oth	obj	crs	fld	cor	yes	acad
Dodd	1996	.26	197	.79		Y-D	A	quan	acc	max	oth	obj	crs	lab	cor	yes	othr
Dysvik	2011	.36	199	.94	.80		A	qual			slf	sub	crs	fld	cor	yes	work
Dysvik	2011	.17	103	.93	.86		A	qual			oth	sub	crs	fld	cor	yes	work
Eisenberger	1999	.21	324		.87		A	qual		typ	oth	sub	lng	fld	cor	yes	work
Elmadag	2007	.28	220	.89	.93		A	qual			slf	sub	crs	fld	cor	no	work
Felton	2013	.14	300	.66	.74	N	A				slf	sub	crs	fld	cor	yes	phys
Felton	2013	.34	300	.81	.74	N	C				slf	sub	crs	fld	cor	yes	phys
Felton	2013	.20	300	.73	.74	N	R				slf	sub	crs	fld	cor	yes	phys
Forbes	1978	.13	50			Y-D	C	quan	acc		oth	obj	lng	lab	cor	yes	othr
Forbes	1978	−.27	50			Y-D	C	quan	acc		oth	obj	lng	lab	cor	yes	othr
Fortier	1995	.03	263				A				oth	obj	lng	fld	cor	yes	acad
Fortier	1995	.15	263				A				oth	obj	lng	fld	cor	yes	acad
Fortier	1995	.09	263				A				oth	obj	lng	fld	cor	yes	acad
Fortier	1995	.13	263				A				oth	obj	lng	fld	cor	yes	acad
Fortier	1995	.20	263				A				oth	obj	lng	fld	cor	yes	acad
Fortier	1995	.22	263				A				oth	obj	lng	fld	cor	yes	acad
Fortier	1995	.22	263				A				oth	obj	lng	fld	cor	yes	acad
Fortier	1995	.22	263				A				oth	obj	lng	fld	cor	yes	acad
Fortier	1995	.42	263				C				oth	obj	lng	fld	cor	yes	acad
Fortier	1995	.38	263				C				oth	obj	lng	fld	cor	yes	acad
Fortier	1995	.40	263				C				oth	obj	lng	fld	cor	yes	acad
Fortier	1995	.44	263				C				oth	obj	lng	fld	cor	yes	acad
Fortier	1995	.32	263				C				oth	obj	lng	fld	cor	yes	acad
Fortier	1995	.34	263				C				oth	obj	lng	fld	cor	yes	acad
Fortier	1995	.36	263				C				oth	obj	lng	fld	cor	yes	acad
Fortier	1995	.37	263				C				oth	obj	lng	fld	cor	yes	acad
Freedman	1985	.15	74	.64			A	quan	acc		oth	obj	crs	lab	cor	yes	othr
Freedman	1985	.16	71	.64			A	quan	acc		oth	obj	crs	lab	cor	yes	othr
Freedman	1985	.34	74	.80			C	quan	acc		oth	obj	crs	lab	cor	yes	othr
Freedman	1985	.32	71	.80			C	quan	acc		oth	obj	crs	lab	cor	yes	othr
Gao	2008	.36	307	.75			C	quan	spd	max	oth	obj	crs	fld	cor	yes	phys

Table 1 continued

1 Source	2 Year	3 *r*	4 n	5 α IV	6 α DV	7 $?	8 need	9 qual vs quan	10 spd vs acc	11 typ vs max	12 slf vs oth	13 objvs sub	14 crs vs lng	15 fld vs lab	16 cor vs exp	17 pub?	18 dom
Gardner	2013	.50	192	.84	.94	N	A	quan			slf	sub	lng	fld	cor	yes	phys
Gillet	2009	.25	90	.77		N	A	quan		max	oth	obj	lng	fld	cor	yes	phys
Gillet	2009	.13	90	.77		N	A	quan		max	oth	obj	crs	fld	cor	yes	phys
Gillet	2009	.38	90	.72		N	C	quan		max	oth	obj	lng	fld	cor	yes	phys
Gillet	2009	.28	90	.72		N	C	quan		max	oth	obj	crs	fld	cor	yes	phys
Gillet	2009	.23	90	.77		N	R	quan		max	oth	obj	lng	fld	cor	yes	phys
Gillet	2009	.06	90	.77		N	R	quan		max	oth	obj	crs	fld	cor	yes	phys
Gillet	2010	.09	101	.91		N	A	quan		max	oth	obj	crs	fld	cor	yes	phys
Goudas	1995	.67	40	.91		Y-D	C			typ	oth	obj	lng	fld	cor	yes	acad
Greguras	2009a, b	.14	163	.66	.87		A			typ	oth	sub	lng	fld	cor	yes	work
Greguras	2009a, b	.22	163	.67	.87		C			typ	oth	sub	lng	fld	cor	yes	work
Greguras	2009a, b	.06	163	.85	.87		R			typ	oth	sub	lng	fld	cor	yes	work
Grolnick	1991	.32	456				C				oth	obj	lng	fld	cor	yes	acad
Grolnick	1994	.62	302				C				oth	obj	lng	fld	cor	yes	acad
Hackman	1971	.26	208	.77	.92	N	A			typ	oth	sub	lng	fld	cor	yes	work
Hackman	1971	.16	208	.77		N	A	qual		typ	oth	sub	lng	fld	cor	yes	work
Hackman	1971	.13	208	.77		N	A	quan		typ	oth	sub	lng	fld	cor	yes	work
Halvari	2009	.24	111	.94		N	A				slf	sub	crs	fld	cor	yes	phys
Halvari	2009	.53	111	.84		N	C				slf	sub	crs	fld	cor	yes	phys
Hanze	2007	.13	137	.62	.51		A			max	oth	obj	crs	fld	cor	yes	acad
Hanze	2007	.16	137	.62	.51		A			max	oth	obj	crs	fld	cor	yes	acad
Hanze	2007	−.03	137	.62	.56		A			max	oth	obj	lng	fld	cor	yes	acad
Hanze	2007	.04	137	.62	.56		A			max	oth	obj	lng	fld	cor	yes	acad
Hanze	2007	.20	137	.82	.51		C			max	oth	obj	crs	fld	cor	yes	acad
Hanze	2007	.28	137	.82	.51		C			max	oth	obj	crs	fld	cor	yes	acad
Hanze	2007	.16	137	.82	.56		C			max	oth	obj	lng	fld	cor	yes	acad
Hanze	2007	.28	137	.82	.56		C			max	oth	obj	lng	fld	cor	yes	acad
Hanze	2007	.12	137	.73	.51		R			max	oth	obj	crs	fld	cor	yes	acad
Hanze	2007	.12	137	.73	.51		R			max	oth	obj	crs	fld	cor	yes	acad
Hanze	2007	.18	137	.73	.56		R			max	oth	obj	lng	fld	cor	yes	acad
Hanze	2007	.06	137	.73	.56		R			max	oth	obj	lng	fld	cor	yes	acad
Harackiewicz	1984	.20	96		1.0	N	C	quan			oth	obj	crs	lab	exp	yes	othr
Harris	1993	.22	90	.86		N	C	quan	acc		oth	obj	crs	lab	cor	yes	othr

Table 1 continued

1 Source	2 Year	3 *r*	4 n	5 α IV	6 α DV	7 $?	8 need	9 qual vs quan	10 spd vs acc	11 typ vs max	12 slf vs oth	13 objvs sub	14 crs vs lng	15 fld vs lab	16 cor vs exp	17 pub?	18 dom
Harris	1993	.28	90	.86		N	C	quan	acc		oth	obj	crs	lab	cor	yes	othr
Harris	1993	.07	90	.87		N	C	quan	acc		oth	obj	crs	lab	cor	yes	othr
Harris	1993	.31	90	.87		N	C	quan	acc		oth	obj	crs	lab	cor	yes	othr
Hohn	2001	.15	357	.66			C						crs	fld	cor	no	acad
Hohn	2001	.09	349	.65			C						crs	fld	cor	no	acad
Hohn	2001	.36	310	.67			C						crs	fld	cor	no	acad
Hohn	2001	.23	308	.60			C						crs	fld	cor	no	acad
Hohn	2001	.32	302	.61			C						crs	fld	cor	no	acad
Hohn	2001	.09	281	.67			C						crs	fld	cor	no	acad
Jelstad	2007	.36	252	.81	.74		A				slf	sub	crs	fld	cor	no	work
Jelstad	2007	.40	252	.69	.74		C				slf	sub	crs	fld	cor	no	work
Jelstad	2007	.12	252	.77	.74		R				slf	sub	crs	fld	cor	no	work
Jeon	2008	.11	248	.90			R				oth	obj	lng	fld	cor	no	acad
Jeon	2008	.04	231	.91			R				oth	obj	lng	fld	cor	no	acad
Jones	2003	−.23	117	.65			A	quan		max	oth	obj	lng	lab	cor	no	work
Jones	2003	−.07	117	.60			C	quan		max	oth	obj	lng	lab	cor	no	work
Jones	2003	.20	117	.94			C	quan		max	oth	obj	lng	lab	cor	no	work
Jones	2003	−.11	117	.81			R	quan		max	oth	obj	lng	lab	cor	no	work
Kalbers	2008	.34	334	.80	.82		A				slf	sub	crs	fld	cor	yes	work
Karatepe	2009	.16	157	.69	.79		C				slf	sub	crs	fld	cor	yes	work
Kuvaas	2009	.18	779	.92	.79	N	A				slf	sub	crs	fld	cor	yes	work
Kuvaas	2009	.15	779	.92	.79	N	R				slf	sub	crs	fld	cor	yes	work
Kwok	1995	.35	125	.80	.93		C	quan	acc	max	oth	obj	crs	fld	cor	yes	acad
Kwok	1995	.35	125	.80	.93		C	quan	acc	max	oth	obj	crs	fld	cor	yes	acad
Kwok	1995	.17	128	.80	.93		C	quan	acc	max	oth	obj	crs	fld	cor	yes	acad
Lam	2000	−.02	360	.83	.92		A			typ	oth	sub	lng	fld	cor	yes	work
Lam	2000	.05	360	.83	.90		A			typ	oth	sub	lng	fld	cor	yes	work
Langdon	2010	−.05	120	.70			A			max	oth	sub	crs	fld	cor	no	phys
Langdon	2010	.14	120	.64			C			max	oth	sub	crs	fld	cor	no	phys
Langdon	2010	.12	120	.84			R			max	oth	sub	crs	fld	cor	no	phys
Leroy	2015	.47	118	.92	.86	N					oth	sub	lng	fld	cor	yes	work
Li	2009	.59	98	.91			C	quan	acc		oth	obj	crs	lab	exp	yes	othr
Li et al.	2005	.35	92		.88		A				slf	sub	crs	fld	cor	yes	work
Li et al.	2005	.31	92		.89		A				oth	sub	crs	fld	cor	yes	work
Lu	2012	.13	248	.71	.93	Y-I	A	qual			oth	sub	crs	fld	cor	yes	work

Table 1 continued

1 Source	2 Year	3 *r*	4 n	5 α IV	6 α DV	7 $?	8 need	9 qual vs quan	10 spd vs acc	11 typ vs max	12 slf vs oth	13 objvs sub	14 crs vs lng	15 fld vs lab	16 cor vs exp	17 pub?	18 dom
McEnrue	1984	.16	340	.83	.92		C				oth	sub	crs	fld	cor	yes	work
Meigher	2001	.48	115	.68			C				oth	obj	lng	fld	cor	no	acad
Mouratidis	2008	.20	227	.80			C		spd	max	oth	obj	crs	fld	exp	yes	phys
Mouratidis	2008	.24	227	.80			C		spd	max	oth	obj	crs	fld	exp	yes	phys
Mouratidis	2008	.20	227	.80			C		spd	max	oth	obj	crs	fld	exp	yes	phys
Mouratidis	2008	.22	227	.85			C		spd	max	oth	obj	crs	fld	exp	yes	phys
Mouratidis	2008	.23	227	.85			C		spd	max	oth	obj	crs	fld	exp	yes	phys
Mouratidis	2008	.23	227	.85			C		spd	max	oth	obj	crs	fld	exp	yes	phys
Mouratidis	2008	.20	198	.87	.86		C			max	oth	obj	lng	fld	cor	yes	phys
Mouratidis	2008	.32	198	.87	.86		C			max	oth	obj	lng	fld	cor	yes	phys
Phillips	1997	.11	151	.74		Y-D	A	qual		max	oth	sub	crs	lab	exp	no	othr
Pohl	2012	.29	222	.94	.77	N	A				slf	sub	crs	fld	cor	yes	work
Pulfrey et al.	2013	.61	89	.80	.87	N	A	quan		max	oth	obj	crs	fld	cor	yes	othr
Roche	2013	.20	418	.65	.87	N	A				slf	sub	lng	fld	cor	yes	work
Roche	2013	.32	418	.65	.91	N	A				slf	sub	lng	fld	cor	yes	work
Roche	2013	.24	418	.63	.87	N	C				slf	sub	lng	fld	cor	yes	work
Roche	2013	.34	418	.63	.91	N	C				slf	sub	lng	fld	cor	yes	work
Roche	2013	.31	418	.78	.87	N	R				slf	sub	lng	fld	cor	yes	work
Roche	2013	.27	418	.78	.91	N	R				slf	sub	lng	fld	cor	yes	work
Sachs	2001	.48	78	.74			C	qual		typ	oth	sub	crs	fld	cor	yes	acad
Senko	2003	.30	50	.79		Y-D	C	quan	spd	max	oth	obj	crs	lab	exp	yes	othr
Senko	2003	.05	79			Y-D	C	quan	spd	max	oth	obj	crs	lab	exp	yes	othr
Senko	2003	.11	166	.67			C	quan			oth	obj	lng	fld	cor	no	acad
Senko	2003	.13	166	.67			C	quan			oth	obj	lng	fld	cor	no	acad
Senko	2003	.76	166				C	quan			oth	obj	lng	fld	cor	no	acad
Senko	2003	.55	166				C	quan			oth	obj	lng	fld	cor	no	acad
Senko	2003	.22	207	.80			C	quan		max	oth	obj	crs	lab	exp	no	acad
Senko	2003	.30	207	.80			C	quan		max	oth	obj	crs	lab	exp	no	acad
Sheldon	2013	.13	68	.67		N	C	quan		max	oth	obj	crs	fld	exp	yes	phys
Sheldon	2013	.06	68	.44		N	R	quan		max	oth	obj	crs	fld	exp	yes	phys
Sink	1993	.60	58	.80			C			max	oth	obj	lng	fld	cor	yes	acad
Sink	1993	.59	58	.80			C			max	oth	obj	lng	fld	cor	yes	acad
Sink	1993	.44	58	.80			C			max	oth	obj	lng	fld	cor	yes	acad
Sink	1993	.45	58	.80			C			max	oth	obj	lng	fld	cor	yes	acad
Sink	1993	.46	58	.80			C			max	oth	obj	lng	fld	cor	yes	acad

Table 1 continued

1 Source	2 Year	3 *r*	4 n	5 α IV	6 α DV	7 $?	8 need	9 qual vs quan	10 spd vs acc	11 typ vs max	12 slf vs oth	13 objvs sub	14 crs vs lng	15 fld vs lab	16 cor vs exp	17 pub?	18 dom
Sink	1993	.42	58	.80			C			max	oth	obj	lng	fld	cor	yes	acad
Sink	1993	.54	58	.80			C			max	oth	obj	lng	fld	cor	yes	acad
Sink	1993	.53	58	.80			C			max	oth	obj	lng	fld	cor	yes	acad
Spray	2006	.08	147	.78			C	quan	acc	max	oth	obj	lng		cor	yes	phys
Spurlock	2002	.00	1435	.73			A	quan		max	oth	obj	lng	fld	cor	no	acad
Spurlock	2002	.18	1435	.73			A	quan		max	oth	obj	lng	fld	cor	no	acad
Spurlock	2002	.50	1435	.78			C	quan		max	oth	obj	lng	fld	cor	no	acad
Spurlock	2002	.19	1435	.69			R	quan		max	oth	obj	lng	fld	cor	no	acad
Stark	1983	.00	113	.81			C			typ	oth		lng	fld	cor	no	work
Stark	1983	−.04	113	.81			C	quan		typ	oth	obj	lng	fld	cor	no	work
Stark	1983	−.05	113	.81			C	quan		typ	oth	obj	lng	fld	cor	no	work
Strain	1999	.14	468	.84	.97		A			typ	oth	sub	crs	fld	cor	yes	work
Strain	1999	−.04	468	.84			A	quan		typ	oth	obj	lng	fld	cor	yes	work
Stringer	2006	.39	155	.79		Y-I	C	quan	acc	max	oth	obj	crs	fld	cor	yes	acad
Stringer	2006	.46	155	.79		Y-I	C	quan	acc	max	oth	obj	crs	fld	cor	yes	acad
Stringer	2006	.44	155	.79		Y-I	C	quan	acc	max	oth	obj	lng	fld	cor	yes	acad
Stringer	2006	.53	155	.79		Y-I	C	quan	acc	max	oth	obj	lng	fld	cor	yes	acad
Thorpe	2007	.34	115	.92	.70		A				slf	sub	crs	fld	cor	yes	work
Trusty	1995	.17	100	.71		Y-D	A	quan	spd	max	oth	obj	crs	lab	exp	yes	othr
Tsigilis	2005	.45	144	.84		N	C	quan	spd	max	oth	obj	crs	fld	cor	yes	phys
Tyagi	1985	.45	94	.58			A	quan		typ	slf	obj	crs	fld	cor	yes	work
Van den Broeck	2014	.32	451	.70	.82	N	A				slf	sub	crs	fld	cor	yes	work
Van den Broeck	2014	.19	451	.70	.81	N	A				slf	sub	crs	fld	cor	yes	work
Van den Broeck	2014	.26	451	.79	.82	N	R				slf	sub	crs	fld	cor	yes	work
Van den Broeck	2014	.23	451	.83	.82	N	C				slf	sub	crs	fld	cor	yes	work
Van Rossum	1990	.42	38	.72	.66		C	quan		max	oth	obj		fld	cor	yes	phys
Van Yperen	2006	.53	279	.90	.77	Y-I	C				oth	obj	lng	fld	cor	yes	acad
Vansteenkiste	2005	.51	130	.80			A	qual	acc		oth	sub	crs	fld	exp	yes	acad
Vansteenkiste	2005	−.04	130	.80			A	quan	acc		oth	obj	crs	fld	exp	yes	acad
Vansteenkiste	2005	.45	130	.80			A	qual	acc		oth	sub	lng	fld	exp	yes	acad
Vansteenkiste	2005	−.14	130	.80			A	quan	acc		oth	obj	lng	fld	exp	yes	acad
Vansteenkiste	2005	.23	113	.77			A	qual	acc		oth	sub	crs	fld	exp	yes	acad
Vansteenkiste	2005	.01	113	.77			A	quan	acc		oth	obj	crs	fld	exp	yes	acad
Vansteenkiste	2005	.24	113	.77			A	qual	acc		oth	sub	lng	fld	exp	yes	acad
Vansteenkiste	2005	.06	113	.77			A	quan	acc		oth	obj	lng	fld	exp	yes	acad

Table 1 continued

1 Source	2 Year	3 *r*	4 n	5 α IV	6 α DV	7 $?	8 need	9 qual vs quan	10 spd vs acc	11 typ vs max	12 slf vs oth	13 objvs sub	14 crs vs lng	15 fld vs lab	16 cor vs exp	17 pub?	18 dom
Vansteenkiste	2005	.41	80	.89			A	qual	acc		oth	sub	crs	fld	exp	yes	acad
Vansteenkiste	2005	.04	80	.89			A	quan	acc		oth	obj	crs	fld	exp	yes	acad
Wang	2012	.26	341	.91		N	A				oth	obj	crs	fld	cor	yes	acad
Waters	1974	.06	105				A				slf	sub	crs	fld	cor	yes	work
Weiner	1978	.53	81			Y-D	C	quan			oth	obj	crs	lab	exp	yes	othr
You	2015	.13	6227	.91		N	C	quan		max	oth	obj	crs	fld	cor	yes	acad
You	2015	.32	6227	.94		N	C	quan		max	oth	obj	crs	fld	cor	yes	acad
You	2015	.32	6227	.91		N	C	quan		max	oth	obj	crs	fld	cor	yes	acad

1 = source; 2 = publication year; 3 = need satisfaction-performance correlation; 4 = sample size 5 = reliability of need satisfaction measure; 6 = reliability of performance measure; 7 = was an incentive provided (Y = yes, N = no) and what was the salience (I = indirectly performance salient, D = directly performance salient)? 8 = psychological needs: autonomy (A), competence (C), and relatedness (R); 9 = quality (qual) vs. quantity (quan); 10 = speeded performance (spd) vs. accuracy performance (acc);11 = typical performance (typ) vs. maximal (max) performance; 12 = self- (slf) vs. other- (oth) report criteria; 13 = objective (obj) vs. subjective (sub) criteria; 14 = cross-sectional (crs) vs. longitudinal (lng) research design; 15 = field (fld) vs. laboratory (lab) location; 16 = correlational (cor) vs. experimental (exp) manipulation; 17 = published (yes) vs unpublished (no); 18 = domain of research: academic (acad), work (work), physical (phys), or other (othr)

incentives did: the between-study correlation reported in Table 5 (variable # 8) showed a strong relationship, such that mean overall need satisfaction was higher in studies where an incentive was present and the incentive was indirectly salient to performance, $r = -.45$. Again, it was not the *presence* of the incentive, but their *salience* that was related to need satisfaction.

Hypothesis 6 (that in the presence of incentives, the predictive validity of need satisfaction is attenuated for directly-salient incentives and augmented for indirectly-salient incentives) received support. As reported in Table 2, when incentives present are indirectly salient to performance ($k = 8$, $N = 1145$, $\rho = .45$; 95 % CI = .35–.55), need satisfaction is a significantly stronger predictor than when incentives present are directly salient to performance ($k = 8$, $N = 679$, $\rho = .22$; 95 % CI = .12–.32). Consistent with our rationale laid out in the introduction, there was not a significant difference between incentives being provided ($k = 16$, $N = 1893$, $\rho = .38$; 95 % CI = .29–.47) or not ($k = 36$, $N = 14{,}483$, $\rho = .36$; 95 % CI = .32–.40), indicating that the mere presence or absence of incentives had no significant impact on the predictive validity of need satisfaction.

We also conducted several ancillary analyses of potentially relevant theoretical factors. Given the potential oversimplification of the performance construct, we also explored several other frameworks for performance (see Table 2); task vs. contextual, speed vs. accuracy, and typical vs. maximal. Although we did not propose any formal hypotheses, our post hoc analyses demonstrated a significant difference between typical and maximal performance, such that the relationship between need satisfaction and performance was stronger for maximal performance tasks ($k = 33$, $N = 11{,}741$, $\rho = .32$; 95 % CI = .28–.36) than typical performance tasks ($k = 13$, $N = 2581$, $\rho = .19$; 95 % CI = .11–.27). No other significant differences were found.

As shown in Table 3, the importance of need satisfaction did not vary significantly across domains, as the confidence intervals for school ($k = 38$, $N = 16{,}249$, $\rho = .34$; 95 % CI = .30–.38), work ($k = 33$, $N = 9013$, $\rho = .31$; 95 % CI = .25–.37), and physical domains ($k = 20$, $N = 3852$, $\rho = .40$; 95 % CI = .35–.45) all overlapped one another. Nor did results vary significantly among different age groups, including children ($k = 12$, $N = 2746$, $\rho = .32$; 95 % CI = .25–.39), adolescents ($k = 30$, $N = 14{,}343$, $\rho = .35$; 95 % CI = .29–.41), college students ($k = 28$, $N = 3574$, $\rho = .38$; 95 % .32–.44), and adults ($k = 34$, $N = 9091$, $\rho = .31$; 95 % CI = .25–.37). Also shown in Table 3, the nature of the task also did not appear to have an impact on the predictive validity of need satisfaction, as evidenced by overlapping confidence intervals for objective criteria ($k = 66$, $N = 18{,}094$,

Table 2 Meta-analysis of need satisfaction and performance

	N	*k*	r_{obs}	SD_r	ρ	$SD_ρ$	80 % CrI		% err	File Drawer		Mean α		95 % CI	
							.10	.90		.10	.05	r_{xx}	r_{yy}	.025	.975
Overall	30,648	108	.27	.12	**.34**	.14	.15	.52	20.49	184	475	.79	.84	.31	.37
Autonomy	11,937	46	.22	.13	**.28**	.16	.08	.48	19.80	55	156	.78	.83	.23	.33
Competence	20,924	70	.30	.12	**.37**	.15	.18	.57	19.18	140	350	.78	.83	.34	.40
Relatedness	6180	19	.20	.11	**.25**	.13	.08	.41	23.21	19	57	.80	.81	.19	.31
Performance type															
Quality	3311	15	.33	.13	**.40**	.16	.20	.60	19.48	35	84	.81	.84	.32	.48
Quantity	13,290	44	.25	.11	**.30**	.13	.14	.47	21.92	66	176	.78	.88	.26	.34
Task	29,376	105	.27	.12	**.34**	.15	.15	.52	19.98	179	462	.79	.84	.31	.37
Contextual	1091	3	.27	.00	**.33**	.00	.33	.33	100.00	5	13	.80	.83	.33	.33
Speed	1127	8	.31	.10	**.34**	.11	.21	.48	38.90	17	42	.79		.26	.42
Accuracy	1349	12	.23	.14	**.27**	.16	.07	.47	30.28	16	43	.81	.93	.18	.36
Typical	2581	13	.16	.12	**.19**	.14	.02	.37	24.85	8	29	.77	.91	.11	.27
Max	11,741	33	.25	.09	**.32**	.10	.19	.46	33.16	50	132	.77	.77	.28	.36
Incentive present?															
Yes	1893	16	.31	.15	**.38**	.18	.15	.62	24.11	34	83	.80	.85	.29	.47
Salience: indirect	1145	8	.37	.12	**.45**	.15	.26	.64	28.34	22	51	.81	.85	.35	.55
Salience: direct	679	8	.19	.12	**.22**	.13	.05	.39	44.41	7	22	.79		.12	.32
No	14,483	36	.30	.10	**.36**	.11	.22	.50	23.47	72	180	.80	.85	.32	.40

N = number of participants/subjects; *k* = number of independent samples; r_{obs} = observed correlation after removing sampling error; SD_{obs} = standard deviation after removing sampling error; ρ = corrected population correlation; $SD_ρ$ = corrected population standard deviation; 80 % CrI = the lower and upper range of the 80 % credibility interval of the true population correlation; % $σ^2$ error = percentage of variance in the corrected population correlation accounted for by statistical artifacts (error); Filedrawer = number of unpublished/unavailable studies at ρ = .10 or .05 needed to pull the corrected population correlation below that value; Mean α = mean Cronbach's alpha reliability estimate; r_{xx} = mean reliability of the independent variable; r_{yy} = mean reliability of the dependent variable; 95 % CI = the lower and upper range of the 95 % confidence interval of the true population correlation

ρ = .33; 95 % CI = .29–.37), subjective criteria (*k* = 42, *N* = 11,211, ρ = .34; 95 % CI = .30–.38), self-report (*k* = 21, *N* = 6068, ρ = .41; 95 % CI = .35–.47), and non-self report (*k* = 84, *N* = 22,538, ρ = .31; 95 % CI = .28–.34) criteria.

Finally, we conducted several exploratory analyses of methodological factors. There were no significant differences as a function of a study's temporal separation of measurement of the IV and DV in Table 4 (i.e., cross-lagged, lagged, or recursive sampling). Similarly, the time lag (in days) between measures reported in Table 5 showed no relationship to observed effect size (*r* = −.05) or to average levels of need satisfaction (*r* = .00). Study location (i.e., lab versus field studies), research methodology (i.e., correlational vs. experimental), and publication status (i.e., published vs. unpublished) showed no significant differences in Table 4. The observed effect size was unrelated in Table 5 to study response rate (*r* = .12), percent female (*r* = .08), or year of publication (*r* = .12). It was, however, positively related to percent white (*r* = .35).

Discussion

The current research has been needed for some time. For over 40 years, SDT and its six component theories have held that satisfaction of basic psychological needs is critical to optimal function across life domains. Yet, although SDT is considered one of the major theories of human motivation, the importance of need satisfaction for performance has infrequently been the main focus of primary studies. In part, this was because previous research drew conflicting conclusions with regards to incentives, need satisfaction, and performance. But also, it was because an adequate response to critics of need satisfaction in the workplace was too infrequently articulated. Further, there was a lack of cumulated evidence and supporting theory to demonstrate need satisfaction-performance links. It was unclear (and never directly examined) whether the joint role of incentives and need satisfaction were antagonistic with both each other and with performance. Aggregation was needed because primary data are often not well suited to explore critical moderating factors, such as incentive

Table 3 Moderators of need satisfaction and performance

	N	*k*	r_{obs}	SD_r	ρ	SD_ρ	80 % CrI		% err	File Drawer		Mean α		95 % CI	
							.10	.90		.10	.05	r_{xx}	r_{yy}	.025	.975
Context															
School	16,249	38	.27	.11	**.34**	.13	.18	.50	21.43	65	167	.79	.83	.30	.38
Work	9013	33	.25	.14	**.31**	.17	.10	.52	16.54	50	132	.80	.84	.25	.37
Physical	3852	20	.32	.10	**.40**	.12	.25	.56	32.53	44	108	.77	.84	.35	.45
Age															
Child	2746	12	.26	.10	**.32**	.12	.16	.47	31.18	19	50	.75	.87	.25	.39
Adolescent	14,343	30	.27	.12	**.35**	.14	.16	.54	15.80	51	132	.79	.81	.29	.41
College	3574	28	.32	.13	**.38**	.15	.19	.57	31.23	62	151	.80	.87	.32	.44
Underclassmen	936	7	.25	.08	**.29**	.09	.18	.40	54.62	11	28	.76	.95	.22	.36
Upperclassmen	437	4	.27	.10	**.31**	.11	.17	.45	47.31	7	18	.81	.95	.20	.42
Adult	9091	34	.25	.14	**.31**	.17	.10	.52	16.62	51	136	.80	.84	.25	.37
Criteria															
Objective	18,094	66	.26	.13	**.33**	.16	.13	.52	19.83	106	277	.80	.82	.29	.37
Subjective	11,211	42	.28	.12	**.34**	.15	.15	.53	19.50	76	193	.80	.85	.30	.38
Self-report	6068	21	.32	.11	**.41**	.13	.24	.57	25.57	46	113	.79	.81	.35	.47
Non-self report	22,538	84	.26	.12	**.31**	.14	.13	.49	20.95	134	353	.80	.87	.28	.34

N = number of participants/subjects; k = number of independent samples; r_{obs} = observed correlation after removing sampling error; SD_{obs} = standard deviation after removing sampling error; ρ = corrected population correlation; SD_ρ = corrected population standard deviation; 80 % CrI = the lower and upper range of the 80 % credibility interval of the true population correlation; % σ^2 error = percentage of variance in the corrected population correlation accounted for by statistical artifacts (error); Filedrawer = number of unpublished/unavailable studies at ρ = .10 or .05 needed to pull the corrected population correlation below that value; Mean α = mean Cronbach's alpha reliability estimate; r_{xx} = mean reliability of the independent variable; r_{yy} = mean reliability of the dependent variable; 95 % CI = the lower and upper range of the 95 % confidence interval of the true population correlation

salience and criterion type. In cases like this, where cumulation is needed, theory is lacking, and existing findings contradictory, meta-analysis is an ideal solution (Schmidt and Hunter 2001). To address this gap, the current meta-analysis examined the relationships among not just incentives and need satisfaction, but also performance.

It was not surprising to find that the true population correlation with performance is solidly positive for all three psychological needs: those who perceive their needs are met tend to outperform those who do not. This finding was most robust, as expected, for the need for competence. This finding is in line with dozens of studies demonstrating that individuals with higher self-efficacy tend to be higher performers (Stajkovic and Luthans 1998). Effects for autonomy are consistent with the Job Characteristics Model (Hackman and Oldham 1976), which specifies autonomy as a core job dimension that serves to enhance motivation through an improved sense of responsibility. We were somewhat surprised by the predictive utility for autonomy and for relatedness needs. Although relatedness needs showed a positive relationship to performance, their impact was comparatively more modest, ρ = .25. It is unlikely this is a measurement issue, given the relatively high mean alpha of the IV and relatively precise meta-analytic estimate. Perhaps this aligns with the criticisms of some (e.g., Locke and Latham 1990) that individuals must perform their job, regardless of whether they find their peers, managers, or subordinates supportive.

Our findings from a fresh perspective advance the debate surrounding incentives and need satisfaction. Incentivization per se has little omnibus effect on overall need satisfaction. Instead, as expected, the impact of incentives in practical contexts is dictated by how salient the incentives are: incentives undermine need satisfaction when they are directly tied to performance and vice versa. These results are consistent with predictions made by self-determination theory. They are also consistent with the pattern for intrinsic motivation and incentives found by Cerasoli et al. (2014) and Deci et al. (1999). However, we did not expect the results to be as robust. Perhaps our study-level finding that incentive salience predicts need satisfaction at $r = -.45$ is stronger than the incentive-intrinsic motivation link observed by Cerasoli et al. and Deci et al. because need satisfaction is a more proximal outcome of incentives and mediates the relationship between incentives and intrinsic motivation.

Thus, at a minimum, our data enables a preliminary response to skeptics who summarily dismiss the importance of need satisfaction in applied contexts. The general critique against SDT in performance contexts has stood

Table 4 Methodological moderators of need satisfaction and performance

	N	*k*	r_{obs}	SD_r	ρ	$SD_ρ$	80 % CrI		% err	File Drawer		Mean α		95 % CI	
							.10	.90		.10	.05	r_{xx}	r_{yy}	.025	.975
Temporal separation															
Cross-sectional	20,034	66	.29	.10	**.35**	.12	.20	.50	27.28	125	317	.79	.84	.32	.38
Lagged	11,398	46	.24	.15	**.29**	.18	.06	.53	15.10	64	175	.78	.85	.24	.34
Recursive	3310	15	.20	.21	**.25**	.26	−.08	.57	9.82	15	45	.82	.78	.12	.38
Study location															
Field	28,588	88	.28	.12	**.34**	.14	.16	.52	19.09	158	405	.79	.84	.31	.37
Lab	1581	18	.23	.13	**.26**	.15	.07	.46	37.00	23	65	.79	1.00	.19	.33
Methodology															
Correlational	28,757	89	.28	.12	**.34**	.14	.15	.52	18.13	160	409	.79	.84	.31	.37
Experimental	1710	19	.26	.10	**.32**	.12	.16	.47	52.53	30	80	.75	.87	.26	.38
Publication status															
Published	25,618	87	.29	.12	**.35**	.14	.17	.53	20.92	165	418	.80	.84	.32	.38
Unpublished	5299	21	.22	.12	**.28**	.14	.09	.46	22.82	25	71	.75	.83	.21	.35

N = number of participants/subjects; k = number of independent samples; r_{obs} = observed correlation after removing sampling error; SD_{obs} = standard deviation after removing sampling error; ρ = corrected population correlation; $SD_ρ$ = corrected population standard deviation; 80 % CrI = the lower and upper range of the 80 % credibility interval of the true population correlation; % σ^2 error = percentage of variance in the corrected population correlation accounted for by statistical artifacts (error); Filedrawer = number of unpublished/unavailable studies at ρ = .10 or .05 needed to pull the corrected population correlation below that value; Mean α = mean Cronbach's alpha reliability estimate; r_{xx} = mean reliability of the independent variable; r_{yy} = mean reliability of the dependent variable; 95 % CI = the lower and upper range of the 95 % confidence interval of the true population correlation

unanswered for over 25 years: assuming foundational characteristics of performance such as control and incentives thwart need satisfaction, what can be the applied value to organizations (cf., Donovan 2001; Locke and Latham 1990)? We have argued that incentives are not inherently inimical to need satisfaction: it's how they're used. As above, we show that the mere presence of incentives has very little effect on need satisfaction. Instead, drilling down deeper, our data show that incentives that are less directly linked to performance actually *boost* need satisfaction.

Previous research has established that incentives themselves predict performance (Jenkins et al. 1998), and our research extends this by showing that need satisfaction and incentives play a joint role in performance contexts. Our current findings show that the mere presence of incentives has little to no impact on the degree to which need satisfaction predicts performance. The real strength in our findings is that the salience of the incentive is much more impactful. Need satisfaction matters least to performance for direct incentives and most for indirectly salient incentives. Given the magnitude of their joint effects, the combined roles of incentives and need satisfaction cannot be ignored in performance contexts.

It merits discussion that our hypothesis surrounding performance quality vs. quantity was not significant. We hypothesized that need satisfaction would be more strongly related to performance quality, as such types of tasks tend to require more of the personal investment and work engagement (Rich 2006) that drives performance. While the relationship was indeed stronger for quality (ρ = .40) than quantity (ρ = .30) type tasks, the confidence intervals overlapped, indicating that the difference may not be meaningful. This difference was however similar to Cerasoli et al.'s (2014) findings for quality (ρ = .35) and quantity (ρ = .26) and are consistent with those of McGraw (1978) and predictions by Vansteenkiste et al. (2004). Thus, although our effect is smaller than anticipated, it is likely that there is a greater effect of need satisfaction for quality than for quantity.

Given our mixed support for Hypothesis 4, we explored additional dimensions of performance. As can been seen in Table 2, the relationship between need satisfaction and performance was significantly stronger for maximal than typical performance. In hindsight, this is not surprising given that maximal performance reflects how one is performing when exerting as much effort as possible (e.g., Sackett et al. 1988). It is no surprise then, that competence, autonomy, and relatedness are more strongly related to performance when one is highly motivated to do well, compared to an average or day-to-day level of performance.

Finally, we note that we have followed the calls of previous research to use the POMP method (Cerasoli et al.

Table 5 Meta-analytic between study means and correlations

	Variable	Mean	SD	1	2	3	4	5	6
1.	NS → Performance	.28	.16	1	75	38	47	17	61
2.	NS: Overall POMP	.68	.13	.11	1	38	47	17	57
3.	NS: Autonomy POMP	.66	.13	−.16	.97	1	15	13	32
4.	NS: Competence POMP	.69	.15	.17	.97	.92	1	14	36
5.	NS: Relatedness POMP	.66	.15	.10	.91	.82	.80	1	14
6.	Performance POMP	.68	.15	−.01	.26	.23	.52	.56	1
7.	Incentive present?	.30	.46	−.01	.08	−.16	.14	–	.03
8.	Indirect vs. Direct	.57	.51	−.30	−.45	.80	−.49	–	−.52
9.	Quality vs. Quantity	.76	.43	−.01	−.11	−.13	−.28	−.09	−.20
10.	Task vs. Contextual	.03	.17	−.01	−.10	−.07	−.18	−.12	−.09
11.	Speed vs. Accuracy	.58	.51	−.25	−.30	.23	−.67	–	.53
12.	Typical vs. Max	.72	.45	.06	.23	.21	.16	.44	−.04
13.	Self vs. Other Criteria	.81	.40	−.10	−.14	−.26	−.19	−.08	.04
14.	Objective vs. Subjective	.39	.49	−.08	.12	.23	.25	.23	.09
15.	Cross. vs. Long.	.39	.49	−.05	−.02	−.23	.07	−.10	.08
16.	NS measured first?	.74	.45	.03	.07	.23	.16	.67	.20
17.	Field vs. Lab	.17	.38	−.07	.02	.06	.02	.18	−.07
18.	Corr. vs. Experimental	.18	.38	.03	−.10	−.04	−.21	−.09	−.14
19.	Published?	.81	.40	.24	−.11	−.19	−.17	−.11	−.24
20.	Work?	.31	.46	−.23	.03	.11	−.01	−.02	.23
21.	Academic?	.35	.48	.13	.08	−.02	.10	−.09	.06
22.	Physical?	.19	.39	.04	.05	.10	−.01	.10	−.28
23.	Sample size	275.39	615.52	−.03	−.08	.14	−.11	.14	.27
24.	IV Reliability	.79	.09	.11	.09	.22	.21	−.01	.28
25.	DV reliability	.84	.10	−.13	−.29	−.17	−.41	.25	−.18
26.	Publication year	2002	1.66	.12	.07	.09	.05	.14	−.05
27.	Mean age	20.13	9.63	−.22	.05	.20	−.05	.01	.00
28.	Percent white	.68	.34	.35	.07	.07	.21	−.08	.10
29.	Percent female	.61	.83	.08	.13	.09	.15	.11	−.13
30.	Time lag in days	62.44	224.56	−.05	.00	−.02	−.07	.08	−.06
31.	Response rate	.66	.17	.12	−.31	−.33	−.53	−.58	−.31

Table 5 continued

	Variable	7	8	9	10	11	12	13	14	15
1.	NS → Performance	50	14	50	108	19	44	103	100	102
2.	NS: Overall POMP	39	10	34	75	13	32	74	73	70
3.	NS: Autonomy POMP	20	3	16	38	6	14	37	36	35
4.	NS: Competence POMP	24	7	21	47	8	25	47	47	44
5.	NS: Relatedness POMP	9	0	4	17	0	7	17	17	16
6.	Performance POMP	31	6	26	61	8	19	60	59	57
7.	Incentive present?	1	14	29	50	8	18	50	50	48
8.	Indirect vs. Direct	–	1	10	14	6	8	14	14	13
9.	Quality vs. Quantity	.05	.22	1	50	16	29	50	49	47
10.	Task vs. Contextual	−.17	–	–	1	19	44	103	100	102
11.	Speed vs. Accuracy	−.15	.32	−.23	–	1	12	19	17	16
12.	Typical vs. Max	.10	−.22	.63	–	–	1	44	42	40
13.	Self vs. Other Criteria	.37	–	.27	−.35	–	.25	1	99	97
14.	Objective vs. Subjective	−.29	−.06	−.81	.22	.24	−.58	−.59	1	95
15.	Cross. vs. Long.	.06	−.35	.07	−.02	.33	−.47	.22	−.11	1
16.	NS measured first?	−.35	.67	−.19	.10	–	.09	−.20	.29	–
17.	Field vs. Lab	.53	.85	.34	−.08	.00	.36	.23	−.28	−.21
18.	Corr. vs. Experimental	.39	.46	.16	−.08	−.14	.35	.17	−.14	−.25
19.	Published?	−.20	.06	.01	.08	.06	−.06	−.10	.09	−.09
20.	Work?	−.24	−.32	−.49	.25	−.06	−.72	−.48	.55	−.04
21.	Academic?	.11	−.56	−.10	−.12	.27	.09	.35	−.34	.37
22.	Physical?	−.39	–	.23	−.08	−.34	.35	−.07	.01	−.16
23.	Sample size	−.15	−.61	.04	.02	−.25	.07	−.02	−.01	−.04
24.	IV Reliability	−.02	−.14	−.27	.02	.26	−.01	.04	.00	−.05
25.	DV reliability	.01	–	.19	−.05	–	−.53	.29	.11	.12
26.	Publication year	−.38	−.68	−.32	.17	−.21	.23	−.25	.21	−.07
27.	Mean age	−.24	.70	−.20	.41	−.08	−.81	−.48	.54	.06
28.	Percent white	−.32	.97	−.39	−.03	.59	.66	−.07	−.22	−.09
29.	Percent female	−.10	.00	.11	.00	−.03	.08	.06	−.09	−.12
30.	Time lag in days	−.10	.31	.06	−.05	–	−.09	.11	.15	.32
31.	Response rate	.09	–	−.49	.21	–	−.19	.32	−.10	.23

Table 5 continued

	Variable	16	17	18	19	20	21	22	23
1.	NS → Performance	38	106	108	108	108	108	108	107
2.	NS: Overall POMP	26	74	75	75	75	75	75	75
3.	NS: Autonomy POMP	11	38	38	38	38	38	38	38
4.	NS: Competence POMP	18	46	47	47	47	47	47	47
5.	NS: Relatedness POMP	8	17	17	17	17	17	17	17
6.	Performance POMP	20	60	61	61	61	61	61	61
7.	Incentive present?	15	49	50	50	50	50	50	50
8.	Indirect vs. direct	5	13	14	14	14	14	14	14
9.	Quality vs. Quantity	9	49	50	50	50	50	50	50
10.	Task vs. Contextual	38	106	108	108	108	108	108	107
11.	Speed vs. Accuracy	2	18	19	19	19	19	19	19
12.	Typical vs. Max	15	43	44	44	44	44	44	44
13.	Self vs. Other Criteria	38	101	103	103	103	103	103	103
14.	Objective vs. Subjective	37	98	100	100	100	100	100	100
15.	Cross. vs. Long.	38	100	102	102	102	102	102	101
16.	NS measured first?	1	36	38	38	38	38	38	38
17.	Field vs. Lab	−.04	1	106	106	106	106	106	105
18.	Corr. vs. Experimental	−.13	1	1	108	108	108	108	107
19.	Published?	.23	−.04	.10	1	108	108	108	107
20.	Work?	−.01	−.20	−.25	−.03	1	108	108	107
21.	Academic?	.06	−.28	−.14	−.18	−.49	1	108	107
22.	Physical?	.01	−.21	−.10	.11	−.32	−.35	1	107
23.	Sample size	.11	−.14	−.14	.02	−.03	.18	−.06	1
24.	IV Reliability	−.32	−.01	−.15	.19	.07	.03	−.11	.15
25.	DV Reliability	.27	.26	.05	.02	.00	−.09	−.03	.17
26.	Publication year	−.08	−.50	−.19	.10	−.01	.07	.29	.17
27.	Mean age	−.05	−.06	−.17	−.19	.86	−.39	−.31	−.05
28.	Percent white	.30	−.15	.32	.20	−.55	.45	−.02	.14
29.	Percent female	.06	−.05	−.05	.06	−.09	−.06	.22	−.01
30.	Time lag in days	.42	−.11	−.12	−.01	−.08	.28	−.17	.12
31.	Response rate	.29	.05	–	.20	−.18	.20	.00	.22

Table 5 continued

	Variable	24	25	26	27	28	29	30	31
1.	NS → Performance	83	39	108	61	23	86	70	34
2.	NS: Overall POMP	63	33	75	43	19	66	50	28
3.	NS: Autonomy POMP	33	22	38	24	11	35	26	19
4.	NS: Competence POMP	37	16	47	28	14	40	29	15
5.	NS: Relatedness POMP	14	9	17	9	7	14	15	8
6.	Performance POMP	50	31	61	34	15	53	45	27
7.	Incentive present?	39	20	50	35	7	44	39	14
8.	Indirect vs. Direct	10	2	14	7	3	14	8	3
9.	Quality vs. Quantity	36	14	50	27	8	41	32	10
10.	Task vs. Contextual	83	39	108	61	23	86	70	34
11.	Speed vs. Accuracy	15	1	19	14	7	18	6	1
12.	Typical vs. Max	32	10	44	25	12	35	24	11
13.	Self vs. Other Criteria	80	38	103	61	23	85	69	33
14.	Objective vs. Subjective	76	38	100	58	21	82	66	32
15.	Cross. vs. Long.	77	37	102	56	21	82	66	33
16.	NS measured first?	27	13	38	20	10	30	31	17
17.	Field vs. Lab	81	39	106	60	23	84	68	34
18.	Corr. vs. Experimental	83	39	108	61	23	86	70	34
19.	Published?	83	39	108	61	23	86	70	34
20.	Work?	83	39	108	61	23	86	70	34
21.	Academic?	83	39	108	61	23	86	70	34
22.	Physical?	83	39	108	61	23	86	70	34
23.	Sample size	83	39	107	61	23	86	69	34
24.	IV Reliability	1	35	83	51	19	70	54	28
25.	DV Reliability	.11	1	39	23	6	32	27	22
26.	Publication year	.16	−.25	1	61	23	86	70	34
27.	Mean age	−.10	−.03	.06	1	16	55	38	20
28.	Percent white	.11	−.14	.08	−.35	1	22	15	7
29.	Percent female	.28	.10	.10	−.07	−.22	1	56	30
30.	Time lag in days	−.19	.36	−.18	.08	.16	−.02	1	21
31.	Response rate	−.08	.35	.18	−.17	.56	.03	−.09	1

Numbers below the diagonal are correlation coefficients; numbers above the diagonal are the number of studies for each coefficient (we suggest caution in interpreting coefficients based on small *k* size); for variables with a question mark 0 = no, 1 = yes; For variables with a "vs." 0 = 1st in pair, 1 = 2nd in pair; POMP = percent of maximum possible, the between-study variable placed on a scale from .00 to 1.00; Cross. = cross-sectional; Long. = longitudinal; a dash (−) indicates insufficient/missing data

2014), which unlocks a wealth of data for subsequent researchers. Although this data goes well beyond the scope of the current research, there are several findings worth noting. In Table 5, we have broken down further by specific need. For the most part, assessing overall need satisfaction makes sense because the effects of all three needs have similar directions and magnitudes of effect; for example, the link between objective vs. subjectively measured criteria and average levels of need satisfaction was similar in direction and magnitude across all three needs ($r = .23, .25, .23$). However, in line with theory, the effect may vary as a function of the need being assessed. For example, as we elaborate upon below, levels of need satisfaction appear related to sample percent White for competence ($r = .21$), but not for autonomy ($r = .07$) or relatedness ($r = -.08$). This suggests using the overall composite ($r = .07$) may mask certain findings. We suggest future researchers use discretion when deciding whether to use an overall assessment of need satisfaction.

From Table 3 and Table 5, there appears to be the possibility of a curvilinear impact of age on the need satisfaction-performance relationship: need satisfaction matters most to performance for those of college age, and less so for adults and children. This could be due to the fact that college students are more stressed than any other age group (e.g., APA 2015); thus, underscoring the importance of psychological need fulfillment on performance. Consistent with the Job Demands Resources Model, psychological need fulfillment likely acts as a resource fundamental to achieving performance goals (e.g., Schaufeli and Bakker 2004), and this is especially true among those experiencing more stress, burnout, and exhaustion. To explore this possibility, future research should follow the lead of previous scholars (e.g., Van den Broeck et al. 2008) and examine how need satisfaction and psychological stress influence performance, namely among vulnerable populations.

In reference to other demographic factors, Table 5 shows the need satisfaction-performance link to be stronger ($r = .35$) and perceived competence to be higher ($r = .21$) among samples reporting a higher percent White. While the main tenets of SDT have typically applied across culture and context, future research might examine where there are differential effects of psychological need satisfaction for race. These findings are consistent with research showing that Whites tend to report higher levels of self-efficacy (e.g., Ross and Sastry 1999) and perceived competence (e.g., Pintrich and Schunk 2002) than other demographic groups. However, these results may be confounded by socioeconomic status (Graham 1994). Furthermore, predominantly White samples were associated with studies that offered direct (vs. indirect; $r = .97$) incentives, and utilized tasks assessing accuracy (vs. speed; $r = .59$), quality (vs. quantity; $r = -.39$), and maximal (vs. typical; $r = .66$) performance. We did not find meaningful relationships for gender.

Finally, we examined several methodological factors in our between study analysis, but few demonstrated any meaningful effects. For instance, the observed effect size appeared largely independent of study setting (field vs. lab, $r = -.07$), research methodology (correlational vs. experimental, $r = .03$), time lag between measurements ($r = -.05$), or nature of the criteria (objective vs. subjective, $r = -.08$). This suggests that the relationship between need satisfaction and performance is largely unaffected by contextual variables. However, the effect of need satisfaction on performance was stronger for published vs. non-published research ($r = .24$). Many of these relationships in Table 5 were ancillary to our main focus, but may be important for future research.

Implications for theory and research

The current review affirms the hypothesis that satisfaction of basic psychological needs is linked to performance, although there remain unanswered questions. While theoretically supported, it remains to be seen whether our proposed mechanisms for the link between need satisfaction and performance hold up. For example, future researchers should empirically examine whether the relationship between perceived autonomy and performance is mediated by locus of causality, volition, and choice.

We designed this review with the hopes that it would foster future research. Future research might meta-analytically examine the relationships among incentives, need satisfaction, intrinsic motivation, and performance, perhaps through meta-analytic regression or path-modeling. Such research could serve several aims. It would provide additional closure to the incentive debate, demonstrating whether the relationship between incentives and erosion of intrinsic motivation is in fact mediated by thwarted need satisfaction, a core tenet of both self-determination theory (Ryan and Deci 2000) and its component cognitive evaluation theory (Deci 1972). If our findings for incentive salience held, such research might also show that using non-salient incentives boosts performance by bolstering need satisfaction as well as intrinsic motivation.

We also note that performance is a broad, multifaceted construct (Campbell et al. 1993). If performance is to be predicted well, it must be well defined and suited to the predictors at hand (Guion 1998). We hypothesized a more fine-grained need-satisfaction - performance relationship by breaking down into quality and quantity. Although our findings were consistent with the expectation that quality would be more strongly predicted by need satisfaction than quantity, the magnitude of the difference was less than expected. However,

we did find a significant difference between maximal and typical performance. As shown by Klehe and Anderson (2007), motivation and ability likely have differential effects on typical vs. maximal performance. Our findings suggest that future researchers should take into account multiple dimensions of performance, such as task versus contextual behavior (Podsakoff et al. 2009), behaviors versus results (Campbell et al. 1993), and team versus individual outputs (Tannenbaum and Cerasoli 2013). The cell size in some analyses, for example non-self report performance in Table 3, $k = 84$, provides ample opportunity for subsequent researchers to drill down where we were not focused.

As others have suggested (Nieminen et al. 2011), our ancillary findings suggest that generalizability from any single study to a larger population must be taken with extreme care. We warn future researchers against one finding in particular, that effect sizes were higher in published studies, reflecting a potential publication bias in the literature.[3] This unfortunately means that researchers likely have to seek out and find large effect sizes to get primary research published (Cortina and Landis 2009). And, it's important to reiterate that findings from one sample or context may not generalize to the next (Dipboye 1990). For example, our findings suggested that need satisfaction may matter more to performance for certain demographics.

Implications for practice

The primary practical implication is that psychological needs are not just "nice to have": they play a central role in performance contexts. Addressing psychological need satisfaction, as we show here, can have performance benefits to organizations for employees, students, and even athletes. But beyond this, there are many indirect benefits as well. Organizations seeking to be better corporate citizens can boost engagement, intrinsic motivation, and psychological well-being by instituting policies and programs that help employees meet their need for autonomy, competence, and relatedness. In turn, an extensive body of work has shown that improved engagement (Christian et al. 2011), intrinsic motivation (Cerasoli et al. 2014), and psychological well-being (Ford et al. 2011) are associated with higher performance.

Interventions to bolster the need for competence are likely have the most utility. One consideration is a goal-setting system. A formal or informal goal setting system encourages individuals to set, fully endorse, and strive for goals that are specific, attainable, and valuable. The act of setting, striving for, and attaining a goal has a strong impact on perceptions of competence and self-efficacy (Locke and Latham 2002), which in turn positively impact performance (Stajkovic and Luthans 1998). More importantly, goal setting has been established through several meta-analyses and hundreds of studies to be a highly effective way to boost performance: individuals who set goals outperform those who do not (Locke and Latham 1990, 2002; Tubbs 1986). Whether goals are established formally or informally, it's also important to provide timely, positive feedback; publicly acknowledged accomplishments can improve subsequent competence and performance (Kluger and DeNisi 1996).

Previous research indicates that there is a strong link between autonomy *supportive environments* and an individual's perceived need *satisfaction* (Gagné 2003; Gagne et al. 2003) Considered alongside our findings, this suggests interventions to boost perceived autonomy will also be valuable to organizations. Telework, a strong facilitator of autonomy (Gajendran and Harrison 2007), has been on the rise in the past decade. Telework refers to the "…proportion of job function(s) performed by employee away from both other employees and the organization's established physical base of operations, using various forms of [technology] to maintain a virtual presence" (Nicklin et al. 2015). Telework's benefits are broad. To society, it reduces automobile traffic, frees up office space, and reduces pollution. To employees, it boosts autonomy by granting a greater sense of control over the pace of work and often by increased ownership and accountability in the work. Organizations reap these benefits in many ways: the higher autonomy telework provides is associated with higher performance (Gajendran and Harrison 2007), as well as improved productivity, retention, and commitment (Martin and MacDonnell 2012). Telework also reduces overhead, broadens the potential talent pool, and reduces downtime due to vacation/sickness (Nicklin et al. 2015).

Finally, relatedness needs can (and should) be fostered. Providing explanations (rather than excuses) makes individuals feel more respected, have a positive view of the organization, and engage in positive behavior going forward (Truxillo et al. 2009). Posting and adhering to agreed-upon policies is also key: the "game" has to be fair. Perceptions of injustice impact organizational commitment, turnover intentions (e.g., Simons and Roberson 2003), satisfaction, and well-being (e.g., Schmitt and Dörfel 1999). From a social exchange theory perspective, trust and perceptions of support are important factors for satisfaction, performance, and well-being (e.g., Aryee et al. 2002).

Limitations

A potential theoretical shortcoming is our simplification of incentives. We treated incentives as categorically present vs. non-present, and directly vs. non-directly salient. In

[3] Reference to a funnel plot (available from the authors) suggested the effect was uniform and not substantial.

theory, incentives come in varying degrees from various sources that change in magnitude over time. However, this tradeoff in theoretical richness is intentional, in that its conceptual simplicity aids understanding and even more important, action. Whereas previous incentive contingencies may have had a high degree of internal validity (Deci et al. 1999), they were unlikely to occur frequently in applied settings (Cerasoli et al. 2014). Although our framing of incentives in terms of salience is a simplified treatment, it nevertheless enables practitioners to consider it when building compensation programs.

Another limitation of our study is the inability to account for the *level* or strength of the incentive. This is a limitation many have noted is common to research on incentives (e.g., Cerasoli et al. 2014; Jenkins et al. 1998). It stands to reason that all things equal, a larger incentive (e.g., $100) should be more motivating than a smaller one (e.g., $1.00). However, demonstrating the strength of this effect in a single primary study is challenging because all things are rarely equal, and human behavior never occurs in a vacuum (Ross and Nisbett 1991). The issue is all the more difficult with meta-analysis, since it's difficult to place incentives from different studies on the same relative metric. Even if in the same currency (e.g., all financial incentives), $1.00 to a child does not have the same incentive value as $1.00 to an adult. Thus, although we showed there to be an effect for the *presence* of incentives, we simply cannot speak to the strength of the effect for incentive *size*.

Notably, we did include some samples from individuals under 18 years of age in our analyses, but do not believe this has a substantial bearing on the results. From a theoretical standpoint, we have no reason to believe that the relationships expected for adults would be opposite to those expected or invalidated for younger individuals, an issue addressed by others (e.g., Greenberg 1987). Further, Cerasoli et al. (2014) in a very similar meta-analysis on the link between intrinsic motivation and performance (as moderated by incentives), found no reason to believe that their results would have varied substantively by excluding children from their analyses. Finally, less than 15 % of the overall sample were children, which would not change the overall conclusions even if there were opposite effects.

A limitation common to meta-analyses is the limited ability to draw causal inferences (Shadish 1996). Because our analyses are based largely on cross-sectional data, our conclusions are similarly limited; causal attributions, while theoretically based, cannot be firmly established with cross-sectional data (Ford et al. 2011; Tannenbaum and Cerasoli 2013) and reciprocity is hard to rule out. For example, there is almost certainly some degree of reciprocity between satisfaction of competence needs and performance: those who feel more competent perform better and those who perform better feel more competent. Claims surrounding linear causality are also challenging, given some temporal research on motivational factors suggesting non-linearity (e.g., Cerasoli and Ford 2014; Gottfried 1990). However, given the lack of difference we found among cross-sectional data (i.e., NS and performance measured concurrently), longitudinal data (i.e., NS measured before performance), and recursive data (i.e., performance measured before NS), this is not likely to have a substantial impact on the conclusions we draw here.

Several other limitations are also common to meta-analysis in general. It is tempting to consider meta-analysis as being more objective or authoritative than primary data. While meta-analysis does provide procedures for cumulating knowledge (Schmidt and Hunter 2001), it involves dozens of subjective decisions (Lepper et al. 1999), so it is important to remember it is both an art and a science (Cerasoli et al. 2014; Rosenthal and DiMatteo 2001). We have of course taken recommended steps to reduce threats to the validity of our findings (Cooper 2003), such as subjectivity (Eysenck 1994) and various checks for publication bias (Aguinis et al. 2011). Even so, some limitations remain. A small number of studies or small sample size limits the conclusions we can reach in certain cells. For example, indirect and non-direct incentives each had only eight samples, suggesting that the reader draw conclusions with care. However, we feel confident based on our search techniques that these cells are small due to holes in the literature, rather than in studies we may have missed (and for which future research could benefit).

Conclusion

People spend more waking time in performance contexts (work, school) than almost anywhere else (Bureau of Labor Statistics 2013). Although widely considered one of the major theories of human motivation, SDT has historically received a lukewarm welcome in such contexts. Traditionally, SDT has been welcomed for its explanation of softer criteria such as well-being, but often ignored or explored secondarily for more concrete performance criteria (Locke and Latham 1990).

We have provided a response to critics of SDT and filled a void in the literature by aggregating research on the role of need satisfaction in performance. Through meta-analytic means, we looked at the combined role of incentives and need satisfaction in performance contexts. We found that at school, work, and in physical (e.g., exercise, sport) domains, the needs for autonomy, competence, and relatedness matter. Importantly, we extended previous research on intrinsic motivation (Cerasoli et al. 2014) by

demonstrating that need satisfaction and indirectly salient incentives are not only compatible, the two have synergistic effects on performance. We implore researchers and practitioners to avoid the temptation to oversimplify incentives as mere *presence*, and instead look more deeply into incentive *salience.*

Compliance with ethical standards

Conflict of interest Christopher P. Cerasoli and Alexander S. Nassrelgrgawi declare that they have no conflicts of interest. Jessica M. Nicklin declares that she has no conflicts of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

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(asterisks indicate studies included in analyses)

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