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Less Information, More Comparison, and Better Performance: Evidence from a Field Experiment

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ABSTRACT

We use a field experiment in professional sports to compare effects of providing absolute, relative, or both absolute *and* relative measures in performance reports for employees. Although studies have documented that the provision of these types of measures can benefit performance, theory from economic and accounting literature suggests that it may be optimal for firms to direct

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employees' attention to some types of measures by omitting others. In line with this theory, we find that relative performance information alone yields the best performance effects in our setting—that is, that a subset of information (relative performance information) dominates the full information set (absolute and relative performance information together) in boosting performance. In cross-sectional and survey-data analyses, we do not find that restricting the number of measures shown per se benefits performance. Rather, we find that restricting the type of measures shown to convey only relative information increases involvement in peer-performance comparison, benefitting performance. Our findings extend research on weighting of and responses to measures in performance reports.

JEL codes: C93, D83, D90, M40, M51, M54

Keywords: performance information; peer comparison; competition; learning; field experiment

1. Introduction

To guide the use of performance evaluation and reporting, a growing literature in accounting examines how internal performance reports affect employee performance (Hannan, Krishnan, and Newman [2008], Tafkov [2013]). Research on effects of performance reports has explored how information users place weight on and respond to different types of measures, and has found that these weights depend on the combination of measures provided—such as nonfinancial and financial measures, or transitory and persistent measures (Lipe and Salterio [2000, 2002], Elliott, Hobson, and White [2015]). Although the popular press has raised the issue of whether reports that show absolute measures, relative measures, or a combination of these measure types to employees will yield the best performance effects (The Atlantic [2015], The Economist [2016]), empirical research has yet to examine this question (Schnieder [2018]). In settings where employees compete against one another on a range of objective performance measures, this question has received substantial attention (McKinsey [2016], Mercer [2019]). We contribute to this issue by conducting a field experiment in a highly competitive setting—professional European football—to compare effects of providing employees with absolute, relative, or both absolute *and* relative information on objective performance measures.[1]

In collaboration with Anton Paar SportsTec—the producers of skills.lab, a state-of-the-art football training simulator used by elite athletes in Germany and Austria—we manipulate performance information reported

[1] We use the word "football" as shorthand for European football, alternatively known as "soccer" in some countries including the United States. We use the term "relative performance information" to refer to performance information that compares the focal agent to his or her peers (e.g., Hannan, Krishnan, and Newman [2008], Blanes i Vidal and Nossol [2011], Tafkov [2013]). We use the term "absolute performance information" to refer to performance information that does not provide a comparison to peers (e.g., Ashton [1990], Kluger and DeNisi [1996]).

during training to 117 professional and semiprofessional players. We vary the attributes of this information on two key performance measures: passing accuracy and speed. These skills are highly valued in this industry and affect the career advancement of players (Liu et al. [2015]), who compete in training for selection in upcoming games and to secure ongoing contracts. We also exploit cross-sectional variation in players' task commitment, immediate career concerns, and level of experience to test for and demonstrate individual characteristics that lead to heterogeneous responses to performance information.

In our tests on the full sample, we find that relative information boosts performance more than absolute information. This result is particularly strong for players who have more direct competitors for their position, and so our study demonstrates the benefits of providing employees with ranks on objective measures in settings where career concerns are strongly tied to relative performance. We then show, across a range of performance outcomes, that relative information is as or more effective at boosting performance than the combination of both relative and absolute information. Players who receive relative information alone, rather than receiving the combination of relative and absolute information, achieve an incremental performance improvement that is equivalent to rising from the 50th percentile to roughly the 70th percentile in terms of both proximity to target and speed of completion. Given that these positive effects occur across both speed and accuracy, our study documents broad performance benefits resulting from performance report design.

The performance benefit of providing relative information in isolation is consistent with studies that account for models of human cognition, which suggest that added information can lead to worse performance (Birnbaum [1976], Tversky and Kahneman [1974, 1983], Simon [1979], Gigerenzer and Goldstein [1996], Casas-Arce, Lourenço, and Martínez-Jerez [2017]). We draw on this literature to understand why relative information outperforms the combination of relative and absolute information in our setting.

First, we exploit cross-sectional variation to examine whether adding absolute information alongside relative information harms performance by providing players with "too many" measures per se. When forced to process quantities of information that exceed their cognitive capacity, information users can become stressed and disengage from the source of the information (Ettema and Zielhuis [1971], Malhotra [1982], Bawden [2001]). Supplemental analysis suggests that this mechanism does not explain our results. Specifically, when we hold constant whether performance information is absolute or relative, we find that adding additional measures does not affect performance. Instead, performance declines only when we provide additional measures by adding absolute information alongside relative information.

We then explore the concept from management accounting literature that employees change their weighting of a measure in the presence of other measures, and that this can lead to worse performance (Kaplan and Norton [1996], Lipe and Salterio [2000], Casas-Arce, Lourenço, and Martínez-Jerez [2017]). In particular, we draw on research from psychology and behavioral economics that shows that individuals place greater weight on and respond more strongly to a cue when it is presented alone rather than in combination with another cue (Lichtenstein, Earle, and Slovic [1975], Birnbaum [1976], Kruschke and Johansen [1999], Dellavigna [2009]). In line with this insight, we find that the average player places less weight on relative performance information—engaging less in peer comparison and performing worse—when we include absolute information alongside relative information in their performance report.

This reduced weighting of relative information does not harm performance for all players, and we examine this cross-sectional variation in our results. Less-experienced players, who are in developmental stages of their careers, benefit from this shift in cognitive weight away from peer comparison and toward their own performance in absolute terms. For the average professional in our study, who is experienced and highly skilled, we find a negative effect of adding absolute information alongside relative information.

Our study makes three primary contributions. First, we extend the literature on the design of performance measurement and evaluation systems within firms. Research in management accounting has demonstrated that internal reports and feedback are effective tools for heightening motivation, communicating strategic priorities, and improving performance (Simons [1995], Kaplan and Norton [1996], Hannan, Krishnan, and Newman [2008], Casas-Arce, Lourenço, and Martínez-Jerez [2017]). To extend this literature, we offer evidence that managers can boost employee performance by reporting the subset of measures that best motivates and facilitates development in a given setting.

Second, our study has implications for the broader accounting literature on the marginal costs and benefits of providing information to decision makers. Studies of financial reporting have shown that, due to investors' limited attention and processing power, disclosing redundant measures or measures that distract from the salience of key measures can lead to inefficient investment (Hirshleifer and Teoh [2003], Elliott, Hobson, and White [2015], Cardinaels, Hollander, and White [2019]). There is also evidence that firms consider these information processing costs when making disclosure decisions (Blankespoor [2019], Basu, Pierce, and Stephan [2019], Blankespoor, deHaan, and Marinovic [2020]). In our study, we highlight that managers should also consider the trade-off between the marginal costs and benefits of providing information *within* the firm. Managers can draw on our findings as evidence that the marginal costs of adding information to a report can be sufficient to outweigh the marginal benefits.

Third, we extend research that examines heterogeneity in responses to performance information. This literature has explored how effects of performance information depend on moderators including ability, gender, and education (Azmat and Iriberri [2010], Barankay [2012], Eyring and Narayanan [2018]). We extend this literature by examining how effects of performance reports depend on task commitment, career concerns, and professional experience. First, we find that task commitment, which we measure using data on how frequently a player normally trains, enhances the performance benefits of relative performance information. Second, we find that career concerns, which we measure in terms of intensity of competition for immediate career outcomes, also strengthen the performance benefits of relative performance information.[2] This is consistent with theory that relative performance information should have stronger effects on motivation when there are stronger incentives to achieve a high rank (Tafkov [2013]). Third, we also find that less-experienced employees, who are more likely to be in a developmental stage of their careers (Podsakoff and Farh [1989], Goodman, Wood, and Hendrickx [2004]), perform best when they receive both absolute and relative performance measures. This result among players in an early stage of their careers is consistent with theory that a broader set of information is useful for learning and skill development (Song et al. [2018]).

The remainder of this paper is organized as follows. Section 2 describes our field site, skills.lab, and the industry in which it operates. Section 3 outlines the related literature and develops our hypotheses. Section 4 outlines our field experiment and data. Section 5 reports the results of our empirical analysis. Section 6 concludes.

2. *Setting and Institutional Background*

2.1 FIELD SITE

Our field site is skills.lab, an indoor training simulator used by professional and semiprofessional football players in Austria and Germany. The simulator guides players through practice passing drills in highly controlled, game-like conditions.[3] Motion-tracking technology allows the simulator to measure and report a player's performance in passing drills (see appendix A, exhibit 1). After a player completes a drill, the simulator displays information on two dimensions of performance that are highly valued in football—passing accuracy and speed (Redwood-Brown [2008],

[2] A number of studies have examined how pay-for-performance contracts moderate effects of relative performance information (Lazear and Rosen [1981], Hannan, Krishnan, and Newman [2008], Tafkov [2013]). Our study complements this literature by using natural variation in career concerns in a field setting, along with randomly assigned provision of relative performance information, to demonstrate how promotion-based incentives moderate effects of relative performance information.

[3] Simulator-based training is now common practice in professional football. As evidence of this, in addition to using the on-site simulator at skills.lab, a number of first-division football teams in Europe have ordered versions of the simulator for installation in their own training facilities (skills.lab [2019a, b]).

Liu et al. [2015]). Managers and coaches can set the simulator to provide their players with absolute, relative (i.e., ranks), or both absolute and relative performance information.

For our experiment, we take advantage of a number of technical features of the simulator. As the simulator is fully programmable and automated, we keep the elements of the passing task perfectly replicable among participants. We randomly assign different performance information treatments at the player level, and precisely measure the performance of each player in our experiment by using skills.lab's tracking technology. We exploit the combination of these features to provide precise, causal estimates of the performance effects of the different types of information.

2.2 INDUSTRY AND INCENTIVES

The workers in our study are professional and semiprofessional athletes. They range in experience from rookies to veterans. The typical player in our sample attends daily training sessions—including regular drills in the skills.lab simulator—and competes weekly in games.[4] During practice and as part of their post-game evaluations, elite football teams commonly provide players with detailed, quantitative performance information, including ranks (The New York Times [2019]).

Strong incentives motivate players to outperform their teammates while training in the skills.lab simulator. The players in our study are interested in securing a spot in the best league and a starting spot in their current team. Managers reported using players' rank in the simulator when making these selection decisions. Managers also explained that players are aware of this practice and thus have strong incentives to perform well in the simulator. This data-driven approach to talent identification is widespread in the industry (Güllich [2014]). Players face stronger competition for starting spots in upcoming games when teammates who play the same position are also participating in the drill. The number of players competing for the same starting spot on a team is apparent to the participants in our study given that they arrive to the simulator in teams for their training sessions. We are able to measure within each team the depth of players at a given position who are participating in the experiment and competing for the same starting spot on the team. In cross-sectional analysis, we use variation in this measure to explore how our results depend on players' immediate career concerns.

Career advancement produces large financial payoffs in our setting. The average annual salary for an athlete playing first-division football in one of Europe's top-five leagues is $2.4 million (The Guardian [2018]). Within the season, players receive bonuses when they are selected for games and

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[4] Professional players spend the bulk of their training time—upward of two to three hours per day—performing practice drills and exercises designed to hone their ball-handling and passing skills (DFB [2018]).

for meeting performance targets (e.g., scoring a certain number of goals; Frick [2011]). At the end of each season, some players who fail to make regular appearances or who perform poorly in games are cut from the roster, traded to rival teams, or relegated to play in one of their club's lower-level teams (Morris, Tod, and Oliver [2015], Gong, Sun, and Wei [2018]).

Managers' use of the simulator for selection decisions is based on their belief, borne out by observations they reported to us, that objective performance in the simulator is associated with subjective evaluations of players and with players' performance in games. Administrators at skills.lab similarly explained, "we observe a strong correlation between skills.lab and in-game performances." Moreover, training is an integral part of players' job responsibilities. Thus, we are studying a task that is both fundamental to a job and one that is related to and influences career outcomes. This helps our study generalize to other settings with these features.

Our study speaks most directly to settings where highly skilled workers in competitive settings receive performance information in terms of objective measures. Workers in such settings include health care providers, mutual fund managers, school teachers, and airline pilots (Muralidharan and Sundararaman [2011], Berk and van Binsbergen [2015], Song et al. [2018], Gosnell, List, and Metcalfe [2020]). More generally, "star" senior executives—whose relative performance is also highly public and commonly covered in the popular press—face career incentives and performance pressures akin to those that professional athletes face (Brickley, Linck, and Coles [1999], Malmendier and Tate [2009], Lucifora and Simmons [2003]). Furthermore, like professional football teams, firms in financial services, consulting, and high-growth industries commonly employ performance ranks to foster internal competition (Cappelli and Tavis [2016], CNBC [2019]).

For these reasons, a number of studies in accounting, economics and finance have similarly used professional sports as a setting to examine fundamental economic questions concerning the role of incentives and information within firms and markets (Brown [2011], Cadman and Cassar [2015], Black and Vance [2017], Allen et al. [2017]). As in those papers' settings, our study's field site involves objective performance measurement. McKinsey [2016] and Mercer [2019] discuss how a number of firms in settings that include heath care, consumer technology, and logistics have switched among the alternatives of providing relative, absolute, or relative and absolute information on objectively measured performance. In section 3, we discuss theory specific to subjective performance measurement. We acknowledge that our findings do not address issues of actual or perceived favoritism and unfairness that can result from subjective performance evaluation systems (Bol et al. [2010], Bol [2011]).

3. Literature Review and Hypotheses

Our predictions draw on literature that examines absolute and relative information as determinants of performance. Absolute performance information describes performance without offering a comparison to others' performance. In contrast, relative performance information describes performance *in relation* to a benchmark group, such as peers or coworkers (Ilgen, Fisher, and Taylor [1979], Kluger and DeNisi [1996]). Accounting research has shown that both absolute and relative performance information serve as developmental and motivational tools for improving performance (Hannan, Krishnan, and Newman [2008], Tafkov [2013], Casas-Arce, Lourenço, and Martínez-Jerez [2017]).

A number of studies demonstrate that each of these types of performance information can facilitate learning about the relationship between an action and an outcome (Adams [1987], Hirst and Luckett [1992], Kluger and DeNisi [1996], Song et al. [2018]). In our setting, performance information should assist learning by allowing players—in particular, less-experienced players who are in a developmental stage of their career—to see how ball-handling and striking techniques affect passing accuracy and speed.

In addition to facilitating development, performance information also motivates workers by establishing a feedback loop between effort and reported improvement (Deci [1972], Ilgen, Fisher, and Taylor [1979], Locke and Latham [1990]). Studies in psychology and economics show that reported success generates positive "affect"—or sensations—and this motivates individuals to exert effort in order to perform well (Ilies and Judge [2005], Barankay [2012]). As an example in accounting, auditors were more motivated and improved their performance on a classification task when given absolute performance information (Ashton [1990]). Performance information in our setting should similarly motivate improvement by allowing players to see changes in their performance on the passing drill.

Studies on performance information have examined the incremental benefits of providing relative performance information as compared to providing absolute performance information.[5] General evaluability theory suggests that these benefits derive partly from the added evaluability of relative information, or its ability to aid in interpreting one's own

[5] See Schnieder [2018] for a review of literature on relative performance information's positive effects on learning and motivation. We note that some studies have found that relative performance information produces negative effects when there is social pressure to conform (Bursztyn and Jensen [2015], Ashraf [2018]). However, as in many settings that have found positive effects of relative performance information (e.g., Hannan, Krishnan, and Newman [2008], Tafkov [2013], Eyring and Narayanan [2018]), the relative performance information that we provide does not reveal participants' identities and ranks to other participants, and so may not generate pressure to conform.

performance (Hsee and Zhang [2010]). Specifically, the benchmark of peer performance helps in identifying whether performance is strong and where improvement is necessary (Song et al. [2018]). Lacking this inherent benchmark, absolute performance information leads the information user to search for a benchmark, which can be an arbitrary standard like position relative to a round number (Abeler et al. [2011], Allen et al. [2017], Eyring and Narayanan [2018]).[6] Especially in competitive settings like ours, where standing relative to peers is relevant for career outcomes, relative information is likely to facilitate learning about the favorability of performance.

In addition to promoting evaluability, relative measures provide sources of motivation that absolute measures alone do not. Specifically, relative measures allow peer-performance comparison, which triggers the inherent desire within individuals to compare favorably to peers (Festinger [1954], Suls and Wheeler [2000], Roels and Su [2014]). As a result, even when payoffs are not tied to relative performance, relative information motivates workers (Frederickson [1992], Azmat and Iriberri [2010], Blanes i Vidal and Nossol [2011], Barankay [2012]). Furthermore, when peers are competing for payoffs, peer-performance comparison operates through financial incentives to motivate workers (Bull, Schotter, and Weigelt [1987], Casas-Arce and Martínez-Jerez [2009], Eriksson, Poulson, and Villeval [2009]). These incentives arise when contracts explicitly account for relative performance, and also when relative performance and career advancement are implicitly connected through hiring and promotion practices (Lazear and Rosen [1981], Campbell [2008], Newman and Tafkov [2014]). The latter scenario describes our setting, in that managers use performance in the simulator as a factor when selecting players for divisions, teams, and starting positions.

We also note that some studies have demonstrated, at least in certain cross-sections, that the provision of relative information in performance reports harms performance (Hannan, Krishnan, and Newman [2008], Ashraf [2018]). The business press has pointed to these and other issues when discussing reasons why some companies have stopped providing relative measures to employees (The Atlantic [2015], Mercer [2019]). For example, relative information can discourage employees who are at developmental stages of their careers (Goodman, Wood, and Hendrickx [2004], Forbes

[6] In accounting research that uses experiments to study performance information, participants often receive absolute performance information on either a task that they are unlikely to have completed before or an entirely novel task designed explicitly for the study (Ashton [1990], Hannan, Krishnan, and Newman [2008], Hecht, Tafkov, and Towry [2012], Tafkov [2013]). In our study, the task is different on some parameters—the particular speed and sequence of balls passed to the player from different directions—but generally similar to those that players have experience with. Experience with similar situations should aid evaluability of absolute information in our setting as compared to one in which the task is completely novel. Nonetheless, relative information offers the advantage of an explicit and inherent benchmark suited to the particular task to promote evaluability.

[2018]). Also, some employees complain that relative information in the form of a ranking, as we use in our study, does not allow managers to provide high marks to all employees even when management is highly satisfied with the entire group's performance (The Atlantic [2015], Forbes [2018]).

These downsides of relative information plausibly apply in our setting and in others, ranging from financial service to consumer technology companies, where managers provide relative information on objective measures to employees in a competitive workforce (The New York Times [2015], McKinsey [2016]). There are other issues that arise in particular contexts, such as feelings of unfairness when relative measures are determined subjectively, that are not at play in our setting. Our results regarding the effects of relative information thus speak to settings in which a subset of problems that can result from relative information are relevant.[7]

Collectively, this theory and prior empirical work suggests that the informational and motivational advantages of relative information should be especially pronounced in our setting. In particular, the players in our study face substantial competition for career advancement, and theory suggests that this will enhance the motivational effect of relative information (Lazear and Rosen [1981], Newman and Tafkov [2014]). Also, in competitive contexts, relative information is more likely to enable learning about the favorability of performance (Hsee and Zhang [2010], Song et al. [2018]). Moreover, the average player is highly skilled and experienced and so is less likely to experience feelings of discouragement from relative information that occur in developmental stages (Bandiera, Barankay, and Rasul [2013]).[8] Taking these features of our setting into account, we predict that relative information will boost performance more than absolute information for the average player in our study. It is worth noting that this prediction describes an average effect, and that our analyses account for and explore variation in cross-sections of the sample.

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[7] Some concerns regarding relative information arise in particular contexts and do not, or are less likely to, apply to our setting. For example, the business press has suggested that subjectively measured ranks can be demotivating if employees feel that the ranking system is biased (CNBC [2019]). As in many performance reports (The New York Times [2015], McKinsey [2016]), the measures in our setting are objective, and so our study does not speak to dynamics that apply in the case of subjective measures. Another potential downside of relative information is that some employees feel that rankings are overly harsh or "cruel" (The Atlantic [2015]). The participants in our setting are accustomed to selection that depends on relative standing by objective measures (Güllich [2014]), and so are less likely to view rankings as overly harsh.

[8] The average player in our sample is highly experienced and has immediate career concerns to achieve a high rank in the training. In terms of players' generally advanced level in their field, we show in table 1 that the average player began playing organized football about 15 years prior to the experiment. We also note that each player has ascended to a paid level of play and so has career concerns to secure a starting spot as aided by obtaining a high rank in the simulator.

H1: Players who receive relative performance information outperform players who receive absolute performance information.

In cross-sectional analyses, we explore moderators of the effect of relative information. We first consider the role of task commitment. Relative performance information presents a descriptive norm, or implicit goal, to outperform peers (Azmat and Iriberri [2010], Blanes i Vidal and Nossol [2011]). Research in psychology has shown that task commitment is a determinant of willingness to exert effort toward a goal (Locke and Latham [2002]). We expect that players who are committed to outperforming peers, as indicated by the frequency with which they train, will benefit more from relative performance information and the implicit goal to outperform peers.

We also expect career concerns to positively moderate the effects of relative performance information on performance. Research suggests that performance effects of relative information will be greater in situations where it is more important to achieve a high rank in order to obtain payoffs (Tafkov [2013]). In our setting, these conditions plausibly apply when a player is competing with more teammates for the same starting lineup spot.[9] In such cases, managers can compare more players based on their rank in the simulator and be more selective when deciding on the starter. We predict a stronger response to relative information under these conditions.

We then consider how adding absolute information to relative will affect performance. On one hand, theories regarding motivation and learning suggest that there are distinctive benefits of relative and absolute information. Thus, it is plausible that providing both measure types will offer the performance benefits of each.[10] For instance, players who have access to absolute measures alongside relative measures should gain the motivational effects of peer-performance comparison and benefit from being able to cleanly observe how small changes in effort affect performance—changes that are unlikely to show up in "chunky" relative measures like ranks (Bonner and Sprinkle [2002]). In theory, this fea-

[9] As mentioned in the setting and institutional background section, the number of players competing for the same spot on a team is apparent to the participants in our study given that they arrive in teams to the simulator for their training sessions.

[10] Hannan et al. [2019] study feedback that varies in its temporal aggregation and detail. They test some conditions that contain absolute information alone and others that include absolute and relative information. They do not compare these to relative information alone. Their lab setting does not involve career concerns or explicit incentives for performance. The authors do not predict or report effects on performance. Instead they study how feedback directs effort toward or away from firm-desired allocations. We assess performance effects in the presence of strong implicit incentives where firm-desired allocation of effort across tasks is not a salient feature (i.e., managers express a strong interest in both passing speed and accuracy). Our study explores whether the provision of less information in a report is able to generate positive, multidimensional performance effects.

ture of absolute-and-relative performance information allows for greater learning and heightened motivation.[11]

On the other hand, two bodies of research on human cognition suggest reasons why players would perform worse when we add absolute measures alongside relative measures (Simon [1979], Einhorn and Hogarth [1981]). First, the literature on information overload suggests that performance reports can present enough measures to exceed an employee's cognitive limits. Studies have shown that difficulty processing large amounts of information can lead to stress and to disengagement with the content (Bawden [2001]). The addition of absolute measures alongside relative measures could provide a sufficient number of information cues to cause information overload. Empirical evidence of information overload, though, has generally found these effects in settings with a larger number of measures than we include in many of our study's performance reports (Miller [1956], Eppler and Mengis [2004]). Moreover, accounting research on the balanced scorecard suggests that managers can learn from large numbers of measures (Kaplan and Norton [1996], Campbell et al. [2015]).

A second body of research explains why the addition of absolute measures alongside relative measures would harm performance by inducing a shift in the weights that players place on information. This literature documents that individuals change the weights that they place on a set of cues if additional information or cues are included in a report (Birnbaum [1976], Gigerenzer and Goldstein [1996], Kruschke and Johansen [1999]). Prior research has shown evidence of this effect whereby information factors less in judgement and decision-making in the presence of other, less useful, cues (Kahneman and Tversky [1972], Tversky and Kahneman [1974, 1983], Gigerenzer and Goldstein [1996]).

In accounting literature in particular, a number of studies have explained how employees reduce their weight on, and response to, performance measures due to their context alongside other measures.[12] In our setting, this suggests that players will reduce the cognitive weight they place on relative information when absolute measures are included alongside relative measures. We expect that this shift in weight away from relative information—and the associated decrease in peer-performance

[11] Behavioral decision research has also shown that individuals who are inexperienced with feedback-based decisions are also more risk-seeking in the loss domain (Barron and Erev [2003]). In our setting, this finding suggests less-experienced players may be more likely to experiment with different techniques and explore "risky" passing strategies. Performance information that contains both absolute and relative performance measures could help this process of experimentation and learning.

[12] For example, Lipe and Salterio [2000] demonstrate that information users ignore unique measures when they are provided with reports that also contain measures that are shared across business units. Lipe and Salterio [2002] and Cardinaels and van Veen-Dirks [2010] document that the groupings and categorizations of measures in a report can cause managers to weight nonfinancial numbers less than financial numbers.

comparison—will, on average, inhibit the learning and motivational benefits of relative measures and harm performance.[13]

Our second set of hypotheses introduces a test of whether adding absolute measures alongside relative measures harms performance and whether this is consistent with information overload. H2a predicts that the addition of absolute measures alongside relative measures will lead to worse performance than providing relative measures alone. H2b predicts that, holding constant whether a report conveys performance in absolute or relative terms, increasing the number of measures by a similar amount through the addition of detail will similarly harm performance. If we find support for H2a and H2b in our setting, our results would be consistent with the idea that this increase in the number of measures in a report induces information overload.

H2a: Players who receive relative performance information alone outperform players who receive absolute and relative performance information.
H2b: Holding constant whether performance information is absolute or relative, players who receive aggregated performance information outperform players who receive detailed performance information.

We then examine whether the weight that players place on information shifts across measures when we add absolute measures alongside relative measures. As we discussed earlier in this section, a shift in cognitive weight away from relative information and associated peer-performance comparison would plausibly reduce performance on average in our setting. To test for this mechanism whereby adding absolute to relative information can reduce performance, we first predict with H3a that peer-performance comparison is positively related with performance in our setting (Tafkov [2013]). H3b then predicts that this involvement in peer-performance comparison will decrease when we add absolute measures alongside relative measures.

H3a: Players who are more involved in peer-performance comparison perform better.
H3b: Compared to players who receive only relative performance information, players who receive both absolute and relative performance information are less involved in peer-performance comparison.

Due to variation in player types across our sample, we also allow for heterogeneity in performance effects. Theory suggests that workers at a developmental stage of their careers are focused on trying different strategies to improve their performance in absolute terms and find relative information less motivating (Vaughn [1936], Podsakoff and Farh [1989],

[13] We do not infer whether this behavior is rational in our setting. The lack of a standardized, public mapping between performance outcomes in the simulator and players' selection incentives prevents a clear identification of "underweighting" relative to a rational player (i.e., we do not know the "true" weights the players *should* place on the performance measures).

Locke and Latham [2002], Goodman, Wood, and Hendrickx [2004]). For these players, the shift in weight away from relative and toward absolute information is likely to benefit performance. We address these portions in cross-sectional tests of our estimated performance effects.

4. *Experiment Design*

4.1 SUBJECTS

We sourced the players in our study from 11 different professional clubs, with four clubs providing 79% of all participants. On average, the athletes in our sample started playing football at five years of age and have approximately 15 years of experience competing in the sport. Players in the sample frequently practice their skills in training and matches, with the average player training just over five times a week and competing in matches most weeks during the season. Seventy-two percent of the individuals in our sample were either starting or substitute players for a professional team in the 2018–2019 football season. Around 10% of players in our sample are goalkeepers, 30% are defenders, 44% are midfielders, and 16% are forwards. This reflects the standard composition by position of players on a team's roster (Bundesliga [2020]). Almost 85% of the sample had trained in the simulator prior to the experiment.

4.2 REAL-EFFORT TASK

As part of their regular training, players had to complete a passing drill two times at the skills.lab simulator (see appendix A, exhibit 2). The training drill required a player to complete 12 passes. To complete a pass, the player received a ball fired sequentially from one of two ball machines located on the left and right sides of the simulator. After receiving the ball, the player then passed the ball to a dynamic target projected onto one of the walls of the simulator. The target consisted of a semicircle with a diameter of 1.85 m at the feet of a projected teammate (see appendix A, exhibit 3).

The specifications of the drill, including the speed of the passes and the target for passes, were adapted for our study. None of the players had practiced this specific version of the drill before. To prevent players from anticipating the location and movement of the target, a sequence of 12 starting and end positions for the target (one for each ball) was randomly drawn for each round. Players had a maximum of about 11 seconds to complete a pass before the next ball was fired from the simulator's ball machines.[14]

Players completed the task once and then received performance information. Players then completed the drill a second time and again received information on their performance. This information showed only the

[14] Based on historical user data, this time limit is the standard setting employed by the site when conducting drills in the simulator.

player's performance on the most immediate iteration of the drill. Players did not exit the simulator between drills and were not exposed to other participants during treatment.

4.3 TREATMENT CONDITIONS

We randomly assigned each player to receive one of six performance information treatments. On the measure-type dimension of treatment, we randomly assigned each player to receive either absolute, relative, or both absolute and relative performance information. On the information detail dimension of treatment, we randomly assigned each player to receive either a report of average performance for all passes during the round (i.e., aggregate information) or to receive a report of average performance for passes that required a right turn, average performance for passes that required a left turn, and average performance for all passes during the round (i.e., detailed information; see appendix A, exhibit 4). The breakdown by turn direction is relevant given that it requires the use of either the dominant or nondominant foot in a different combination, which can lead to slower times and less accuracy for the player's less preferred side. Skill at both types of passes is key to performance at the highest levels of football (Rein, Raabe, and Memmert [2017]). The procedure of the experiment is outlined in appendix A, exhibits 5 and 6.

Players in the *Absolute* information treatment arm received the following performance measures on passing accuracy and speed of execution: percent of passes on target, average distance of pass from the center of the target (in meters), fastest time handling ball (in seconds), and average time handling ball (in seconds). We describe these measures more fully in subsection 4.4 and in appendix B. Players in the *Relative* information treatment arm received the same performance measures but presented in the form of a performance rank for each of the measures (e.g., 19 of 32 for average time handling the ball, etc.). To arrive at this rank, each player's performance was compared to the performances of players from a common reference group. The reference group consisted of 31 professional or semiprofessional players who completed the same training drill in the simulator at skills.lab during the pre-experiment period. No player from the reference group participated in the experiment. The players in the reference group were of a similar age, ability, and level of experience as the subjects who participated in the experiment. Finally, players in the *Absolute&Relative* information treatment arm also received the same performance measures but presented in both absolute *and* relative terms.

In addition to receiving the same measures as the players in the *Aggregate* information treatment arm, players in the *Detail* information treatment received a breakdown showing the measures for passes that required the player to turn to their right and for passes that required the player to turn to their left. As such, players in the *Detail* information treatment arm received three times the number of performance measures as players in the *Aggregate* information treatment arm.

The interaction of these two treatment arms led to six treatments: *Absolute* x *Aggregate*, *Absolute* x *Detail*, *Relative* x *Aggregate*, *Relative* x *Detail*, *Absolute&Relative* x *Aggregate*, *Absolute&Relative* x *Detail* (see appendix A, exhibit 7). In line with prior field-based research on performance information, we do not have an experimental group that received no performance information (Casas-Arce, Lourenço, and Martínez-Jerez [2017], Song et al. [2018]). We take this approach because feedback is a strong organizational norm in our setting and players who train at skills.lab expect to receive at least some performance information after each drill. In terms of the total number of performance measures contained within the different treatments, *Absolute* x *Aggregate* and *Relative* x *Aggregate* featured four measures, *Absolute* x *Detail* and *Relative* x *Detail* featured 12 measures, *Absolute&Relative* x *Aggregate* featured eight measures, and *Absolute&Relative* x *Detail* featured 24 measures.

4.4 MEASURES

Our study employs player performance data at the drill level. Our measures of performance on the drill are the main dependent variables. These measures capture the accuracy and speed of the passes completed by each player. To describe the sample and address effect moderators and mechanisms, we gathered demographic data and self-reported measures of responses to the performance information.

In our analysis, we use the two measures of passing accuracy reported to players while in the training simulator. The first, *Hitrate*, is defined as the proportion of passes on target that a player completed during the drill. *Distance* is a continuous measure of accuracy and is defined as the average distance (in meters) from the center of the target for the 12 passes that the player completed during the drill. The lower the score on this measure, the more accurate the player's passing.

We also use the two measures of ball-handling and passing speed recorded by the training simulator and included in the performance information. *Fast_Time* is the quickest time (in seconds) it took the player to complete a pass during the drill. *Avg_Time* is the average time (in seconds) it took the player to complete a pass over the 12 passes completed during the drill. For both of these measures, lower times reflect quicker ball-handling and passing.

Our analysis also uses player demographics and responses to surveys. We observe the age, gender, height and weight, playing attributes, experience, and language of all subjects in our sample. Using a post-survey questionnaire, we collected information on peer-performance comparison and on perceptions of the quantity of information provided.

Appendix B contains a full list of variable definitions. We use *Hitrate*, *Distance*, *Fast_Time*, and *Avg_Time* as the main dependent variables in our experiment. Table 1 reports descriptive statistics for our per-

TABLE 1
Descriptive Statistics

	N	Mean	SD
Performance measures			
Hitrate (dec.)	117	0.76	0.13
Distance (m)	117	0.8	0.35
Fast_Time (s)	117	2.27	0.13
Avg_Time (s)	117	4.3	1.04
Demographic variables			
Age	117	21.44	4.65
Gender	117	0.15	0.36
League Level	117	0.22	0.42
% Games Entered	117	72.05	31.73
Tenure	117	4.02	3.03
Simulator Experience	117	1.79	1
Training	117	5.54	1.09
Height	117	179.49	7.42
Weight	117	72.56	8.95
Football Experience	117	15.54	4.80
Position Depth	117	1.92	1.31
Post-experiment survey			
Comparison (standardized mean)	117	0	0.31
Too Many Measures	117	2.52	1.32

This table presents the descriptive statistics for measures of performance, demographic variables, and post-experiment survey questions. The performance measures are reported as in Round 2, after the delivery of performance information. The factor analysis used to compute *Comparison* yields a score that is standardized to mean zero. An analysis of covariate balance shows that there are no statistically significant differences among the six assigned treatment groups on performance prior to the delivery of performance information or on demographic variables at the 0.05 level. Appendix B contains a full list of variable definitions.

formance measures, player demographics, and post-experiment survey responses.[15]

5. *Analysis*

We employ ordinary least squares (OLS) regression, with full interaction of treatments, to test for effects. We include controls for initial performance, league level, and player demographics in line with the guidance from econometric research that, in field experiments where randomization is used, “it is customary to control for covariates to correct for chance associations between treatment status and applicant characteristics and to increase precision” (Angrist and Pischke [2008]). Field-experimental re-

[15] An analysis of covariate balance shows that there are no statistically significant differences among the six assigned treatment groups on pre-treatment performance or on demographic variables at the 0.05 level. We note that players in all treatments report considering comparison at multiple times during the experiment. Those players in the relative treatment arm report considering comparison significantly more often than those in the other treatments. This effect represents a 0.98-point increase ($p < 0.01$) in comparison on the construct’s one- to seven-point scale.

TABLE 2

Effect of Relative Information and Detail in Performance Report

	(1) *Hitrate*	(2) *Hitrate*	(3) *Distance*	(4) *Distance*	(5) *Avg_Time*	(6) *Avg_Time*	(7) *Fast_Time*	(8) *Fast_Time*
Relative	$0.10^{***,\circ}$	$0.11^{**,\circ}$	$-0.21^{**,\circ}$	−0.21	$-0.76^{***,\circ}$	$-0.86^{**,\circ}$	-0.05^{**}	−0.06
	[2.62]	[2.27]	[−2.08]	[−1.54]	[−2.75]	[−2.27]	[−2.03]	[−1.63]
Absolute&Relative	0.04	0.04	−0.08	−0.09	-0.43^{*}	−0.41	-0.08^{***}	-0.14^{***}
	[1.40]	[0.87]	[−0.71]	[−0.65]	[−1.79]	[−1.14]	[−3.13]	[−3.67]
Detail	−0.01	−0.00	0.05	0.04	0.06	0.03	0.02	−0.02
	[−0.33]	[−0.07]	[0.59]	[0.25]	[0.26]	[0.07]	[1.19]	[−0.47]
Relative × *Detail*		−0.03		0.01		0.19		0.01
		[−0.47]		[0.06]		[0.36]		[0.27]
Absolute&Relative × *Detail*		0.01		0.02		−0.07		0.11^{**}
		[0.15]		[0.10]		[−0.14]		[2.29]
Age	−0.01	−0.01	0.02^{*}	0.02	0.05	0.05	0.00	0.00^{*}
	[−1.51]	[−1.46]	[1.68]	[1.62]	[1.61]	[1.56]	[1.55]	[1.72]
Gender	-0.12^{**}	-0.12^{**}	0.10	0.10	0.94^{**}	0.91^{**}	0.04	0.04
	[−2.26]	[−2.12]	[0.85]	[0.82]	[2.34]	[2.20]	[1.27]	[1.43]
Height	−0.00	−0.00	−0.01	−0.01	0.03	0.03	0.00	0.00
	[−1.17]	[−1.00]	[−0.78]	[−0.75]	[1.24]	[1.09]	[1.09]	[0.97]
Weight	0.00	0.00	0.00	0.00	−0.01	−0.01	−0.00	−0.00
	[0.33]	[0.21]	[0.31]	[0.30]	[−0.59]	[−0.48]	[−0.88]	[−0.74]

(*Continued*)

TABLE 2—*(Continued)*

	(1) *Hitrate*	(2) *Hitrate*	(3) *Distance*	(4) *Distance*	(5) *Avg_Time*	(6) *Avg_Time*	(7) *Fast_Time*	(8) *Fast_Time*
League Level	0.02	0.01	0.01	0.01	−0.13	−0.13	−0.04	−0.04*
	[0.48]	[0.45]	[0.05]	[0.05]	[−0.55]	[−0.52]	[−1.60]	[−1.75]
% Games Entered	0.00	0.00	0.00	0.00	−0.00	−0.00	0.00	0.00
	[0.56]	[0.42]	[0.06]	[0.06]	[−0.52]	[−0.41]	[0.79]	[0.58]
Tenure	−0.01	−0.01	0.02	0.01	0.05	0.05	0.01	0.01*
	[−1.25]	[−1.09]	[1.06]	[1.01]	[1.19]	[1.06]	[1.62]	[1.86]
Simulator Experience FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Language FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Training FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Position FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prior Performance	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prior Performance Squared	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	117	117	117	117	117	117	117	117

This table presents estimates of the effect of performance information type and level of detail on the performance measures *Hitrate, Distance, Avg_Time,* and *Fast_Time*. The coefficient on *Relative* represents the effect of showing only relative as compared to showing only absolute measures. The coefficient on *Absolute&Relative* represents the effect of showing both absolute and relative measures as compared to showing only absolute measures. The coefficient on *Detail* represents the effect of showing detailed rather than aggregated measures. The interaction terms test whether showing relative measures either alone or with absolute measures is more or less effective, as compared to showing absolute measures alone, when the measures are detailed. *t*-Statistics are based on heteroskedastic-robust standard errors and are reported in brackets below each coefficient.

*, **, and *** denote significance at the 0.1, 0.05, and 0.01 levels, respectively.

°denotes that the estimated effect of *Relative* is of greater magnitude than the estimated effect of *Absolute&Relative* at at least the 0.1 level.

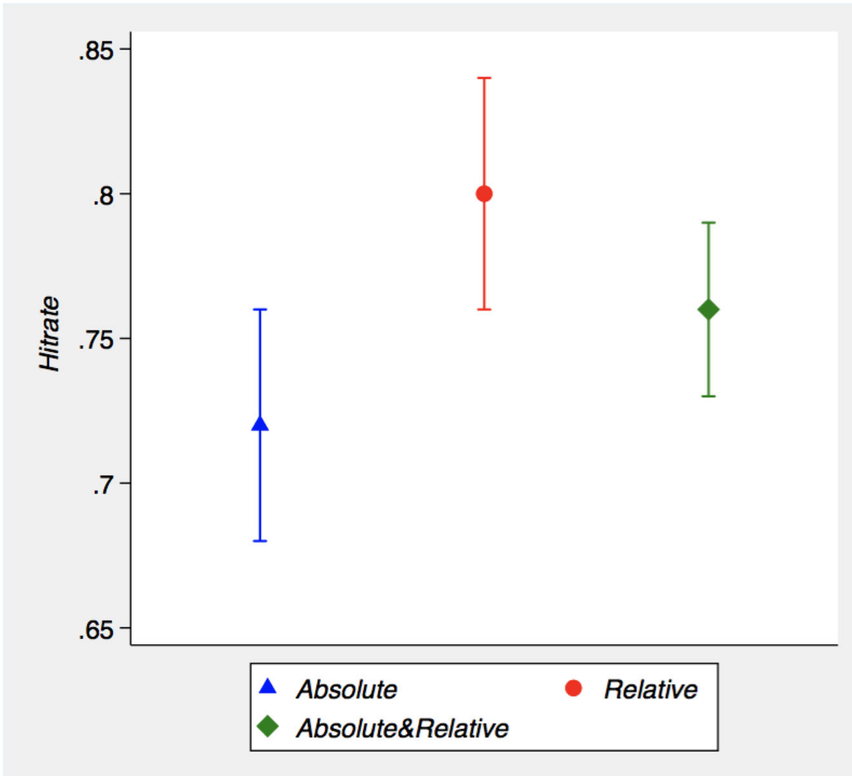

FIG 1.—*Hitrate* by type of measures in performance report. This figure displays performance on the measure *Hitrate*, or proportion of passes that were on target, from the second round of the passing drill after the provision of performance information. Performance is presented by the type of measures in the report—absolute only, relative only, or combined absolute and relative. The symbols represent the mean for each treatment type and the lines represent 90% confidence intervals.

search in accounting and economics has applied OLS in the same manner (Kreuger and Whitmore [2001], Angrist and Pischke [2008], Casas-Arce, Lourenço, and Martínez-Jerez [2017]).[16]

Table 2 contains the main performance effects and the fully interacted performance effects of our 3 × 2 treatment design for each of our four

[16] In our analysis, we follow Kreuger and Whitmore [2001] and Banerjee et al. [2010] by comparing levels after treatment. Our results also include initial performance as a control when regressing performance on treatment conditions. This approach is widely employed in studies in economics that use field experiments (Duflo, Kremer, and Robinson [2011], Fryer et al. [2020]). In untabulated robustness tests, we also conducted each of our main analyses by comparing residualized gain scores (Cronbach and Furby [1970], Hendrix, Carter, and Hintze [1978], Knapp and Schafer [2009]). We find that our estimates are of similar magnitude and statistical significance with this approach as in our main specification.

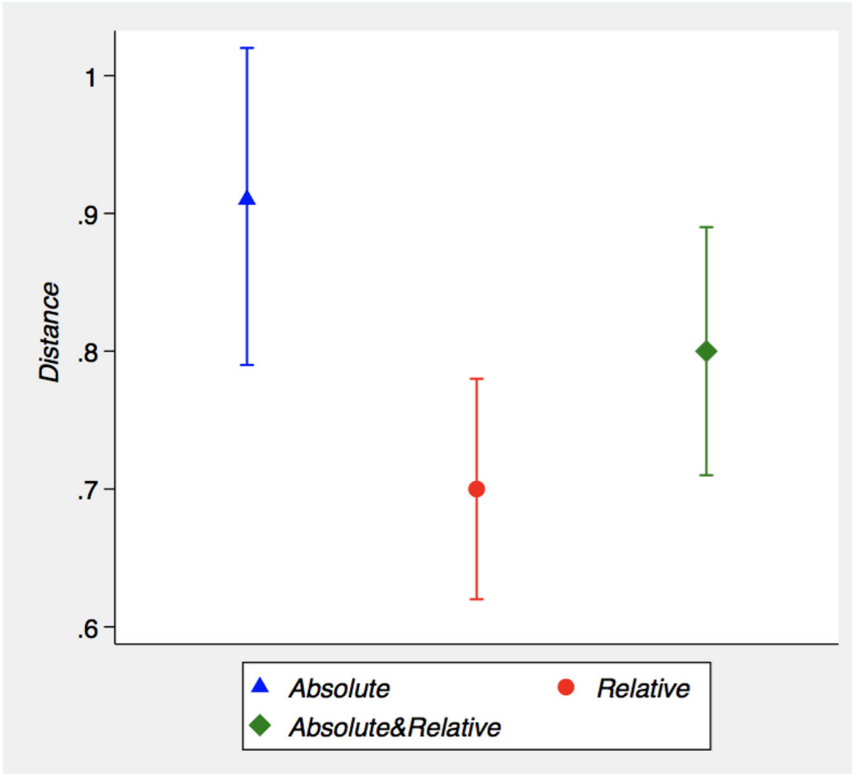

FIG 2.—*Distance* by type of measures in performance report. This figure displays performance on the measure *Distance*, or average distance in meters between passes and the target, from the second round of the passing drill after the provision of performance information. Performance is presented by the type of measures in the report—absolute only, relative only, or combined absolute and relative. The symbols represent the mean for each treatment type and the lines represent 90% confidence intervals.

performance measures. The omitted treatment condition is *Absolute* x *Aggregate* information. Thus, the coefficients on *Relative* information and on *Absolute&Relative* information represent the estimated effect of those treatments as compared to *Absolute* information. By the same principle, the coefficients on *Detail* information represent the estimated effect of that type of information as compared to *Aggregate* information. For each dependent variable, we run the model with main effects—*Relative*, *Absolute&Relative*, and *Detail*—in the odd-numbered columns. We run the fully interacted model in the even-numbered columns.[17]

[17] For ease of reference and to aid in interpreting the results, we provide a summary of the theoretical insights that inform each of our hypotheses in appendix C.

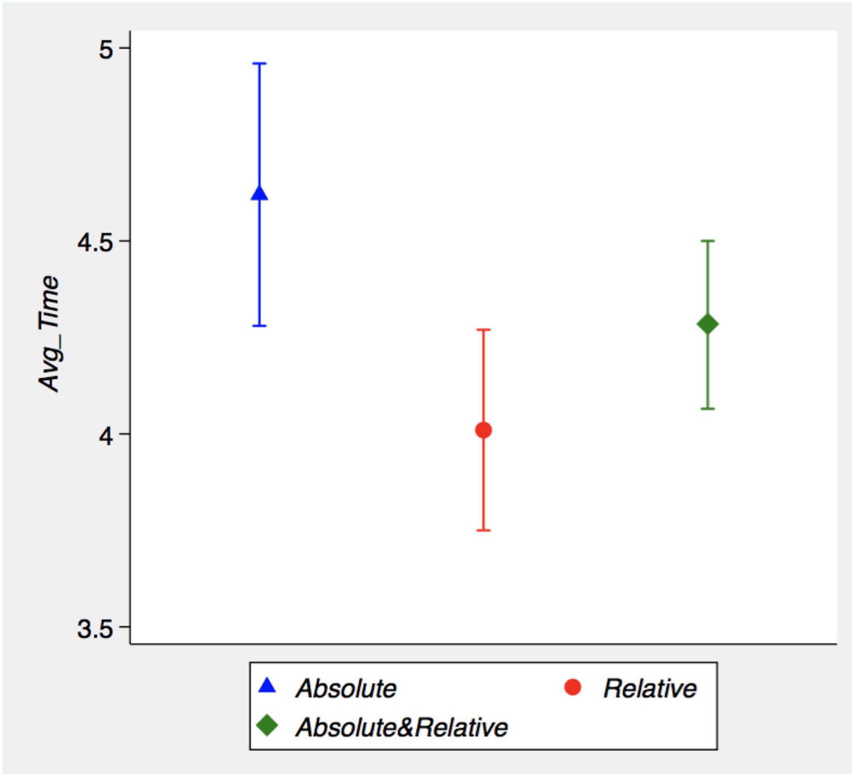

FIG 3.—*Avg_Time* by type of measures in performance report. This figure displays performance on the measure *Avg_Time*, or average time in seconds taken to complete a pass, from the second round of the passing drill after the provision of performance information. Performance is presented by the type of measures in the report—absolute only, relative only, or combined absolute and relative. The symbols represent the mean for each treatment type and the lines represent 90% confidence intervals.

For all of our measures of performance, and consistent with H1, there is a statistically significant performance benefit of providing relative rather than absolute information. The statistically significant coefficients on *Relative* in table 2, columns 1, 3, 5, and 7, document this result. In reading these coefficients, note that a decrease in *Avg_Time* or *Fast_Time*, represented by a negative coefficient, reflects an improvement in time-related performance. Similarly, a decrease in *Distance*, also represented by a negative coefficient, reflects an improvement in passing accuracy. The magnitudes of these performance effects are substantial. Providing relative information alone leads to at least a 0.4-standard-deviation increase in performance, depending on the measure, as compared to the performance of players who receive absolute information alone.

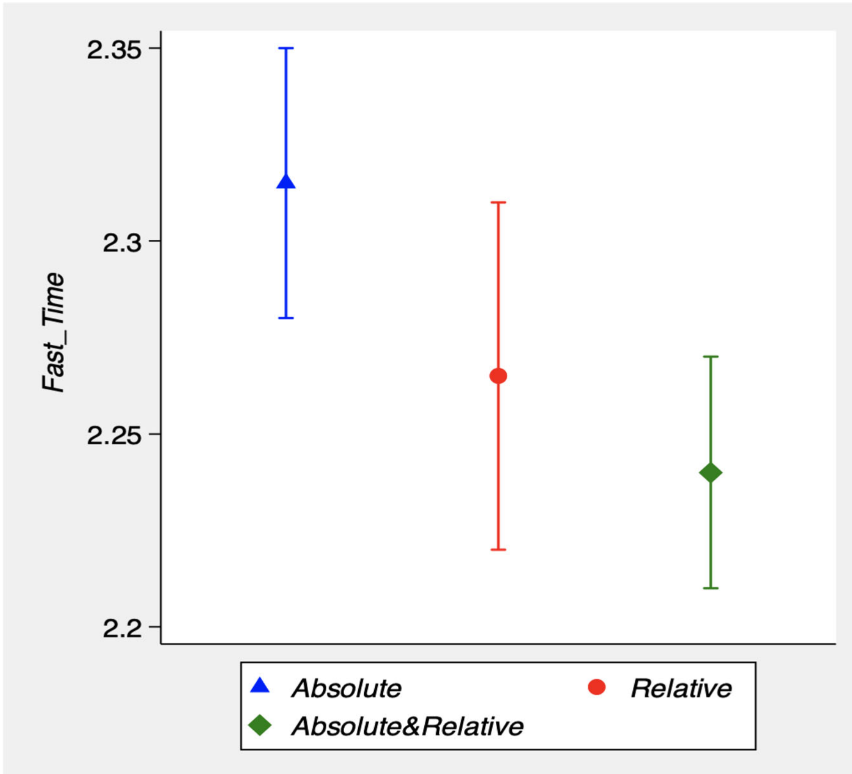

FIG 4.—*Fast_Time* by type of measures in performance report. This figure displays performance on the measure *Fast_Time*, or minimum time in seconds taken to complete a pass, from the second round of the passing drill after the provision of performance information. Performance is presented by the type of measures in the report—absolute only, relative only, or combined absolute and relative. The symbols represent the mean for each treatment type and the lines represent 90% confidence intervals.

H2a predicted that performance would be better when the performance report contained only relative information. In table 2, we use a circle symbol to denote that the effect of *Relative* is statistically significantly stronger than the effect of *Absolute&Relative* for *Hitrate*, *Distance*, and *Avg_Time*. These results support H2a. In subsequent analyses, we explore why there is not a statistically significant difference between the coefficient on *Relative* and the coefficient on *Absolute&Relative* for the measure *Fast_Time*.

Figures 1–4 show the mean and a 90% confidence interval for each performance measure (*Hitrate*, *Distance*, *Avg_Time*, and *Fast_Time*) after the provision of performance information, by assignment to *Absolute*, *Relative*, or *Absolute&Relative* information. These figures show that the *Relative* treatment led to higher performance than the *Absolute&Relative* treatment, which in turn generally led to better performance than the

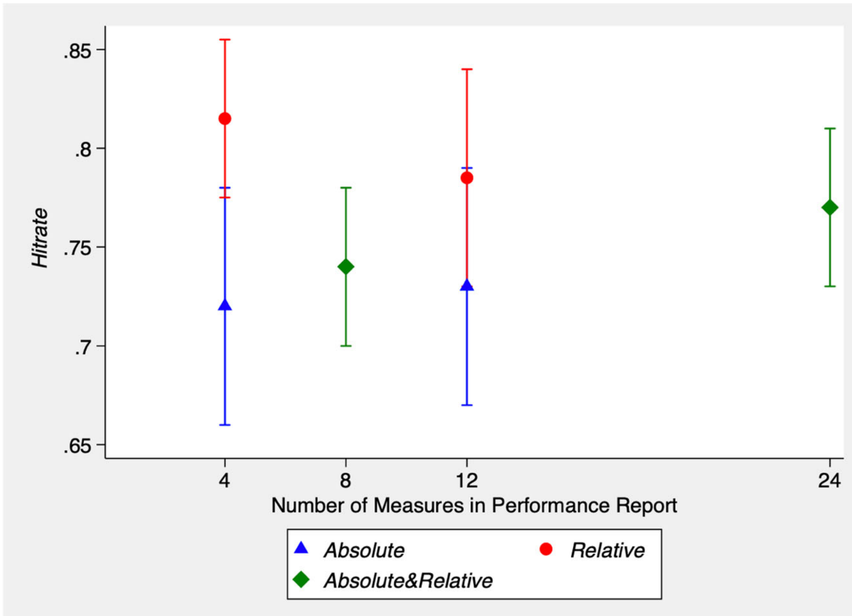

FIG 5.—*Hitrate* by type and number of measures in performance report. This figure displays performance on the measure *Hitrate*, or proportion of passes that were on target, from the second round of the passing drill after the provision of performance information. Performance is presented by the type of measures in the report—absolute only, relative only, or combined absolute and relative—and the number of measures in the report. The symbols represent the mean for each treatment type and the lines represent 90% confidence intervals.

Absolute treatment.[18] As shown across figures 1–4, this pattern in the results holds for measures of both passing accuracy (*Hitrate, Distance*) and passing speed (*Avg_Time*). Research on multidimensional performance has documented that speed and accuracy are typically competing dimensions of performance and that it is challenging to generate improvement on both at the same time (Bonner and Sprinkle [2002]).[19] Our study documents a means of improving overall performance across these dimensions.

With regard to the *Detail* condition, the coefficients on this term in all columns of table 2 document that we find no statistically significant evidence that increasing the number of measures per se while holding con-

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[18] When the confidence intervals of two estimates do not overlap, this implies a statistically significant difference, but it is worth noting that confidence-interval overlap does not imply the lack of a statistically significant difference (Schenker and Gentleman [2001], Cumming and Finch [2005]). Thus, we refer the reader to the tables to identify statistically significant differences between the treatment groups represented in figures 1–4.

[19] Based on our conversations with skills.lab administrators, we expect this tension between performing well on speed and performing well on accuracy in our setting. In particular, when the simulator allows less time between balls, requiring quicker passing, accuracy typically falls.

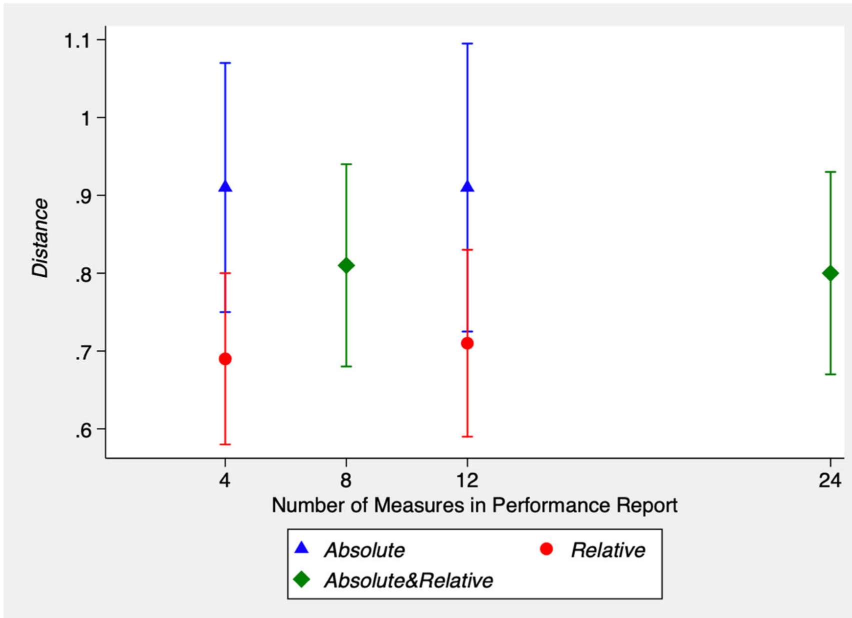


FIG 6.—*Distance* by type and number of measures in performance report. This figure displays performance on the measure *Distance*, or average distance in meters between passes and the target, from the second round of the passing drill after the provision of performance information. Performance is presented by the type of measures in the report—absolute only, relative only, or combined absolute and relative—and the number of measures in the report. The symbols represent the mean for each treatment type and the lines represent 90% confidence intervals.

stant the scope of performance information—that is, as absolute, relative, or combined absolute and relative—leads to worse performance. This fails to support H2b, and suggests that the benefit of restricting a report to contain relative information is not a function of the quantity of measures displayed per se. Furthermore, if the negative effect of *Absolute&Relative*, as compared to *Relative*, were driven by information quantity, we would expect the negative effect to be moderated by *Detail*, which represents an increase in information quantity. The coefficients on the interaction terms in table 2 generally fail to provide evidence to support this.

We use figures 5–8 to illustrate that, across measures of passing speed and accuracy, we observe that there is no pattern whereby an increase in the number of measures in a report harms performance. Specifically, for the given dimension of performance shown in each of figures 5–8, we do not see a negative trend in performance as we move further along the X-axis by increasing the number of measures in the report. Rather, we see differences by symbol color, which represents whether the player was assigned to the *Absolute*, *Relative*, or *Absolute&Relative* condition. This demonstrates that the pairing of absolute and relative performance information in particular,

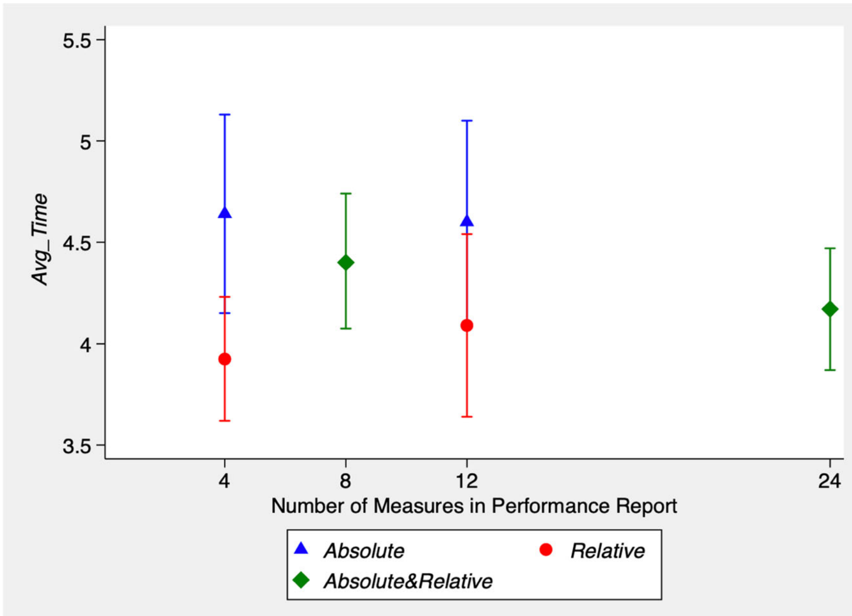


FIG 7.—*Avg_Time* by type and number of measures in performance report. This figure displays performance on the measure *Avg_Time*, or average time in seconds taken to complete a pass, from the second round of the passing drill after the provision of performance information. Performance is presented by the type of measures in the report—absolute only, relative only, or combined absolute and relative—and the number of measures in the report. The symbols represent the mean for each treatment type and the lines represent 90% confidence intervals.

rather than simply any increase in the number of measures included in the report, drives the performance effects that we observe.

Table 3 uses survey data to further document the lack of evidence to support the idea that providing both absolute and relative information provides too many measures per se. In the post-experiment survey, reports that the number of measures was "too many" are not statistically significantly affected by whether players received the combination of absolute and relative information instead of either absolute or relative information alone. Column 1 shows this result for the full sample. Columns 2 and 3 show that this result is similar whether the information displayed was aggregated or detailed.

To address another potential mechanism for the benefit of restricting performance reports to show relative measures alone, we test whether providing only relative measures increases the intensity of peer-performance comparison. We follow prior research on relative performance information and peer-performance comparison by conducting a factor analysis of questions regarding self-reported involvement in peer-performance comparison (Tafkov [2013]). We use the resulting factor, *Comparison*, as our

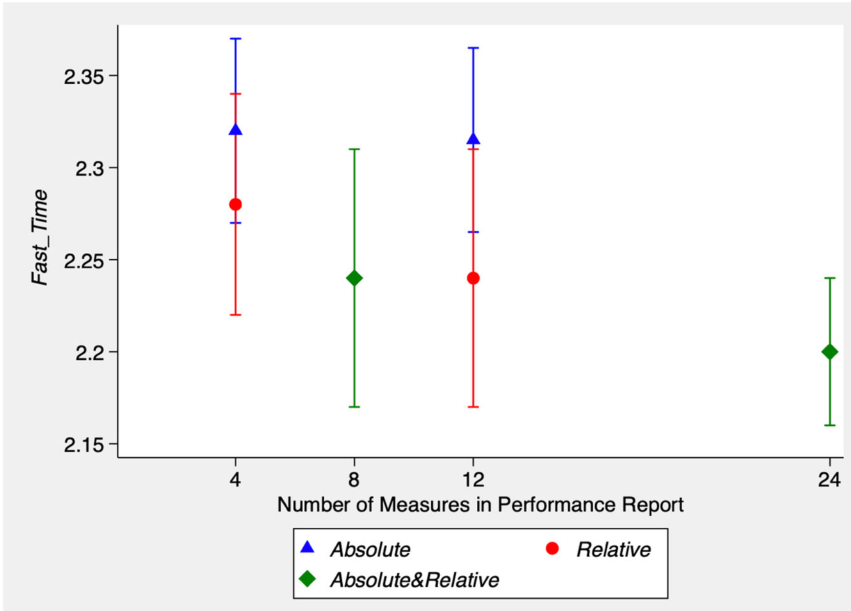


FIG 8.—*Fast_Time* by type and number of measures in performance report. This figure displays performance on the measure *Fast_Time*, or minimum time in seconds taken to complete a pass, from the second round of the passing drill after the provision of performance information. Performance is presented by the type of measures in the report—absolute only, relative only, or combined absolute and relative—and the number of measures in the report. The symbols represent the mean for each treatment type and the lines represent 90% confidence intervals.

measure of peer-performance-comparison involvement. Table 4 shows that there is a statistically significant effect of *Relative*, as compared to both *Absolute&Relative* and *Absolute*. Table 5 documents that our measure of peer-performance comparison is positively and statistically significantly related to performance for all four of our measures. These results support H3a and H3b, suggesting that restricting information to relative terms alone yields a performance benefit through increased engagement in peer-performance comparison.

To further examine our results, we use cross-sectional and supplemental analyses. The first of these analyses examines why we find statistically significant improvement resulting from the *Absolute&Relative* treatment for the measure *Fast_Time*. Although the other three performance measures are averages, and so would require consistent effort for a player to improve, *Fast_Time* is an extremum, and could be boosted with a trade-off that involves making a few passes with low accuracy but high speed. This strategy would dramatically improve reported performance on *Fast_Time* while having a relatively small effect on reported performance by accuracy, which is an average of 12 passes. Studies of trade-offs among measures have es-

TABLE 3

Effect of Providing both Absolute and Relative Information on Reports that the Number of Measures is Too Many

	(1) *Too Many Measures*	(2) *Too Many Measures*	(3) *Too Many Measures*
Absolute&Relative	−0.23	−0.50	−0.14
	[−0.81]	[−1.24]	[−0.28]
Age	−0.01	0.02	−0.00
	[−0.35]	[0.30]	[−0.04]
Gender	−0.02	0.01	0.25
	[−0.03]	[0.01]	[0.34]
Height	−0.06	0.03	−0.13*
	[−1.35]	[0.50]	[−1.92]
Weight	0.07*	0.05	0.11*
	[1.90]	[1.03]	[1.97]
League Level	0.18	−0.30	0.52
	[0.43]	[−0.50]	[0.75]
% Games Entered	0.01	0.01	0.01
	[1.36]	[1.46]	[0.99]
Tenure	0.01	0.00	0.01
	[0.17]	[0.05]	[0.05]
Simulator Experience FE	Yes	Yes	Yes
Language FE	Yes	Yes	Yes
Training FE	Yes	Yes	Yes
Position FE	Yes	Yes	Yes
Sample	Full	*Detail*	*Aggregate*
N	117	58	59

This table presents estimates of the effect of displaying both absolute and relative measures on post-experiment survey responses regarding participants' perceptions of having received too many measures. The survey responses are on a seven-point Likert scale. The coefficients on *Absolute&Relative* represent the effect of showing both absolute and relative as compared to showing only absolute or relative measures. *t*-Statistics are based on heteroskedastic-robust standard errors and are reported in brackets below each coefficient.

*, **, and *** denote significance at the 0.1, 0.05, and 0.01 levels, respectively.

tablished widespread evidence that employees use such strategies, sacrificing performance to a small degree by one measure when this leads to a larger or preferred effect on another measure (Asch [1990], Courty and Marschke [2004]). Although less effective than *Relative* in our setting, *Absolute&Relative* may be sufficiently motivating to encourage players to opportunistically trade off passing speed and accuracy, a strategy that does not require sustained effort to generate reported improvement.

To examine this idea empirically, we test whether there is a change in the relationship between *Hitrate* and *Fast_Time* after we provide players with relative information. If players trade off performance outcomes by making a small trade in terms of a slightly reduced *Hitrate* to achieve a significantly reduced *Fast_Time*, we would expect to see a stronger (positive) relationship between these two variables in Round 2 than in Round 1. Table 6 supports this idea, showing that, in a regression on *Hitrate*, there is a positive and statistically significant interaction between *Fast_Time* and

TABLE 4
Effect of Relative Information on Peer-Performance Comparison

	(1) *Comparison*
Relative	0.25***,°
	[3.98]
Absolute&Relative	0.09
	[1.28]
Age	−0.01
	[−1.35]
Gender	0.11
	[1.04]
Height	0.01
	[0.90]
Weight	0.00
	[0.34]
League Level	0.04
	[0.56]
% Games Entered	0.00
	[0.73]
Tenure	−0.00
	[−0.33]
Simulator Experience FE	Yes
Language FE	Yes
Training FE	Yes
Position FE	Yes
N	117

This table presents estimates of the effect of performance information type on *Comparison*. In line with prior research, we measure *Comparison* as the result of a factor analysis. The factor analysis inputs are the participant's responses to a set of questions regarding involvement in peer-performance comparison during the experiment. The coefficient on *Relative* represents the effect of showing relative as compared to showing only absolute measures. The coefficient on *Absolute&Relative* represents the effect of showing both absolute and relative as compared to showing only absolute measures. *t*-Statistics are based on heteroskedastic-robust standard errors and are reported in brackets below each coefficient.

*, **, and *** denote significance at the 0.1, 0.05, and 0.01 levels, respectively.

°denotes that the estimated effect of *Relative* is of greater magnitude than the estimated effect of *Absolute&Relative* at at least the 0.1 level.

Round 2. This interaction only occurs for the measure of speed that can be strategically manipulated—*Fast_Time*—and not for the measure of speed that requires sustained performance to improve—*Avg_Time*. Moreover, the interaction does not occur unless the report includes relative information. Collectively, these results suggest the effect of relative information on *Fast_Time* works partly through a trade-off between accuracy and *Fast_Time*.

Table 7 provides a test of how motivation to achieve immediate career advancement affects the relevance of information. When more teammates who are competing to start at a given position are participating in the experiment, the team's managers will have more players to compare on simulator performance when selecting the starters. We use the number of teammates who are competing for the same starting spot as the given player, scaled by the number of places in the starting lineup at that position, to proxy for immediate career concerns. In table 7, the coefficients on *Relative* x

TABLE 5
Relationship Between Peer-Performance Comparison and Performance

	(1) *Hitrate*	(2) *Distance*	(3) *Avg_Time*	(4) *Fast_Time*
Comparison	0.06*	−0.14*	−0.49*	−0.07*
	[1.68]	[−1.68]	[−1.70]	[−1.76]
Age	0.00	−0.01	−0.01	−0.00
	[0.51]	[−1.10]	[−0.56]	[−0.22]
Gender	−0.13***	0.26**	1.07***	0.08***
	[−3.27]	[2.60]	[3.48]	[2.62]
Height	0.00	−0.01	−0.01	0.00
	[0.52]	[−1.63]	[−0.40]	[0.07]
Weight	−0.00	0.01*	0.01	−0.00
	[−0.84]	[1.88]	[0.60]	[−0.46]
League Level	−0.01	0.05	0.07	−0.01
	[−0.31]	[0.46]	[0.35]	[−0.34]
% Games Entered	0.00	0.00	−0.00	0.00
	[0.25]	[1.23]	[−0.15]	[0.29]
Tenure	−0.00	0.00	0.01	0.00
	[−0.22]	[0.19]	[0.15]	[0.11]
Simulator Experience FE	Yes	Yes	Yes	Yes
Language FE	Yes	Yes	Yes	Yes
Training FE	Yes	Yes	Yes	Yes
Position FE	Yes	Yes	Yes	Yes
N	234	234	234	234

This table presents estimates of the relationships between *Comparison* and the performance measures *Hitrate, Distance, Avg_Time,* and *Fast_Time* measured in rounds 1 and 2 of the passing drill. *Comparison* is the result of a factor analysis of questions regarding the degree of peer-performance comparison that the participant felt involved in during the experiment. *t*-Statistics are based on standard errors clustered at the participant level and are reported in brackets below each coefficient.

*, **, and *** denote significance at the 0.1, 0.05, and 0.01 levels, respectively.

Position Depth and on *Absolute&Relative* x *Position Depth* offer evidence that the effects of relative information are stronger when career concerns, as proxied by *Position Depth*, are greater.[20] This suggests that much of the benefit of *Relative* information in our setting is due to the presence of career concerns—that is, competition for starting positions, rather than self-image concerns alone.

Table 8 provides a test of how task commitment influences responses to relative information. To proxy for a player's task commitment, we use the measure *Training*, or the number of days per week that the player reports playing football. We find that both the *Relative* and *Absolute&Relative* treatments boost performance more on the dimensions *Hitrate*, *Distance*, and *Avg_Time* for players who train as or more frequently than the median player in our sample than for players who train less than the median. We do not find these differences in our results across partitions when, in unt-

[20] These coefficients are statistically significant for three of the four dependent-variable performance measures in our study. In the case of *Fast_Time*, the sign of the coefficient represents a performance improvement but the result is not statistically significant.

TABLE 6

Evidence of Attempt to Reduce Fast_Time by Reducing Hitrate

	(1) *Hitrate*	(2) *Hitrate*	(3) *Hitrate*	(4) *Hitrate*
Fast_Time	−0.23	−0.39*		
	[−1.66]	[−1.89]		
Average_Time			−0.13***	−0.13***
			[−88.63]	[−40.07]
Round 2	−0.58	−0.24	−0.01	0.00
	[−1.62]	[−0.31]	[−1.41]	[0.04]
Fast_Time × *Round 2*	0.27*	0.09		
	[1.72]	[0.28]		
Average_Time × *Round 2*			0.00	−0.00
			[0.72]	[−0.15]
Sample	*Relative* or *Absolute&Relative*	*Absolute*	*Relative* or *Absolute&Relative*	*Absolute*
N	156	78	156	78

This table presents results of a test for whether there was a change in the relationship between *Hitrate* and *Fast_Time* or between *Hitrate* and *Avg_Time* that occurs between rounds 1 and 2 of the passing drill, after the provision of performance information. The coefficient on the interaction terms represents whether there was a change in the relationship after the performance information was provided. *t*-Statistics are based on standard errors clustered at the player level and are reported in brackets below each coefficient.

*, **, and *** denote significance at the 0.1, 0.05, and 0.01 levels, respectively.

abulated analyses, we partition the sample and examine players by whether they had above- or below-median initial performance. This suggests that task commitment, rather than associated stronger initial performance, is the source of variation in our results. This analysis provides evidence that relative information is particularly beneficial in the presence of greater task commitment.

Table 9 examines how our effects depend on whether a player is in a developmental stage of his or her career. Specifically, we test our effects among players who are within two years of the minimum age for their league and who are in the lower half of experience with their parent club within that group. Among these players, the *Absolute&Relative* condition outperforms the *Relative* condition—that is, the coefficient on *Absolute&Relative* is statistically significant for all four dimensions of performance while the coefficient on *Relative* is not. Despite the reduced power we have to compare treatment effects in this sample of 40 trainees, we find that the difference in estimated effects of *Relative* and *Absolute&Relative* are statistically significant for two of those dimensions of performance, spanning both speed and accuracy. These results demonstrate cross-sectional variation in information demands and effects. In particular, the typical player in our sample benefits when we isolate relative information, but developing players benefit from the addition of absolute information alongside relative information.

TABLE 7

Effect of Relative Information in Performance Report: Moderation by Depth at Position

	(1) *Hitrate*	(2) *Hitrate*	(3) *Distance*	(4) *Distance*	(5) *Avg_Time*	(6) *Avg_Time*	(7) *Fast_Time*	(8) *Fast_Time*
Relative	0.10***	−0.02	−0.22**	0.01	−0.83***	0.14	−0.06**	−0.04
	[2.94]	[−0.44]	[−2.30]	[0.07]	[−3.12]	[0.34]	[−2.19]	[−0.83]
Absolute&Relative	0.05	−0.09*	−0.09	0.19	−0.47**	0.49	−0.08***	−0.07
	[1.63]	[−1.74]	[−0.81]	[0.99]	[−2.09]	[1.32]	[−3.16]	[−1.55]
Position Depth	−0.02	−0.08***	0.06	0.16**	0.20	0.59***	0.02*	0.02
	[−1.43]	[−4.05]	[1.36]	[2.43]	[1.60]	[4.05]	[1.80]	[1.43]
Relative × *Position Depth*		0.08***		−0.14*		−0.58***		−0.01
		[3.90]		[−1.95]		[−3.84]		[−0.61]
Absolute&Relative × *Position Depth*		0.07***		−0.15*		−0.51***		−0.01
		[3.58]		[−1.86]		[−3.38]		[−0.28]
Age	−0.01	−0.01*	0.02	0.02	0.04	0.05*	0.00	0.00
	[−1.38]	[−1.73]	[1.43]	[1.51]	[1.46]	[1.76]	[1.40]	[1.38]
Gender	−0.09	−0.07	0.04	0.01	0.67	0.51	0.02	0.01
	[−1.46]	[−1.12]	[0.27]	[0.10]	[1.45]	[1.11]	[0.48]	[0.41]
Height	−0.00	−0.00	−0.01	−0.01	0.03	0.02	0.00	0.00
	[−1.04]	[−0.95]	[−0.93]	[−1.13]	[1.09]	[1.01]	[0.97]	[0.96]
Weight	0.00	0.00	0.00	0.00	−0.02	−0.02	−0.00	−0.00
	[0.48]	[0.78]	[0.23]	[0.13]	[−0.76]	[−1.04]	[−1.07]	[−1.07]

(*Continued*)

TABLE 7—*(Continued)*

	(1) *Hitrate*	(2) *Hitrate*	(3) *Distance*	(4) *Distance*	(5) *Avg_Time*	(6) *Avg_Time*	(7) *Fast_Time*	(8) *Fast_Time*
League Level	−0.01	−0.02	0.06	0.09	0.06	0.18	−0.02	−0.02
	[−0.20]	[−0.70]	[0.54]	[0.83]	[0.23]	[0.72]	[−0.66]	[−0.60]
% Games Entered	0.00	0.00	0.00	0.00	−0.00	−0.00	0.00	0.00
	[0.32]	[0.31]	[0.30]	[0.28]	[−0.23]	[−0.21]	[0.88]	[0.86]
Tenure	−0.01	−0.01*	0.02	0.02	0.06	0.07*	0.01*	0.01*
	[−1.49]	[−1.87]	[1.22]	[1.28]	[1.42]	[1.72]	[1.83]	[1.79]
Simulator Experience FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Language FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Training FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Position FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prior Performance	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prior Performance Squared	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	117	117	117	117	117	117	117	117

This table presents estimates of the effect of performance information type on the performance measures *Hitrate, Distance, Avg_Time,* and *Fast_Time*, interacting performance information type with *Position Depth*–the number of participants from the same team at the given player's position who were participating in the experiment, scaled by the number of spots in the starting lineup at that position. The coefficient on *Relative* represents the effect of showing only relative as compared to showing only absolute measures. The coefficient on *Absolute&Relative* represents the effect of showing both absolute and relative measures as compared to showing only absolute measures. *t*-Statistics are based on heteroskedastic-robust standard errors and are reported in brackets below each coefficient.

*, **, and *** denote significance at the 0.1, 0.05, and 0.01 levels, respectively.

TABLE 8

Effect of Relative Information in Performance Report, Partitioned by Training Frequency

	(1) *Hitrate*	(2) *Hitrate*	(3) *Distance*	(4) *Distance*	(5) *Avg_Time*	(6) *Avg_Time*	(7) *Fast_Time*	(8) *Fast_Time*
Relative	−0.05	0.20$^{***,\circ,\dagger}$	−0.01	−0.28**,†	0.36	−1.53$^{***,\circ,\dagger}$	−0.08**	−0.06
	[−1.11]	[3.54]	[−0.04]	[−2.03]	[1.03]	[−3.51]	[−2.49]	[−1.12]
Absolute&Relative	−0.06	0.12**,†	0.19	−0.30*,†	0.33	−0.95**,†	−0.13***	−0.06
	[−1.25]	[2.24]	[0.92]	[−1.91]	[0.94]	[−2.36]	[−3.14]	[−1.11]
Detail	0.02	−0.01	−0.02	0.05	−0.20	0.07	−0.01	0.03
	[0.45]	[−0.13]	[−0.14]	[0.38]	[−0.64]	[0.24]	[−0.36]	[1.03]
Age	0.00	−0.01***	0.00	0.03*	−0.03	0.12***	0.00	0.01*
	[0.64]	[−2.94]	[0.17]	[1.80]	[−0.74]	[3.09]	[0.60]	[1.81]
Gender	−0.03	−0.12	−0.01	0.02	0.13	0.96	0.00	0.09
	[−0.41]	[−1.22]	[−0.02]	[0.07]	[0.28]	[1.28]	[0.09]	[1.50]
Height	−0.01	−0.01	0.01	−0.01	0.04	0.06	0.00	0.01
	[−0.99]	[−1.45]	[0.66]	[−0.83]	[1.05]	[1.50]	[0.33]	[1.50]
Weight	0.01	0.00	−0.02	0.01	−0.05	−0.03	−0.00	−0.00
	[1.12]	[0.95]	[−1.06]	[0.76]	[−1.44]	[−1.12]	[−1.23]	[−0.60]
League Level	−0.02	0.07	0.12	−0.05	0.16	−0.52	−0.04	−0.02
	[−0.59]	[1.40]	[1.00]	[−0.27]	[0.60]	[−1.34]	[−1.36]	[−0.42]

(*Continued*)

TABLE 8—*(Continued)*

	(1) *Hitrate*	(2) *Hitrate*	(3) *Distance*	(4) *Distance*	(5) *Avg_Time*	(6) *Avg_Time*	(7) *Fast_Time*	(8) *Fast_Time*
% Games Entered	−0.00	0.00	0.00	−0.00	0.00	−0.01	−0.00	0.00
	[−0.33]	[1.03]	[0.21]	[−0.18]	[0.48]	[−0.90]	[−0.58]	[1.36]
Tenure	0.01	−0.02**	−0.03	0.04	−0.05	0.14**	0.01	0.01
	[0.67]	[−2.30]	[−0.89]	[1.58]	[−0.76]	[2.25]	[1.22]	[0.85]
Simulator Experience FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Language FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Training FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Position FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prior Performance	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prior Performance Squared	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Training frequency	Below median	Median or above	Below median	Median or above	Below median	Median or above	Below median	Median or above
N	55	62	55	62	55	62	55	62

This table presents estimates of the effect of performance information type on the performance measures *Hitrate, Distance, Avg_Time,* and *Fast_Time* for samples partitioned by training frequency, or the number of times per week that the player reports playing football. The coefficient on *Relative* represents the effect of showing only relative as compared to showing only absolute measures. The coefficient on *Absolute&Relative* represents the effect of showing both absolute and relative measures as compared to showing only absolute measures. *t*-Statistics are based on heteroskedastic-robust standard errors and are reported in brackets below each coefficient.

*, **, and *** denote significance at the 0.1, 0.05, and 0.01 levels, respectively.

° denotes that the estimated effect of *Relative* is of greater magnitude than the estimated effect of *Absolute&Relative* at at least the 0.1 level.

† denotes that the estimated effect of the given treatment type (*Relative* or *Absolute&Relative*) is different in the median- or above-median training frequency sample than in the below-median training frequency sample at at least the 0.1 level.

TABLE 9

Effect of Relative Information in Performance Report, Partitioned by Level of Experience

	(1) *Hitrate*	(2) *Hitrate*	(3) *Distance*	(4) *Distance*	(5) *Avg_Time*	(6) *Avg_Time*	(7) *Fast_Time*	(8) *Fast_Time*
Relative	0.07^{*}	0.03	−0.18	−0.10	-0.61^{*}	−0.28	−0.06	−0.02
	[1.70]	[0.34]	[−1.42]	[−0.60]	[−1.85]	[−0.41]	[−1.56]	[−0.48]
Absolute&Relative	0.00	$0.14^{**,\circ,\dagger}$	0.03	-0.26^{*}	−0.14	-1.10^{**}	-0.09^{**}	$-0.11^{***,\circ}$
	[0.12]	[2.16]	[0.22]	[−1.77]	[−0.48]	[−2.09]	[−2.11]	[−3.24]
Detail	0.01	−0.04	0.05	−0.16	−0.14	0.23	0.01	0.01
	[0.39]	[−0.49]	[0.50]	[−1.13]	[−0.54]	[0.38]	[0.41]	[0.41]
Age	−0.00	−0.04	0.01	0.15^{**}	0.03	0.31	0.01^{*}	0.00
	[−0.78]	[−1.10]	[0.72]	[2.47]	[0.78]	[1.22]	[1.97]	[0.37]
Gender	-0.20^{***}	−0.00	0.13	0.07	1.50^{***}	0.01	0.02	0.05
	[−3.44]	[−0.03]	[0.74]	[0.30]	[3.60]	[0.01]	[0.40]	[0.84]
Height	−0.00	0.00	−0.00	−0.01	0.00	−0.00	0.00	−0.00
	[−0.04]	[0.18]	[−0.36]	[−0.74]	[0.00]	[−0.06]	[1.04]	[−0.52]
Weight	−0.00	−0.00	−0.00	0.02^{*}	0.01	0.02	−0.00	0.00
	[−0.46]	[−0.59]	[−0.31]	[1.88]	[0.37]	[0.35]	[−1.05]	[1.07]

(*Continued*)

TABLE 9—*(Continued)*

	(1) *Hitrate*	(2) *Hitrate*	(3) *Distance*	(4) *Distance*	(5) *Avg_Time*	(6) *Avg_Time*	(7) *Fast_Time*	(8) *Fast_Time*
League Level	0.02	−0.03	0.05	0.03	−0.16	0.19	−0.03	−0.07***
	[0.37]	[−0.36]	[0.39]	[0.12]	[−0.39]	[0.35]	[−0.66]	[−3.04]
% Games Entered	0.00	−0.00	−0.00	−0.00	−0.00	−0.00	−0.00	0.00*
	[0.73]	[−0.03]	[−0.09]	[−0.94]	[−0.72]	[−0.14]	[−0.18]	[1.90]
Tenure	−0.01	0.00	0.00	0.11**	0.07	−0.00	0.01*	−0.00
	[−1.17]	[0.21]	[0.06]	[2.23]	[1.05]	[−0.01]	[1.82]	[−0.01]
Simulator Experience FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Language FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Training FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Position FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prior Performance	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prior Performance Squared	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Level of experience	Advanced	Trainee	Advanced	Trainee	Advanced	Trainee	Advanced	Trainee
N	77	40	77	40	77	40	77	40

This table presents estimates of the effect of performance information type on the performance measures *Hitrate, Distance, Avg_Time,* and *Fast_Time* for samples partitioned by level of professional experience. We term players who are within two years of the minimum age for their league and who are in the lower half of experience with their parent club within that group "Trainees." We term other players "Advanced." The coefficient on *Relative* represents the effect of showing only relative as compared to showing only absolute measures. The coefficient on *Absolute&Relative* represents the effect of showing both absolute and relative measures as compared to showing only absolute measures. *t*-Statistics are based on heteroskedastic-robust standard errors and are reported in brackets below each coefficient.

*, **, and *** denote significance at the 0.1, 0.05, and 0.01 levels, respectively.

° denotes that the estimated effect of *Absolute&Relative* is of greater magnitude than the estimated effect of *Relative* at at least the 0.1 level.

† denotes that the estimated effect of *Absolute&Relative* is different in the Trainee sample than in the Advanced sample at at least the 0.1 level.

6. *Conclusion*

We use a field experiment in a highly competitive setting—professional European football—to compare the performance effects of providing absolute, relative, or both absolute and relative performance information. Although performance information interventions typically use relative and absolute information either alone or in some combination, ours is the first study to assign this set of conditions in a randomized controlled trial to assess performance effects. Our analysis extends accounting research on how firms can deliver internal performance reports in a way that best affects performance. We also contribute to management accounting literature that explores how employees place weight on and respond to different types of performance measures. Contrary to the notion that increased information is more advantageous for performance, we find, on average, that restricting performance information to relative measures alone yields the best effects.

Our survey data shed light on the mechanism for this result. We show that adding absolute information alongside relative information causes workers to place less weight on the relative measures and more weight on the absolute measures, leading to less peer-performance comparison. We also use demographic data to understand heterogeneity in responses to the performance information we provide. We find evidence that there are greater benefits of relative performance information in the presence of greater task commitment and stronger career concerns. For substantially less-experienced players, who are engaged in learning and skill-development, we show that providing the broader information set—both absolute and relative measures—benefits performance. Thus, in addition to documenting an average performance benefit of limiting the information in a report in our setting, we demonstrate the potential to customize the provision of absolute and relative information based on a worker's characteristics and context in order to achieve the strongest performance effects.

APPENDIX A: FIELD SITE AND TREATMENT

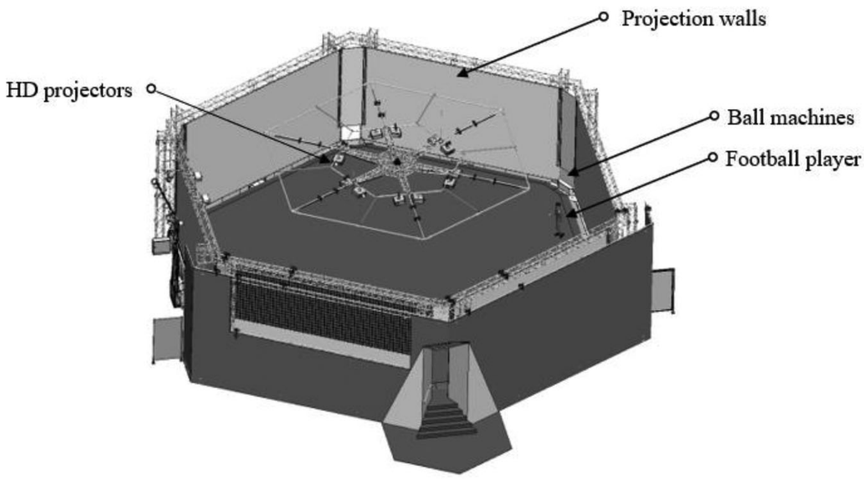


EXHIBIT 1.—Layout of the football training simulator skills.lab

This exhibit shows the layout of the skills.lab football training simulator. The integrated projectors display the passing target onto the walls of the simulator. One of the four ball machines is shown on the right side of the simulator. For scale, a football player is shown in the right corner of the simulator.

EXHIBIT 2.—The passing drill: "Passes after controlling the ball with a 180° turn"

This exhibit describes in detail the passing drill. In the first step of the task, the football player waits for a ball to be passed from one of the simulator's ball machines. In the second step of the task, the player must control the ball and locate the passing target. In the final step of the task, the player passes the ball to the target.

EXHIBIT 3.—Target visualization in the passing drill

This exhibit shows the moving target in the passing drill. Participants were instructed to aim for the bullseye centered on the foot of the projected player.

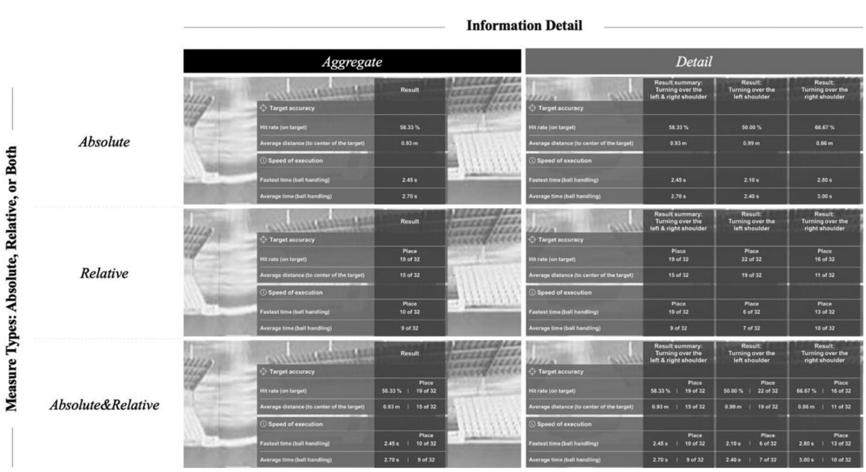


EXHIBIT 4.—3 x 2 experiment design

This exhibit shows the fully interacted 3 × 2 design employed in the experiment. The measure-type treatment arm contains three treatments: *Absolute*, *Relative*, or *Absolute&Relative*. The information-detail treatment arm contains two treatments: *Aggregate* or *Detail*.

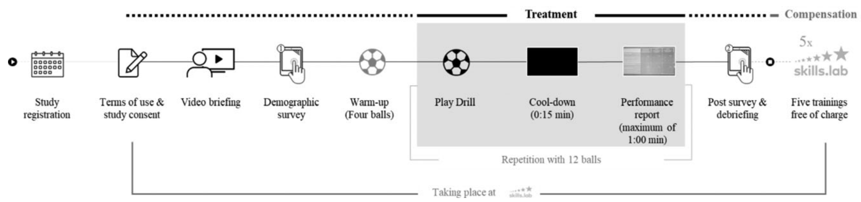
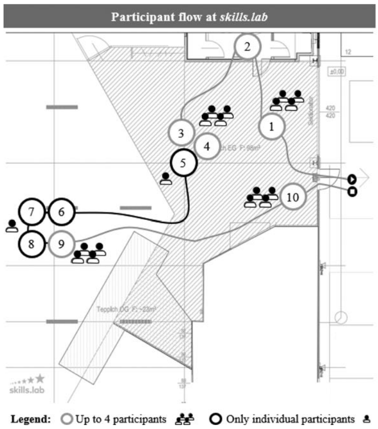


EXHIBIT 5.—On-site procedure of the field experiment

This exhibit shows in detail the experimental procedure. In the first step of the procedure, participants registered for study participation with Anton Paar SportsTec. In the second step, participants read and signed the terms of use of skills.lab and provided consent. At this step, participants were randomly assigned to one of the treatment groups. Participants were not informed of the details of the experiment nor the specific treatment to which they were assigned. Participants next watched a standardized video briefing that explained the experimental task and procedure. In the fourth step, participants took part in a demographic survey. This survey was consistent with the regular data entry process employed by the site when collecting information from users. In the fifth step, participants performed a warm-up drill. After this, each participant completed the competitive passing drill, where each player faced a total of 12 balls. This was followed by a short cool-down period after which the player received performance information. This report was displayed on to the walls of the simulator. After receiving this information, participants again completed the passing drill and received a second round of performance information. Following the experimental drills, participants exited the simulator and individually completed the post-experimental survey. Each participant was then debriefed. As compensation for taking part in the study, participants could play five trainings free of charge at skills.lab.



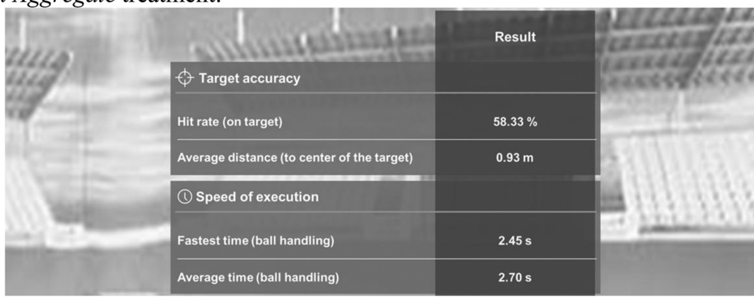
Details on the procedure

Step	Description
(1) **Arrival & welcome**	*Arrival and welcoming by skills.lab staff*
(2) **Change of clothes**	*If necessary, change of clothes to football gear*
(3) **Terms of use & consent**	*Signing of physical copies*
(4) **Video Briefing**	*Standardized briefing on a TV in reception area*
(5) **Demographics**	*Filling in survey*
(6) **Warm-up**	*Scripted explanation and testing of drill (4 balls with guidance from an instructor)*
Randomization	
(7) **Experimental drills**	*12 balls followed by cool-down and results*
(8) **Post-survey & Debriefing**	*Filling in survey and reading debriefing*
(9) **Compensation**	*5 free drills played individually or in a group*
(10) **Thank you & end**	*Thank you by skills.lab staff and leaving*

EXHIBIT 6.—Participant flow during the field experiment

This exhibit shows the flow of participants through the training facility during the field experiment. The experiment procedure was designed such that participants could not interact with each other between steps 5 and 8 of the experiment when we collected demographic information, delivered the intervention, measured performance, and collected post-survey responses.

Absolute x Aggregate treatment:

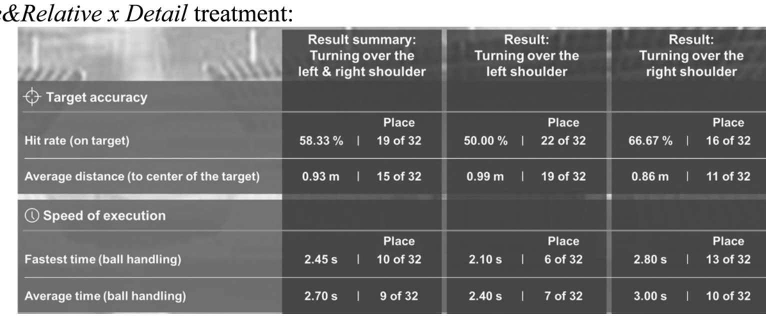


	Result
Target accuracy	
Hit rate (on target)	58.33 %
Average distance (to center of the target)	0.93 m
Speed of execution	
Fastest time (ball handling)	2.45 s
Average time (ball handling)	2.70 s

Relative x Detail treatment:

	Result summary: Turning over the left & right shoulder	Result: Turning over the left shoulder	Result: Turning over the right shoulder
Target accuracy			
Hit rate (on target)	Place 19 of 32	Place 22 of 32	Place 16 of 32
Average distance (to center of the target)	15 of 32	19 of 32	11 of 32
Speed of execution			
Fastest time (ball handling)	Place 10 of 32	Place 6 of 32	Place 13 of 32
Average time (ball handling)	9 of 32	7 of 32	10 of 32

Absolute&Relative x Detail treatment:



	Result summary: Turning over the left & right shoulder	Result: Turning over the left shoulder	Result: Turning over the right shoulder
Target accuracy			
Hit rate (on target)	58.33 % | Place 19 of 32	50.00 % | Place 22 of 32	66.67 % | Place 16 of 32
Average distance (to center of the target)	0.93 m | 15 of 32	0.99 m | 19 of 32	0.86 m | 11 of 32
Speed of execution			
Fastest time (ball handling)	2.45 s | Place 10 of 32	2.10 s | Place 6 of 32	2.80 s | Place 13 of 32
Average time (ball handling)	2.70 s | 9 of 32	2.40 s | 7 of 32	3.00 s | 10 of 32

EXHIBIT 7.—Example performance report treatments

This exhibit shows examples for three out of the six treatment conditions in detail. The full six treatment conditions were shown on a smaller scale in appendix A, exhibit 4. All three examples here are shown in English, while they were provided in German during the study. The *Absolute* x *Aggregate* report contains four measures. The *Relative* x *Detail* report contains 12 measures. The *Absolute&Relative* x *Detail* report contains 24 measures.

APPENDIX B

Variable Definitions

Variables	Description
Performance measures	
Hitrate	The proportion of the total amount of 12 balls played in one round of the task where a participant has hit the target area.
Distance	The mean distance from a participant's passes to the center of the target for all 12 balls played in one round of the task, measured in meters.
Avg_Time	The mean time that it took a player to complete a pass averaged across all 12 balls played in one round of the task, measured in seconds.
Fast_Time	The fastest time that it took a player to complete a pass among the 12 balls played in one round of the task, measured in seconds.
Treatment variables	
Absolute	An indicator variable equal to 1 if the participant is assigned to the treatment group that receives absolute performance information on passing accuracy and speed of execution in the experiment.
Relative	An indicator variable equal to 1 if the participant is assigned to the treatment group that receives performance ranks relative to a reference group on passing accuracy and speed of execution in the experiment.
Absolute&Relative	An indicator variable equal to 1 if the participant is assigned to the treatment group that receives absolute performance information and performance ranks relative to a reference group on passing accuracy and speed of execution in the experiment.
Aggregate	An indicator variable equal to 1 if the participant is assigned to the treatment group that receives a summary result for all 12 balls played in one round of the task in the experiment.
Detail	An indicator variable equal to 1 if the participant is assigned to the treatment group that receives a summary result for all 12 balls and two subcategories (turn to pass left and right) for six balls each played in one round of the task in the experiment.
Post-experiment survey	
Too Many Measures	Response to survey question, "Based on the training you just played, please answer the following question: I would prefer to see less results." 1 = Strongly disagree; 4 = Neither agree or disagree; 7 = Strongly agree.

Variables	Description
Comparison	Result of a factor analysis of two survey questions (based on Tafkov [2013]). "Please indicate to what extent the following statements describe your experience during the training: 'I often thought about how my performance in the passing drill ranked relative to that of the other participants.' 1 = Never; 4 = Sometimes; 7 = Very often. 'I found that thoughts about performance comparisons interfered with my ability to concentrate on the passing drill.'" 1 = Not at all; 4 = To a moderate extent; 7 = To a great extent.
Demographic variables	
Age	The individual age of the participant at the time of participation.
Gender	An indicator variable equal to 1 if the participant is female.
Height	Response to survey question, "Please state your current height in centimeters (cm)."
Weight	Response to survey question, "Please state your current weight in kilogram (kg)."
League Level	An indicator variable based on the response to a survey question, "What is your current performance level?", equal to 1 if the participant is currently a professional player in the Bundesliga (division level I and II).
% Games Entered	Response to survey question, "How many games did you play for your team in the last season (both in the starting line-up and as a substitute)?", slider on a line from 0 % to 100% or field to enter percent, 0% = No games; 25% = Few games; 50% = Half of all games; 75% = Many games; 100% = All games.
Tenure	Response to survey question, "How many full years have you played for your current club?"
Simulator Experience	A categorical variable based on responses to two survey questions, "Have you trained before at skills.lab?", "If yes, how many times did you train at skills.lab?" 0 = 0 times; 1 = 1 time; 2 = 2–5 times; 3 = more than 5 times.
Language	A categorical variable representing the participant's first language. This is gathered using the survey question, "What language do you speak most often at home? Please select the most commonly spoken language."
Training	Response to survey question, "How many days a week do you usually play football (including training and matches)?" 0 = 0 days; 1 = 1 day; 2 = 2 days; 3 = 3 days; 4 = 4 days; 5 = 5 days; 6 = 6 days; 7 = 7 days.
Football Experience	The difference between the player's age at the time of the experiment and the player's response to the survey question, "How old were you when you first started to play football in a club?"
Position	Response to the survey question, "Which position do you play most often for your team?" 1 = Goalkeeper; 2 = Defender; 3 = Midfielder; 4 = Striker.

Variables	Description
Prior Performance	Performance in the first round of the drill on the dimension of performance (*Hitrate*, *Distance*, *Avg_Time*, or *Fast_Time*) that is the dependent variable in the given model.
Position Depth	The number of participants from a player's team who are competing for the same position on the team as the player (goalkeeper, defender, midfielder, striker) divided by the number of places in the starting lineup at that position.

APPENDIX C

Hypotheses and Related Theory

		Support for Prediction		
	Prediction	Plus	Minus	Conclusion
H1	*Players who receive relative performance information outperform players who receive absolute performance information.*	Relative measures enable peer-performance comparison. This increases competition and enhances motivation (Lazear and Rosen [1981], Tafkov [2013]). Relative measures also provide an inherent benchmark of one's peers. This gives the information more evaluability, which aids in learning (Hsee and Zhang [2010], Song et al. [2018]).	For developing players, who are less likely to be in a position to outperform their peers, relative measures and peer-performance comparison can be demotivating (Goodman, Wood, and Hendrickx [2004]). Absolute measures can motivate these players to improve over their own prior performance (Podsakoff and Farh [1989], Locke and Latham [2002]).	Advanced players and those facing substantial competition for a starting spot on their team are more likely to be competing for top positions and so benefit from the motivation that relative information provides. Given that these types of players make up the majority of our sample, we expect that, on average, players in our setting who receive relative measures will outperform players who receive absolute measures. We test for different responses among developing players.

		Support for Prediction		
	Prediction	Plus	Minus	Conclusion
H2a	*Players who receive relative performance information alone outperform players who receive absolute and relative performance information.*	Presenting absolute measures alongside relative measures may harm performance for two reasons. First, adding absolute measures alongside relative measures could induce information overload (Miller [1956], Eppler and Mengis [2004]). Second, adding absolute measures alongside relative measures could cause players to reduce the cognitive weight they place on the relative measures, reducing peer-performance comparison and its associated performance effects (Birnbaum [1976], Gigerenzer and Goldstein [1996]).	Absolute and relative measures each have benefits as described in the motivation for H1. Players who receive both absolute and relative measures would plausibly receive the benefits of each type of information. Studies have generally found that information processing constraints bind in settings with a larger number of measures than we include in many of our study's performance reports (Miller [1956], Eppler and Mengis [2004]).	In light of the two avenues whereby adding absolute information alongside relative measures could harm performance—through information overload and changes in the cognitive weighting of information—we expect that adding absolute information alongside relative information will negatively affect performance. We conduct follow-on tests to identify if support for this hypothesis works through either or both of these avenues.

	Prediction	Support for Prediction: Plus	Support for Prediction: Minus	Conclusion
H2b	*Holding constant whether performance information is absolute or relative, players who receive aggregated performance information outperform players who receive detailed performance information.*	Added detail in a report can present an overwhelming number of measures that exceeds the information user's cognitive limits. This, in turn, can induce information overload and associated disengagement from the source of information (Miller [1956], Bawden [2001], Eppler and Mengis [2004]).	Added detail can aid in learning (Casas-Arce, Lourenço, and Martínez-Jerez [2017]). Studies have generally found that information processing constraints bind in settings with a larger number of measures than we include in many of our study's performance reports (Miller [1956], Eppler and Mengis [2004]).	This test helps us to examine whether adding absolute measures alongside relative measures harms performance because the number of measures becomes too great. If so, we would expect a similar negative effect when we increase measure quantity in a report by a similar magnitude through adding detail. H2b proposes this hypothesis, although prior research suggests that the number of measures added may not be large enough to cause information overload.
H3a	*Players who are more involved in peer-performance comparison perform better.*	Peer-performance comparison increases competition and should relatedly motivate players (Lazear and Rosen [1981], Tafkov [2013]).	For developing players, who are less likely to be in a position to outperform their peers, relative measures and peer-performance comparison can be demotivating (Goodman, Wood, and Hendrickx [2004], Bandiera, Barankay, and Rasul [2013]).	Advanced players and those with more competition for a starting spot on their team are more likely to experience a performance benefit associated with peer-performance comparison. Given that these types of players make up the majority of our sample, we expect a positive association on average between peer-performance comparison and performance in our setting.

		Support for Prediction		
	Prediction	Plus	Minus	Conclusion
H3b	*Compared to players who receive only relative performance information, players who receive both absolute and relative performance information are less involved in peer-performance comparison.*	Players are likely to place greater cognitive weight on relative measures when these cues are presented alone rather than alongside absolute measures (Birnbaum [1976], Gigerenzer and Goldstein [1996]). Players are, relatedly, likely to be more involved in peer-performance comparison when they place greater cognitive weight on relative measures as these measures enable comparison.		Presenting relative measures alone, rather than alongside absolute measures, keeps players focused on peer-performance comparison.

REFERENCES

Abeler, J.; A. Falk; L. Goette; and D. Huffman. "Reference Points and Effort Provision." *American Economic Review* 101 (2011): 470–92.

Adams, J. A. "Historical Review and Appraisal of Research on the Learning, Retention, and Transfer of Human Motor Skills." *Psychological Bulletin* 101 (1987): 41–74.

Allen, E. J.; P. M. Dechow; D. G. Pope; and G. Wu. "Reference-Dependent Preferences: Evidence from Marathon Runners." *Management Science* 63 (2017): 1657–72.

Angrist, J. D., and J. S. Pischke. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton, NJ: Princeton University Press, 2008.

Asch, B. J. "Do Incentives Matter? The Case of Navy Recruiters." *Industrial and Labor Relations Review* 43 (1990): 89–106.

Ashraf, A. "Do Performance Ranks Increase Productivity? Evidence from a Field Experiment." Discussion paper, University of Warwick, 2018. Available at http://conference.iza.org/conference_files/WoLabConf_2018/ashraf_a26261.pdf

Ashton, R. H. "Pressure and Performance in Accounting Decision Settings: Paradoxical Effects of Incentives, Feedback, and Justification." *Journal of Accounting Research* 28 (1990): 148–80.

Azmat, G., and N. Iriberri. "The Importance of Relative Performance Feedback Information: Evidence from a Natural Experiment Using High School Students." *Journal of Public Economics* 94 (2010): 435–52.

Bandiera, O.; I. Barankay; and I. Rasul. "Team Incentives: Evidence from a Firm Level Experiment." *Journal of the European Economic Association* 11 (2013): 1079–14.

Banerjee, A. V.; E. Duflo; R. Glennerster; and D. Kothari. "Improving Immunisation Coverage in Rural India: Clustered Randomized Controlled Evaluation of Immunisation Campaigns with and Without Incentives." *Bmj* 340 (2010): 2220. https://doi.org/10.1136/bmj.c2220.

Barankay, I. "Rank Incentives: Evidence from a Randomized Workplace Experiment." Working paper, 2012. University of Pennsylvannia. Available at http://repository.upenn.edu/bepp_papers/75

Barron, G., and I. Erev. "Small Feedback-based Decisions and Their Limited Correspondence to Description-Based Decisions." *Journal of Behavioral Decision Making* 16 (2003): 215–33.

Basu, R.; S. Pierce; and A. Stephan. "The Effect of Investor Inattention on Voluntary Disclosure." Working paper, 2019. Northwestern University. Available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3071399

Bawden, D. *Information Overload*. London: South Bank University [Library Information Technology Centre], 2001.

Berk, J. B., and J. H. Van Binsbergen. "Measuring Skill in the Mutual Fund Industry." *Journal of Financial Economics* 118 (2015): 1–20.

Birnbaum, M. H. "Intuitive Numerical Prediction." *The American Journal of Pychology* 89 (1976): 417–29.

Black, D. E., and M. D. Vance. "Do First Impressions Last? The Impact of Initial Assessments and Subsequent Performance on Promotion Decisions." *Management Science* (2020).

Blanes i Vidal, J., and M. Nossol. "Tournaments Without Prizes: Evidence from Personnel Records." *Management Science* 57 (2011): 1721–36.

Blankespoor, E. "The Impact of Information Processing Costs on Firm Disclosure Choice: Evidence from the XBRL Mandate." *Journal of Accounting Research* 57 (2019): 919–67.

Blankespoor, E.; E. Dehaan; and I. Marinovic. "Disclosure Processing Costs, Investors' Information Choice, and Equity Market Outcomes." *Journal of Accounting and Economics* 70, (2020): 101344.

Bonner, S. E., and G. B. Sprinkle. "The Effects of Monetary Incentives on Effort and Task Performance: Theories, Evidence, and a Framework for Research." *Accounting, Organizations and Society* 27 (2002): 303–45.

Bol, J. C. "The Determinants and Performance Effects of Managers' Performance Evaluation Biases." *The Accounting Review* (2011): 1549–75.

Bol, J. C.; T. M. Keune; E. M. Matsumura; and J. Y. Shin. "Supervisor Discretion in Target Setting: An Empirical Investigation." *The Accounting Review* 85 (2010): 1861–86.

Brickley, J. A., J. S. Linck, and J. L. Coles. "What Happens to CEOs After They Retire? New Evidence on Career Concerns, Horizon Problems, and CEO Incentives." *Journal of Financial Economics* 52 (1999): 341–77.

Brown, J. "Quitters Never Win: The (Adverse) Incentive Effects of Competing with Superstars." *Journal of Political Economy* 119 (2011): 982–1013.

Bull, C.; A. Schotter; and K. Weigelt. "Tournaments and Piece Rates: An Experimental Study." *Journal of Political Economy* 95 (1987): 1–33.

Bundesliga. "Soccer Positions Explained: Names, Numbers and What They Do." 2020. Available at https://www.bundesliga.com/en/bundesliga/news/soccer-positions-explained-names-numbers-what-they-do-2579-786

Bursztyn, L., and R. Jensen. "How Does Peer Pressure Affect Educational Investments?" *The Quarterly Journal of Economics* 130 (2015): 1329–67.

Cadman, B. D., and G. Cassar. "Explicit and Implicit Incentives: Longitudinal Evidence from NCAA Football Head Coaches Employment Contracts." Working paper, 2015. University of Utah. Available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2310164

Campbell, D. "Nonfinancial Performance Measures and Promotion-Based Incentives." *Journal of Accounting Research* 46 (2008): 297–332.

Campbell, D.; S. M. Datar; S. L. Kulp; and V. G. Narayanan. "Testing Strategy with Multiple Performance Measures: Evidence from a Balanced Scorecard at Store24." *Journal of Management Accounting Research* 27 (2015): 39–65.

Cappelli, P. and A. Tavis. "The Performance Management Revolution." *Harvard Business Review* 94, (2016): 58–67.

Cardinaels, E.; S. Hollander; and B. J. White. "Automatic Summarization of Earnings Releases: Attributes and Effects on Investors' Judgments." *Review of Accounting Studies* 24 (2019): 860–90.

Cardinaels, E., and P. M. G. Van Veen-Dirks. "Financial Versus Non-Financial Information: The Impact of Information Organization and Presentation in a Balanced Scorecard." *Accounting, Organizations, and Society* 35 (2010): 565–78.

Casas-Arce, P., and F. A. Martínez-Jerez. "Relative Performance Compensation, Contests, and Dynamic Incentives." *Management Science* 55 (2009): 1306–20.

Casas-Arce, P.; S. M. Lourenço; and F. A. Martínez-Jerez. "The Performance Effect of Feedback Frequency and Detail: Evidence from a Field Experiment in Customer Satisfaction." *Journal of Accounting Research* 55 (2017): 1051–88.

CNBC. "Inside Facebook's Cult-Like Workplace, Where Dissent is Discouraged and Employees Pretend to Be Happy All the Time." 2019. Available at https://www.cnbc.com/2019/01/08/facebook-culture-cult-performance-review-process-blamed.html

Courty, P., and G. Marschke. "An Empirical Investigation of Gaming Responses to Explicit Performance Incentives." *Journal of Labor Economics* 22 (2004): 23–56.

Cronbach, L. J., and L. Furby. "How We Should Measure Change: Or Should We?" *Psychological Bulletin* 74 (1970): 68–80.

Cumming, G., and S. Finch. "Inference by Eye: Confidence Intervals and How to Read Pictures of Data." *American Psychologist* 60 (2005): 170–80.

Deci, E. L. "Intrinsic Motivation, Extrinsic Reinforcement, and Inequity." *Journal of Personality and Social Psychology* 22 (1972): 113–20.

DellaVigna, S. "Pscyhology and Economics: Evidence from the Field." *Journal of Economic Literature* 47 (2009): 315–72.

DFB. "DFB-Training Online: Das Passspiel Verbessern und Beherrschen." 2018. Available at https://www.dfb.de/trainer/bambini/artikel/dfb-training-online-das-passspiel-verbessern-und-beherrschen-2802/

Duflo, E.; M. Kremer; and J. Robinson. "Nudging Farmers to Use Fertilizer: Theory and Experimental Evidence from Kenya." *American Economic Review* 101 (2011): 2350–90.

Einhorn, H. J., and R. M. Hogarth. "Behavioral Decision Theory: Processes of Judgment and Choice." *Annual Review of Psychology* 32 (1981): 53–88.

Elliott, W. B.; J. L. Hobson; and B. J. White. "Earnings Metrics, Information Processing, and Price Efficiency in Laboratory Markets." *Journal of Accounting Research* 53 (2015): 555–92.

Eppler, M. J., and J. Mengis. "The Concept of Information Overload: A Review of Literature from Organization Science, Accounting, Marketing, MIS, and Related Disciplines." *The Information Society* 20 (2004): 325–44.

Eriksson, T.; A. Poulson; and M. C. Villeval. "Feedback and Incentives: Experimental Evidence." *Labour Economics* 16 (2009): 679–88.

Ettema, J. H., and R. L. Zielhuis. "Physiological Parameters of Mental Load." *Ergonomics* 14 (1971): 137–44.

Eyring, H., and V.G. Narayanan. "Performance Effects of Setting a High Reference Point for Peer-Performance Comparison." *Journal of Accounting Research* 56 (2018): 581–615.

Festinger, L. "A Theory of Social Comparison Processes." *Human Relations* 7 (1954): 117–40.

Forbes. "Are You Still Using Force Rankings? Please Stop." 2018. Available at https://www.forbes.com/sites/johnkotter/2018/05/23/are-you-still-using-force-rankings-please-stop/#1f3714fb334d

Frederickson, J. R. "Relative Performance Information: The Effects of Common Uncertainty and Contract Type on Agent Effort." *The Accounting Review* 67 (1992): 647–69.

Fryer, R. G.; S. D. Levitt; L. A. List; and A. Samsek. "Introducing CogX: A New Preschool Education Program Combining Parent and Child Interventions." *National Bureau of Economic Research Working Paper*, 2020.

Frick, B. "Performance, Salaries, and Contract Length: Empirical Evidence from German Soccer." *International Journal of Sports Finance* 6 (2011): 88–118.

Gigerenzer, G., and D. G. Goldstein. "Reasoning the Fast and Frugal Way: Models of Bounded Rationality." *Psychological Review* 103, (1996): 650–69.

Goodman, J. S.; R. E. Wood; and M. Hendrickx. "Feedback Specificity, Exploration, and Learning." *Journal of Applied Psychology* 89 (2004): 248–62.

Gong, J.; A. Sun; and Z. Wei. "Choosing the Pond: On-the-Job Experience and Long-Run Career Outcomes." *Management Science* 64 (2018): 860–72.

Gosnell, G. K.; J. A. List; and R. D. Metcalfe. "The Impact of Management Practices on Employee Productivity: A Field Experiment with Airline Captains." *Journal of Political Economy* 128 (2020): 1195–233.

Güllich, A. "Selection, De-Selection and Progression in German Football Talent Promotion." *European Journal of Sport Science* 14 (2014): 530–37.

Hannan, R. L.; G. P. Mcphee; A. H. Newman; and I. D. Tafkov. "The Informativeness of Relative Performance Information and its Effect on Effort Allocation in a Multitask Environment" *Contemporary Accounting Research* 36 (2019): 1607–33.

Hannan, R. L.; R. Krishnan; and A. H. Newman. "The Effects of Disseminating Relative Performance Feedback in Tournament and Individual Performance Compensation Plans." *The Accounting Review* 83 (2008): 893–913.

Hecht, G.; I. Tafkov; and K. L. Towry. "Performance Spillover in a Multitask Environment." *Contemporary Accounting Research* 29 (2012): 563–89.

Hendrix, L. J.; M. W. Carter; and J. L. Hintze. "A Comparison of Five Statistical Methods for Analyzing Pretest-Posttest Designs." *Journal of Experimental Education* 47 (1978): 96–102.

Hirshleifer, D., and S. H. Teoh. "Limited Attention, Information Disclosure, and Financial Reporting." *Journal of Accounting and Economics* 36 (2003): 337–86.

Hirst, M. K., and P. F. Luckett. "The Relative Effectiveness of Different Types of Feedback in Performance Evaluation." *Behavioral Research in Accounting* 4 (1992): 1–22.

Hsee, C. K., and J. Zhang. "General Evaluability Theory." *Perspectives on Psychological Science* 5 (2010): 343–55.

Ilgen, D. R.; C. D. Fisher; and M. S. Taylor. "Consequences of Individual Feedback on Behavior in Organizations." *Journal of Applied Psychology* 64 (1979): 349–71.

Ilies, R., and T. Judge. "Goal Regulation Across Time: The Effects of Feedback and Affect." *Journal of Applied Psychology* 90 (2005): 453–67.

Kahneman, D., and A. Tversky. “Subjective Probability: A Judgment of Representativeness.” *Cognitive Psychology* 3 (1972): 430–54.

Kaplan, R. S., and D. P. Norton. “Using the Balanced Scorecard as a Strategic Management System.” *Harvard Business Review* 74 (1996): 75–85.

Kluger, A. N., and A. Denisi. “The Effects of Feedback Interventions on Performance: A Historical Review, A Meta-analysis, and a Preliminary Feedback Intervention Theory.” *Psychological Bulletin* 119 (1996): 254–84.

Knapp, T. R., and W. D. Schafer. “From Gain Score t to ANCOVA F (and vice versa).” *Practical Assessment, Research, and Evaluation* 14 (2009): 6. https://doi.org/10.7275/yke1-k937

Kreuger, A. B., and D. Whitmore. “The Effect of Attending a Small Class in the Early Grades on College-Test Taking and Middle School Test Results: Evidence from Project STAR.” *The Economic Journal* 111 (2001): 1–28.

Kruschke, J. K., and M. K. Johansen. “A Model of Probabilistic Category Learning.” *Journal of Experimental Psychology: Learning, Memory, and Cognition* 25 (1999): 1083–119.

Lazear, E. P., and S. Rosen. “Rank-order Tournaments and Optimum Labor Contracts.” *Journal of Political Economy* 89 (1981): 841–64.

Lichtenstein, S., T. C. Earle, and P. Slovic. “Cue Utilization in a Numerical Prediction Task.” *Journal of Experimental Psychology: Human Perception and Performanec* 1 (1975): 77–85.

Lipe, M. G., and S. E. Salterio. “The Balanced Scorecard: Judgmental Effects of Common and Unique Performance Measures.” *The Accounting Review* 75 (2000): 283–98.

Lipe, M. G., and S. E. Salterio. “A Note on the Judgmental Effects of the Balanced Scorecard’s Information Organization.” *Accounting, Organizations and Society* 27 (2002): 531–40.

Liu, H.; M. Á. Gomez; C. Lago-Peñas; and J. Sampaio. “Match Statistics Related to Winning in the Group Stage of 2014 Brazil FIFA World Cup.” *Journal of Sports Sciences* 33 (2015):1205–13

Locke, E. A., and G. P. Latham. “Work Motivation and Satisfaction: Light at the End of the Tunnel.” *Psychological Science* 1 (1990): 240–46.

Locke, E. A., and G. P. Latham. “Building a Practically Useful Theory of Goal Setting and Task Motivation: A 35-year Odyssey.” *American Psychologist* 57 (2002): 705–17.

Lucifora, C., and R. Simmons. “Superstar Effects in Sport: Evidence from Italian Soccer.” *Journal of Sports Economics* 4 (2003): 35–55.

Malhotra, N. K. “Information Load and Consumer Decision Making.” *Journal of Consumer Research* 8 (1982): 419–30.

Malmendier, U., and G. Tate. “Superstar CEOs.” *The Quarterly Journal of Economics* 124 (2009): 1593–638.

McKinsey. “Ahead of the Curve: The Future of Performance Management.” *McKinsey Quarterly*, May 2016. Available at https://www.mckinsey.com/business-functions/organization/our-insights/ahead-of-the-curve-the-future-of-performance-management

Mercer. “Global Performance Management Survey.” 2019. Available at https://www.imercer.com/uploads/common/HTML/LandingPages/AnalyticalHub/june2019-mercer-2019-global-performance-management-survey-executive-summary.pdf

Miller, G. A. “The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information.” *Psychology Review* 63 (1956): 81–97.

Morris, R.; D. Tod; and E. Oliver. “An Analysis of Organizational Structure and Transition Outcomes in the Youth-to-senior Professional Soccer Transition.” *Journal of Applied Sport Psychology* 27 (2015): 216–34.

Muralidharan, K., and V. Sundararaman. “Teacher Performance Pay: Experimental Evidence from India.” *Journal of Political Economy* 119 (2011): 216–34.

Newman, A. H., and I. D. Tafkov. “Relative Performance Information in Tournaments with Different Prize Structures.” *Accounting, Organizations and Society* 39 (2014): 348–61.

Podsakoff, P. M., and J. Farh. “Effects of Feedback Sign and Credibility on Goal Setting and Task Performance.” *Organizational Behavior and Human Decision Processes* 44 (1989): 45–67.

Redwood-Brown, A. “Passing Patterns Before and After Goal Scoring in FA Premier League Soccer.” *International Journal of Performance Analysis in Sport* 8 (2008): 172–82.

Rein, R.; D. Raabe; and D. Memmert. “Which Pass is Better? Novel Approaches to Assess Passing Effectiveness in Elite Soccer.” *Human Movement Science* 55 (2017): 172–81.

Roels, G., and X. Su. "Optimal Design of Social Comparison Effects: Setting Reference Groups and Reference Points." *Management Science* 60 (2014): 606–27.

Schnieder, C. "How Relative Performance Information Affects Employee Performance: A Systematic Review of Empirical Research." Working paper, University of Münster, 2018. Available at https://ssrn.com/abstract=3327238.

Schenker, N., and J. F. Gentleman. "On Juding the Significance of Differences by Examining the Overlap Between Confidence Intervals." *The American Statistician* 55 (2001): 182–86.

Simon, H. A. "Rational Decision Making in Business Organizations." *The American Economic Review* 69 (1979): 493–513.

Simons, R. "Control in an Age of Empowerment." *Harvard Business Review* 73 (1995): 80–88.

Skills.lab. "FC Bayern kauft skills.lab Arena." 2019a. Available at https://skills-lab.com/fc-bayern-kauft-fusballsimulator-skills-lab/

Skills.lab. "Lech Poznań investiert in skills.lab Arena." 2019b. Available at https://skills-lab.com/lech-poznan-kauft-skills-lab-arena/

Song, H.; A. L. Tucker; K. L. Murrell; and D. R. Vinson. "Closing the Productivity Gap: Improving Worker Productivity Through Public Relative Performance Feedback and Validation of Best Practices." *Management Science* 64 (2018): 2628–49.

Suls, J. M., and L. Wheeler. *Handbook of Social Comparison: Theory and Research*. New York: Kluwer Academic/Plenum Publishers, 2000.

Tafkov, I. D. "Private and Public Relative Performance Information under Different Compensation Contracts." *The Accounting Review* 88 (2013): 327–50.

The Atlantic. "How Millenials Forced GE to Scrap Performance Reviews." 2015. Available at https://www.theatlantic.com/politics/archive/2015/08/how-millenials-forced-ge-to-scrap-performance-reviews/432585/

The Economist. "The Measure of a Man." 2016. Available at https://www.economist.com/business/2016/02/20/the-measure-of-a-man

The Guardian. "Barcelona Become First Sports Team to Average £10m a Year in Wages." 2018. Available at https://www.theguardian.com/football/2018/nov/25/barcelona-team-average-10m-year-wages-sporting-intelligence.

The New York Times. "Inside Amazon: Wrestling Big Ideas in a Bruising Workplace." 2015. Available at https://www.nytimes.com/2015/08/16/technology/inside-amazon-wrestling-big-ideas-in-a-bruising-workplace.html

The New York Times. "How Data (and Some Breathtaking Soccer) Brought Liverpool to the Cusp of Glory." 2019. Available at https://www.nytimes.com/2019/05/22/magazine/soccer-data-liverpool.html

Tversky, A., and D. Kahneman. "Judgment under Uncertainty: Heuristics and Biases." *Science* 185 (1974): 1124–31.

Tversky, A., and D. Kahneman. "Extensional versus Intuitive Reasoning: The Conjunction Fallacy in Probability Judgment." *Psychology Review* 90 (1983): 293–315.

Vaughn, J. "An Experimental Study of Competition." *Journal of Applied Psychology* 20 (1936): 1–15.