The Impact of Feedback Frequency and Performance-Contingent Bonuses on Learning and Performance

Jeremy Lill

University of Kansas

jeremylill@ku.edu

Alice Muncy

Baylor University

Alice_Muncy@baylor.edu

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ABSTRACT:

This study investigates how the distribution of cognitive feedback interacts with bonus incentives in an environment with incomplete information. We experimentally examine how identical feedback influences performance when it is either provided evenly distributed throughout a task, or distributed early at the beginning of the task, and whether the effect is moderated by the presence of a performance-contingent bonus. We predict and find that evenly distributed feedback produces higher performance when there is no bonus. However, when a bonus is offered, identical feedback distributed early is more effective. Additional tests reveal that without a bonus, feedback distributed early leads to cognitive overload, and consequently lowers performance. However, when a bonus is provided, workers take a more active approach to learning and spend more time trying to understand the feedback, which leads to higher performance. This study adds to the growing body of accounting studies on the effects of feedback distribution on performance. Importantly it highlights that performance-contingent incentives can influence the effectiveness of feedback.

Keywords: Feedback; Cognitive Feedback; Feedback Distribution; Bonus

I. INTRODUCTION

Feedback is a ubiquitous aspect of the workplace and is important for both the control and monitoring activities of management (Luckett and Eggleton 1991). In complex environments, one type of feedback which can be useful to decision makers is cognitive feedback. Cognitive feedback provides information about a task and the relationships between features of the task and performance (Balzer et al. 1989). This is especially important in work environments where there is no single best way of performing a task (Steinmann 1976). Advances in information technology give managers the ability to offer constructive cognitive feedback on tasks with complex mechanisms, and to do so frequently. Consequently, managers must make decisions about the cognitive feedback distribution that they provide to their employees. These decisions are important because the feedback will directly influence their employees' learning and subsequent performance.

A common arrangement found in practice is to provide employees with considerable feedback throughout the early stages of their development, which then peters out as the employee gains experience (Park et al. 2019).[1] This approach contends that feedback should be distributed early in the learning process so that adjustments to performance strategy can be made sooner rather than later (Fisher 2019). However, while the natural inclination may be to give feedback as early as possible, research indicates that this can have varying results (Cook 1967; Lam et al. 2011; Casas-Arce et al. 2017; Chhokar and Wallin 1984). This research suggests that the cognitive resources devoted towards processing feedback plays a pivotal role in the effectiveness of frequent cognitive feedback (e.g., Lam et al. 2011). We contend that firm-level

[1] This feedback is different from training in that training occurs before the employee has started performing their job, whereas feedback is given throughout the employee's task.

environmental features, notably the presence or absence of a performance-contingent bonus, can affect the cognitive resources employees devote to incorporating feedback. In this study, we examine how active learning and subsequent performance differs when cognitive feedback is evenly distributed throughout a task, or distributed early within the task. We further examine whether the presence or absence of a bonus can incentivize workers to take a more active role in incorporating cognitive feedback.

We examine the distribution of feedback in a setting where uncertainty exists about the best strategy to maximize performance. Cognitive feedback helps individuals make mental representations of a task and develop and refine strategies to improve their performance (Balzer et al. 1989). For example, providing new auditors with insight on how transactions flow through different accounts helps them form a broader mental representation of the audit. This improves future performance by showing the auditor how auditing their specific account helps the success of the overall audit. Given the nature of this feedback, workers must use cognitive resources to understand it (Diehl and Sterman 1995; Sengupta and Abdel-Hamid 1993; Steinmann 1976). Distributing a greater amount of feedback near the beginning of the task is more cognitively demanding than spacing it evenly throughout the task because workers must assimilate multiple pieces of feedback in quick succession. Without proper incentives to attend to this information, workers will likely not incorporate the cognitive feedback to the same extent when it is distributed early within the task as when identical feedback is evenly distributed throughout the task. As such, in the absence of a performance-contingent bonus, we hypothesize that workers who receive feedback distributed early will not devote the cognitive resources necessary to fully attend to all early distributed cognitive feedback items. However, when identical feedback is evenly distributed throughout the task, workers will require fewer cognitive resources to attend to all cognitive feedback items, and will thus more fully incorporate the feedback, resulting in higher performance. Thus, in the absence of a performance-contingent bonus we predict that cognitive feedback evenly distributed throughout a task will lead to better performance than identical cognitive feedback distributed early within the task.

We further posit that a performance-contingent bonus moderates this effect. In particular, we predict that in the presence of a performance-contingent bonus, early distributed cognitive feedback yields higher subsequent performance than identical evenly distributed cognitive feedback. At the heart of this prediction is the effect that a performance-contingent bonus has on active learning. Active learning involves the selective, controlled processing of one's environment and feedback cues (Iran-Nejad 1990; Schneider and Shiffrin 1977). We contend that, when engaged in active learning, workers will allocate more cognitive resources to understanding the implications of cognitive feedback provided. When they do, feedback distributed early within the task will be more useful because it helps workers develop an understanding of the task earlier, compared to evenly distributed feedback. Thus, we hypothesize that when a performance-contingent bonus is present, early distributed feedback leads to better performance than identical feedback evenly distributed throughout the task.

We test our hypothesis using an incentivized computer-based experiment in which participants select one figure (e.g., a blue circle with the letter "A", a purple star with the letter "C") from three possibilities. Each figure is worth points based on its features and participants' pay is based on the number of points they accumulate. The point value of each feature is unknown to participants and constant throughout the experiment. At various times during the experiment, participants receive cognitive feedback on how the features translate into points, for example that a green square is worth more than a purple star. Both the content of the feedback and the total number of feedback statements are held constant across all conditions. Using a 2 x 2 between-participants design, we manipulate the distribution of the feedback (*Evenly Distributed* versus *Distributed Early*) and whether or not participants can earn a performance-contingent bonus (*Bonus* versus *No Bonus*). In the *Evenly Distributed* condition, feedback is provided at the end of every fourth round. In the *Distributed Early* condition, feedback is given more at the beginning of the experiment, and declines in frequency throughout the task. In the *Bonus* condition, participants are informed they will receive a bonus if they earn above a fixed number of points, while in the *No Bonus* condition this opportunity is absent.

Consistent with our hypotheses, we find that when workers are not given a bonus, they perform better when cognitive feedback is evenly distributed rather than distributed early. However, when motivated using a bonus, workers perform better when feedback is distributed early rather than evenly distributed. Testing of a causal mechanism indicates that this is due to workers taking a more active approach to learning when provided with a bonus. Additionally, workers viewed early distributed feedback as more appropriate in the *Bonus* condition.

Our study contributes to literature and practice. Early research on feedback suggests that more frequent feedback leads to better performance (Cook 1967; Luckett and Eggleton 1991). However, a number of recent studies suggest that infrequent feedback might be more beneficial to performance (Mohammadi et al. 2011; Casas-Arce et al. 2017). Our study contributes to this discussion by examining a feature of the setting (i.e., performance-contingent rewards) and highlighting that the presence or absence of that feature will change the effectiveness of feedback distribution. This is important to consider as some prior accounting research has found that incentives and feedback are independent of each other (Christ et al. 2016; Lourenço 2016). Our study not only highlights the interdependent nature of feedback and performance-contingent incentives, but also provides insight into the nature of that interdependency: in particular that the cognitive resources devoted towards processing feedback influences whether or not more frequent feedback leads to better performance.

Our study also has important implications for firms seeking to provide employees with cognitive feedback. When employees begin working on new tasks, one suggestion is to provide frequent feedback early in the task to enable learning (Park et al. 2019). This is reinforced when dealing with a younger workforce as a common refrain is to provide them with more frequent feedback (Thompson and Gregory 2012; Baker and Hastings 2018; Holderness et al. 2019b). Our study suggests that, when implementing this approach, it is important to consider environmental features present. In particular, we show that the benefit of providing early distributed versus evenly distributed cognitive feedback is contingent upon the presence of an environmental feature that will evoke more active learning in employees. Our study provides managers one such feature that can be implemented within organizations to trigger this active learning: a performance-contingent bonus. Thus, our study highlights the importance of considering the incentive structure when implementing a feedback system.

The remainder of this paper is organized as follows. Section II provides the background, theory and hypotheses. Section III describes the experiment and related procedures. Section IV presents results. Section V concludes.

II. BACKGROUND AND THEORY

Background

In the workplace, there are often tasks that have clear outcome goals, but the best strategy to achieve these goals is ambiguous (Farrell et al. 2008). Additionally, while prior experience improves task performance, some environments are complex enough that an employee may take years to fully develop their understanding of the environment (Bonner 1994). In order to perform well on these types of tasks, workers use prior experience as well as feedback from the organization to develop familiarity with their task and improve their performance (Ilgen et al. 1979). In this paper, we examine how feedback influences employee performance in an environment where the best strategy for maximizing task performance is unclear.

Feedback provides employees with information on how their actions are related to specific goals or objectives (London 1995; Luckett and Eggleton 1991). When there are many different informational signals or 'cues' that an individual has to take into consideration when making decisions, the information contained in the feedback becomes important (Steinmann 1976). Feedback that helps workers to learn about their task will improve task strategies and facilitate goal completion (Cervone and Wood 1995).[2] Additionally, feedback can help to motivate and regulate employees' performance (Kluger and DeNisi 1996).

The type of feedback given can influence how well the feedback helps workers meet their goals (Adelman 1981; Atkins et al. 2002). Often, workers are given feedback on the outcome of their prior actions. However, outcome feedback alone lacks the process information that can inform employees of how they could improve their performance (Luckett and Eggleton 1991; Steinmann 1976). Therefore, additional feedback is often given which provides workers with information about the task itself and strategies to improve performance. Specifically, cognitive feedback is useful for strategy development (Steinmann 1976). Cognitive feedback provides workers with information about the task, the cognitive processes of decision-makers, or information about the relationship between the task and the cognitive processes of decision-

[2] Feedback may not always contain information that helps an individual meet their goals, however feedback containing useful information is more prevalent, thus we focus specifically on feedback that has information that will help a worker meet their goals.

makers. (Balzer et al. 1989). This is important in an environment with multiple strategies for completing a task, and multiple cues to consider. It helps to focus attention on the underlying processes behind a decision rather than only focusing on the correctness of a specific decision (Hoffman et al. 1981). However, cognitive feedback does not provide an individual with the "correct" answer (Balzer et al. 1989). Because of this, the usefulness of this type of feedback depends on both the cognitive processing capacity of the worker as well as the effort a worker is willing to put in to understanding the feedback provided (Bettman et al. 1990; Cervone and Wood 1995; Lam et al. 2011).

An aspect of feedback that plays a role in the cognitive processing capacity of the worker is feedback frequency (Lam et al. 2011; Lurie and Swaminathan 2009). Research indicates that more frequent feedback is often more cognitively demanding than less frequent feedback (Lam et al. 2011). This research finds that in some cases feedback given more frequently improves productivity, however, in other cases providing less frequent feedback led to better performance outcomes (Casas-Arce et al. 2017; Chhokar and Wallin 1984; Cook 1967; Lam et al. 2011; Lurie and Swaminathan 2009; Mohammadi et al. 2011). This was due in part to the complexity and cognitive demands of the task. However, we argue that the cognitive demands of the feedback itself can also influence performance.

Most prior studies on feedback timing examine feedback at fixed intervals of time (e.g., (Casas-Arce et al. 2017; Lam et al. 2011; Lurie and Swaminathan 2009; Mohammadi et al. 2011). Either feedback was given more frequently at short evenly distributed intervals of time, or less frequently at longer, evenly distributed intervals of time. However, there is a third option. Organizations can provide more frequent feedback at the beginning of a task and slowly decrease the frequency of the feedback provided as an employee becomes more familiar with the task. In this way, feedback is distributed early, at the beginning of a task.

We examine a situation in which the total amount of feedback is constant, however it is either provided more frequently at the beginning of the task and decreased over time or evenly distributed throughout the task.

Early-distributed feedback could be useful to employees because more feedback is given when the employee is spending more time learning a task. Cognitive feedback given more frequently at early stages of a task can help the employee to more quickly develop a mental representation of the task (Balzer et al. 1989). Thus, workers can improve their decision-making more quickly than if feedback were evenly distributed throughout the task. Moreover, correcting adjustments to strategy can be done at the beginning of the task, which leads to greater performance later.

However, there may be benefits to providing feedback at set intervals of time. Employees can anticipate when they are going to receive feedback, and organizations are able to plan feedback sessions in an organized manner. Additionally, some theories suggest that when feedback is given too frequently, it can overwhelm the individual with too much information and inhibit the processing of this information (Cervone and Wood 1995; Lurie and Swaminathan 2009). When given evenly distributed feedback, workers are given more time to process the information contained within the feedback. Thus, the feedback is not as cognitively demanding as feedback distributed early. In environments that are already complex, reducing the cognitive demands of feedback may help performance improvement (Holderness et al. 2019a).

In this study, we examine how performance differs when cognitive feedback is distributed early at the beginning of the task compared to being evenly distributed throughout the task. We argue that a worker’s performance on a task depends on both the distribution of feedback provided and the learning strategy applied.

Learning Strategy

Within organizations, employees learn how to improve on a task over time. Learning in these environments is done through both observing the outcome of prior actions, and processing feedback received from the organization (Frederickson et al. 1999). Employees may consciously or unconsciously decide on a learning strategy in order to improve performance at a given task (Iran-Nejad 1990). There are two overarching learning strategies that workers may employ. First, they may learn without making a conscious attempt to do so. We refer to this as automatic learning (Schneider and Shiffrin 1977). In such a case, knowledge acquisition is done with the worker applying relatively less conscious effort to learn. In this state, individuals spend relatively fewer cognitive resources trying to process feedback given to them. On the other hand, workers may take an active, controlled approach to learning. Using this strategy, they engage relatively more with the learning process and actively try to understand how the feedback received interrelates with the environment they are placed in (Schneider and Shiffrin 1977). In this situation, individuals make a more conscious effort to learn and understand how to improve their performance.

The learning strategy applied often depends on the motivation an individual has for performing a task (Schmidt and Watanabe 2001). Workers regulate the intensity of attention devoted towards a task based upon their motivation for doing well at the task. When a task is not intrinsically rewarding, then there is often an imbalance in the cost of sustaining effort towards a task and the benefits of completing the task (Langner and Eickhoff 2013). When in this situation, individuals may resort to using an automatic method of learning rather than expending too much cognitive and self-regulatory resources on actively trying to understand the task environment. If an organization wishes to promote a more active approach to learning, something is needed to reduce the imbalance between the cost of sustained effort towards a task and the reward of performing well at the task. An outside source of motivation aims to reduce this imbalance. One source of motivation often used in practice is a performance-contingent bonus.

We argue that providing a bonus to a worker leads to them taking a more active role in the learning process. Additionally, the effect of feedback distribution on performance depends on learning strategy applied. Whenever an automatic learning strategy is applied, we posit that evenly distributed feedback will lead to better performance than early distributed feedback. However, whenever an active strategy is chosen, those given early distributed feedback will perform better.

When a more automatic learning strategy is applied, we posit that evenly distributed feedback will lead to better performance than early distributed feedback. Evenly distributed feedback is not as cognitively demanding as early distributed feedback. With early distributed feedback, more information is provided near the beginning of the task. This gives individuals less time to process each piece of information. Evenly distributed feedback provides workers with a routine for which they can receive and incorporate feedback. Workers are able to process each piece of feedback as it is received without also simultaneously processing prior feedback. When workers take a more automatic approach to learning, less time between pieces of feedback means less of a benefit from each piece of information. Because of this we hypothesize;

> *H1: When there is no bonus, workers given evenly distributed cognitive feedback will perform better than workers given early distributed cognitive feedback.*

One approach organizations use to promote a more active learning strategy is providing a bonus for good performance (Drake et al. 2007). Research indicates that incentives induce greater effort

(Sprinkle 2000). When incentivized with a bonus, workers may decide to allocate greater effort towards learning the task. This results in a more active learning strategy. When workers use a more active learning strategy, we posit that those given early distributed feedback will perform better than those given evenly distributed feedback. Early distributed feedback provides workers with a greater amount of information upfront. When workers are more motivated to perform well at the task, they expend greater cognitive resources in processing each piece of information. In this manner, they are able to improve their mental model of the task faster than those given evenly distributed feedback. Because their mental model of the task is more accurate they will perform better than those given evenly distributed feedback. Thus we hypothesize;

> *H2: With a bonus, workers given early distributed cognitive feedback will perform better than workers given evenly distributed cognitive feedback.*

III. METHOD

Overview

We use an experiment created on Qualtrics and hosted on Amazon Mechanical Turk to test our theory. In each of 38 rounds, participants select one of three figures to earn points. Each figure has three features that determine the number of points it is worth. At the end of each round, participants are informed how many points their chosen figure is worth. Additionally, after specific rounds, participants receive cognitive feedback that provides insight as to how different features translated into points.

We use a 2 x 2 between-participants experimental design, manipulating the distribution of the cognitive feedback (*Distributed Early* versus *Evenly Distributed*) and participants' compensation (*Bonus* versus *No Bonus*). We provide the same nine cognitive feedback statements across all conditions, but in the *Distributed Early* condition, participants receive them at the end of the 1st, 2nd, 4th, 7th, 11th, 16th, 22nd, 29th, and 36th rounds, while in the *Evenly*

Distributed condition participants received them at the end of every fourth round.[3] In the *Bonus* condition, participants were informed that if they earned 12,500 points, they would receive a bonus worth $1.50. This bonus did not exist in the *No Bonus* condition.

Detailed Procedures

Participants began by reading instructions about the task and compensation and answering comprehension check questions. The instructions informed participants that the task involved selecting one of three figures each round, and that the features of their selected figure would ultimately determine how many points they received. The instructions also informed participants that both the point value of the features and the mathematical equation to combine the points from each feature would remain constant throughout the experiment, but did not inform participants of the actual point values or the equation. Throughout the instructions, participants in the *no bonus (bonus)* conditions answered 6 (8) comprehension check questions. If a participant missed any comprehension check question three times, they were excluded from participating in the experiment. This was done to ensure participants understood the instructions and were not "clicking through" the experiment.

The figures that participants saw each round varied across three features: shape, color, and letter. For example, in the first round participants could select a blue square with a "C" in the middle, a yellow triangle with a "B" in the middle, or a purple square with a "B" in the middle. In total, there were four different shapes, colors, and letters that were combined to make the figures. These different features were worth points, summarized in Panel A of Table 1. To

[3] Generally the pattern in the *Early Distributed* condition is that the number of rounds between each feedback statement increases by one (i.e., 0 rounds between rounds 1 and 2, 1 round between rounds 2 and 4, 2 rounds between rounds 4 and 7, etc.) We follow this increasing pattern until the last feedback statement. We have 6 rounds between both the 7th and 8th feedback statement and the 8th and 9th. This was done to ensure that across both the *Early Distributed* and *Evenly Distributed* conditions, participants received their last feedback statement on the 36th round.

determine the number of total points that a figure is worth, we summed the point values from shape, color, and letter. At the end of each round, participants learned the point value of their selected figure.

At the end of certain rounds, participants received cognitive feedback, which provided insight into the process of how total points are calculated.[4] This feedback always provided insight into the comparison of two color-shape combinations. For example, the first cognitive feedback participants received was “Ignoring the possible effect of any other features, a green square is worth more than a purple star.” As mentioned, we manipulated the distribution of when participants received the feedback. Across all conditions, the number of feedback statements and their content is held constant. However, in the *Evenly Distributed* condition, participants receive a hint at the end of every fourth round, while in the *Distributed Early* condition, participants receive them more frequently at the beginning and less frequently at the end. Panel B of Table 1 provides all nine cognitive feedback statements and the rounds in which participants received them across the feedback distribution conditions.[5]

[Insert Table 1]

Compensation

Across all conditions, participants were informed in the instructions that they would receive $0.10 for every 1,000 points they earned. Participants in the *Bonus* condition also had the opportunity to earn additional compensation. These participants were informed in the instructions that they could earn a bonus of $1.50 if they earned 12,500 points or more. To determine the bonus threshold, we first ran the *No Bonus* condition and examined the

[4] We called the cognitive feedback “hints” in the experiment.
[5] Note that the cognitive feedback was given in the same order in all conditions and was not contingent upon prior choices. This kept the information consistent across conditions.

performance distribution. We settled on 12,500 points because it was a natural break in the distribution where slightly less than half the participants (46 percent) would have received the bonus. We chose a bonus level of $1.50 based on the average pay in the *No Bonus* condition. In particular, we wanted the bonus to be a substantial portion of their overall compensation to evoke active learning in participants.

In the *No Bonus* condition, participants earned an average of $1.42 with compensation ranging from $0.50 to $3.53.[6] In the *Bonus* condition, participants earned an average of $2.38 with compensation ranging from $0.50 to $5.25, which included the awarding of 28 bonuses (49 percent of participants). Across all conditions, participants earned an average of $1.89 and spent 13.6 minutes to complete the task, earning an average rate of $8.36 per hour, which is consistent with other accounting studies (e.g., Bucaro et al. 2019)

Design Choices

We highlight several design choices that warrant further discussion. We designed the cognitive feedback such that it compared the relative value of two features. This was done to provide feedback that gave some insight into the process of how points were calculated, but did not provide perfect knowledge. For example, instead of providing feedback that "the color blue is worth 700 points" we chose to give feedback that compared two features relative to each other. This forced participants to cognitively attend to the feedback and created variation in how helpful the feedback was based on how much effort participants put into understanding and recalling the feedback. This design choice is also analogous to natural settings in which supervisors provide process-oriented feedback. For example, a manager might be able to provide

[6] It was possible for participants to earn negative points in some rounds. If participants ended the session with a negative number of points, they would still earn a base pay of $0.50. Participants were made aware of this in the instructions.

feedback comparing the historical relative worth of two tasks (e.g., developing existing sales leads is more valuable than pursuing new sales leads), but they are unable to provide perfect information as to exactly how much in sales revenue each task will generate.

We designed one feature (i.e., the letter) to contribute zero points to the amount participants earned each round. Additionally, this feature is not mentioned in the cognitive feedback. One key characteristic of a complex environment is that there are features which have an unclear influence on performance, and which may not be addressed in cognitive feedback (Bonner 1994; Wood 1986). Thus, we made the design choice to include this feature in order to create ambiguity in the environment. That is, it increased the number of unique figures from 16 to 64 by including a letter with four options with the four options for color and shape. However, given the complexity of this design, we decided to make this feature worth zero points. This was done to maintain the salience of the point values of the two characteristics that are mentioned in the cognitive feedback.

Finally, we paid all participants variable pay based on the number of points they earned. This was to ensure that all participants had a reason to attend to the cognitive feedback and to work to improve their performance. To the extent that this compensation scheme evoked active learning in the *No Bonus* condition, it biases against us finding a moderating effect for the bonus.

IV. RESULTS

Participants

Our experiment was conducted on Amazon Mechanical Turk with 107 participants randomly assigned to one of four experiment conditions. Overall, 64 percent of our participants are male, 61 percent are native English speakers, and the average age is 32 years old. Panel A of

Table 2 provides demographic information across our four conditions. We note that, relative to our other conditions, a large number of native English speakers are in the *Bonus / Evenly Distributed* condition. As such, we conduct a one-way ANOVA using language as the dependent variable and an indicator variable for our conditions as the independent variable to determine if there are significant differences across conditions for native English speakers. The test reveals that native English speakers are not equally distributed across our conditions (F = 2.66; p = 0.05).[7] Therefore, we control for native English speakers in our subsequent analyses.

Performance

We next examine performance metrics. *Total Score* is the number of points participants earned across all 38 rounds of the experiment. The maximum (minimum) number of points a participant could earn is 41,800 (-22,350). Across all conditions, on average, participants earned 14,401 points. Panel B of Table 2 provides *Total Score* across our four conditions. We observe a pattern consistent with our hypothesis. That is, participants in the *Bonus* condition earned *more* points with early distributed versus evenly distributed feedback while participants in the *No Bonus* condition earned *fewer* points with early distributed versus evenly distributed feedback. We also observe a similar pattern with our alternative dependent variable, *Correct Choice*. We code *Correct Choice* -1 (0) [1] when participants choose the shape that provides the fewest (middle) [most] points, which gives it a range of -38 to 38.[8]

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[7] We also perform two similar one-way ANOVAs using gender and age as the dependent variables. We find that neither gender (F = 1.68; p = 0.18) nor age (F = 0.51; p = 0.68) is significantly different across conditions.

[8] Our study attempts to generalize to settings in which there is a clear objective, but environmental features make it difficult to know what strategy is best to achieve the objective. In our experiment, participants knew the objective was to maximize the number of points they earn, but they were uncertain as how many points each feature was worth and the mathematical function that combined the points. To validate the uncertainty in how the total points were determined, we asked participants, at the end of the experiment, to rank the four different shapes and the four different color in terms of how many points they were worth. We find that 12 out 107 participants (11.2 percent) and 14 out of 107 participants (13.1 percent) correctly rank the shape and color, respectively. Only 2 out of 107 participants (1.9 percent) correctly rank both the shape and the color. Thus, in our setting, most participants were not able to determine by the end of the experiment how features translated to points.

[Insert Table 2]

Hypothesis Testing

Our hypothesis predicts that the effect of feedback distribution will depend on the presence of a bonus, with early distributed feedback resulting in higher (lower) performance than evenly distributed feedback with (without) a bonus. In Figure 1, this appears to be supported. That is, evenly distributed feedback results in greater performance than early distributed feedback without a bonus; however, when a bonus is offered, early distributed feedback results in greater performance than evenly distributed feedback. Panel A of Table 3 provides the results of an ANCOVA with *Total Score* as the dependent variable, indicator variables for feedback distribution and presence of a bonus as the independent variables, and an indicator for native English speakers as a covariate. As shown in Panel A of Table 3, the interaction is significant ($F = 3.64$; $p = 0.03$, one-tailed), which supports our hypothesis. Panel C of Table 3 provides similar support for our hypothesis with a significant interaction when we use *Correct Choice* as the dependent variable ($F = 3.15$, $p = 0.04$, one-tailed).[9]

Panels B and D provide the simple effect analyses. Using either dependent variable, we find that evenly distributed feedback leads to marginally greater performance than early distributed feedback when no bonus is present ($F = 2.30$, $p = 0.07$ and $F = 1.61$, $p = 0.10$, one-tailed), while early distributed feedback leads to directionally greater performance than evenly distributed feedback in the presence of a bonus ($F = 1.43$, $p = 0.12$ and $F = 1.57$, $p = 0.11$, one-tailed). Together, this suggests that, in our experimental setting, the effect of feedback distribution is contingent upon the presence or absence of a bonus. We next examine possible

[9] We also create a participant-level variable that measures the number of rounds in which that participant selected the top-scoring shape. We run an additional ANCOVA with this dependent variable and find similar results ($F = 3.10$; $p = 0.04$, one-tailed).

mechanisms underlying our finding.

[Insert Table 3]

Performance over Time

In order to better understand our results, we analyze performance changes over time. Our theory suggests that the learning strategy a worker utilizes will result in performance changes which should be more pronounced as they progress through the experiment. In order to examine these changes, we run separate ANCOVAs for the score in the first, middle, and last third of our experiment. Our independent variables are the same as in the main analyses. Our three dependent variables are the summed scores for rounds 1-12, 13-24, and 25-38, respectively. Table 4 presents our results. We find that the interaction is insignificant when we use only the score for the first third of the experiment ($F = 0.27$; $p < 0.60$). However, the interaction becomes significant in the second and last third of the experiment ($F = 5.70$; $p < 0.02$ and $F = 3.34$; $p < 0.07$).[10] This pattern of results provides additional support for our theory. It suggests that the performance begins to diverge as additional information is available, which is consistent with learning differences due to an active versus passive learning strategy.

[Insert Table 4]

Causal Mechanisms

To examine possible causal mechanisms underlying our results, we first turn our attention to how the presence of a bonus affected participants. We argue that providing a bonus causes participants to take a more active approach in determining how the shapes translated to points. To examine this claim, we ask participants the following three post-experiment questions: (1) I

[10] Because the same number of points were not available in all rounds, we also ran an analysis in which we scaled points by the number of points available. We note that performance increase from the first third to the second third, however it drops off somewhat in the last third of the experiment. We surmise that this could be due to fatigue or end-game effects.

tried to understand how the features in which I received feedback (i.e., hints) gave me points, (2) The feedback (i.e., hints) motivated me to consider how features translated into points, and (3) To what extent did you consider the feedback (i.e., hints) you had received in prior rounds when making your decisions?[11] We combine these three questions using principal component analysis (PCA) and use the factor scores to create a single variable we call *Active Focus*.[12] We find that *Active Focus* is higher in the bonus condition relative to non-bonus condition (0.38 vs. -0.41). We next perform an ANCOVA with *Active Focus* as the dependent variable and indicator variables for our conditions as the independent variables.[13] As shown in Panel A of Table 5, we observe a significant main effect for *Bonus* ($F = 8.77$; $p < 0.01$, two-tailed), which suggests that a bonus caused participants to take a more active approach in determining how the shapes translated to points. Panel B of Table 5 provide the simple effects, which shows the effect occurs regardless of the feedback distribution, but it appears to be stronger with early distributed versus evenly distributed feedback ($F = 8.43$; $p < 0.01$ vs. $F = 1.70$; $p = 0.20$, two-tailed).[14]

[Insert Table 5]

We next examine the effect of early distributed versus evenly distributed feedback on performance when a bonus is absent and when it is present. By definition, early distributed feedback presents more pieces of feedback earlier in the process than evenly distributed feedback. If participants are not actively focused on attending to the feedback, early distributed feedback can leave to cognitive overload relative to evenly distributed feedback, resulting in

[11] Participants responded to all questions using a 7 point Likert scale. The end points for questions 1 and 2 were Strongly Agree/Strongly Disagree. The end points for question 3 was Strongly Considered/Not Considered.
[12] The unrotated PCA yields a single factor with an Eigenvalue greater than one (1.90), which explains 63.3 percent of the variance. All questions load in the expected direction with factor scores greater than 0.57.
[13] One participant did not answer one of the three PEQs used to create *Intentionality*. Thus we have 106 observations for these analyses.
[14] We also examine the duration that participants spent on the survey as a secondary measure. We find that participants spent marginally more time when a bonus was present vs. absent, controlling for native English speaking ability (861.07 vs. 765.00 seconds; $t = 1.74$, $p = 0.09$, two-tailed)

lower performance. To investigate this proposition, we ask participants at the end of the experiment their agreement with the following statement: "I forgot the hints soon after they were given to me." We label their responses to this question *Forget* and run an ANCOVA with *Forget* as the dependent variable, and indicator variables for our conditions as independent variables. We present the results in Table 6. As shown in Panel C, when a bonus is absent, participants more strongly agree that they forget the feedback information quickly with early distributed feedback versus evenly distributed feedback (4.49 vs. 3.57; F = 4.28; p = 0.04, two-tailed). However, when a bonus was present, the extent to which participants agreed with the statement does not differ across feedback distribution (4.23 vs. 4.15; F = 0.03; p = 0.86, two-tailed). We next turn our attention to the effect of feedback distribution when a bonus is present.

[Insert Table 6]

When a bonus is present, we contend that it increases the active focus of participants. With an active focus, participants will not feel overwhelmed with feedback in the early distributed conditions. Instead, they will feel that the feedback is appropriate and potentially helpful since they receive greater feedback at the beginning of the experiment. To examine this proposition, we use two post-experiment questions: (1) I felt I received an appropriate amount of feedback (i.e., hints) and (2) I felt the feedback (i.e., hints) was appropriately spaced throughout the task. We combine these two questions using (PCA) and use the factor scores to create a single variable we call *Appropriate Feedback*.[15] We perform an ANCOVA with *Appropriate Feedback* as the dependent variable and indicator variables for our conditions as the independent variables. As shown in Panel B of Table 7, we observe a marginal simple effect for feedback distribution when a bonus is present (F = 2.78, p = 0.10, two-tailed), but no effect when bonus is

[15] The unrotated PCA yields a single factor with an Eigenvalue greater than one (1.61), which explains 80.1 percent of the variance. All questions load in the expected direction with factor scores greater than 0.71.

absent (F = 0.01, p = 0.95). Together this suggests that when a bonus is present, participants are not overwhelmed with early distributed feedback and, in fact, believe this type of feedback to be relatively more appropriate compared to those who receive evenly distributed feedback.

[Insert Table 7]

V. CONCLUSION

This study reports the results of an experiment that examines the effects that feedback distribution and bonus incentives have on performance in a complex task environment. We do this in an environment where feedback is either distributed early within a task, or evenly distributed throughout a task, while the total amount and the content of feedback is held constant. Overall, our results suggest that the effectiveness of providing early distributed feedback depends on the learning strategy employed by the worker. We find that when workers do not take an active approach to learning, they are more likely to become cognitively overwhelmed by early distributed feedback. However, when feedback is evenly distributed throughout the task, workers are able to assimilate more of it. Additionally, we find that incentivizing workers with a bonus encourages them to take a more active approach to the learning process. When an active approach is taken, workers benefit from having more feedback near the beginning of the task. This is primarily due to workers paying closer attention to each piece of feedback as they are provided it, and being able to assimilate it into their strategy earlier than if the feedback is evenly distributed throughout the task.

Our study contributes to both literature and practice by examining a feature commonly found in organizations (i.e., performance-contingent rewards) and highlighting that the presence or absence of this feature will change the effectiveness of feedback distribution. Our study not only highlights the interdependent nature of feedback and performance-contingent incentives, but also provides insight into the nature of that interdependency: in particular that the cognitive resources devoted towards processing feedback influences whether or not more frequent feedback leads to better performance. Thus, our study highlights the importance of considering the incentive structure when implementing a feedback system.

Our study also has important implications for practice. While it is often suggested that cognitive feedback should be provided early on as an employee is starting a new task, our study indicates that feedback which is distributed too early within the learning process may hinder learning. Instead, our study suggests that in order for early distributed feedback to be effective and active learning strategy must be evoked within the employee. Additionally, we provide managers with performance contingent bonuses as a feature which can be implemented to encourage active learning.

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FIGURE 1
Performance (Average Number of Points) Across Conditions

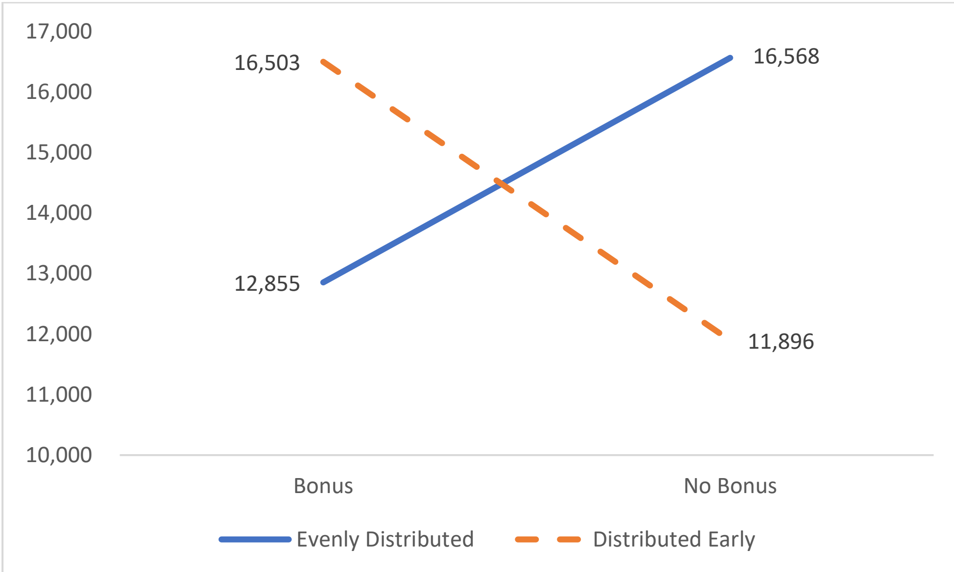

TABLE 1
Experiment Features

Panel A: Features and Point Values

Shape	Points	Color	Points	Letter	Points
Circle	-1,350	Purple	-500	A	0
Triangle	-850	Yellow	400	B	0
Star	250	Blue	700	C	0
Square	950	Green	1,200	D	0

Panel B: Feedback Statements and Round Provided

Feedback Statement	Evenly Distributed	Distributed Early
Ignoring the possible effect of any other feature, a green square is worth more than a purple star.	4	1
Ignoring the possible effect of any other feature, a yellow star is worth more than a blue triangle.	8	2
Ignoring the possible effect of any other feature, a yellow square is worth more than a purple star.	12	4
Ignoring the possible effect of any other feature, a green triangle is worth more than a blue circle.	16	7
Ignoring the possible effect of any other feature, a green square is worth more than a yellow circle.	20	11
Ignoring the possible effect of any other feature, a blue triangle is worth more than a yellow circle.	24	16
Ignoring the possible effect of any other feature, a green star is worth more than a purple square.	28	22
Ignoring the possible effect of any other feature, a yellow circle is worth more than a blue square.	32	29
Ignoring the possible effect of any other feature, a purple triangle is worth more than a green star.	36	36

TABLE 2
Descriptive Statistics Across Conditions

	Bonus Evenly Distributed (n = 28)	**Bonus Distributed Early (n = 27)**	**No Bonus Evenly Distributed (n = 25)**	**No Bonus Distributed Early (n = 27)**
Panel A: Demographics				
Gender	0.64	0.70	0.76	0.48
Language	0.82	0.56	0.48	0.56
Age	32.14	31.18	34.00	32.61
Panel B: Performance				
Total Score				
Mean	12,854.80	16,502.94	16,568.28	11,895.53
Std. Error	2,152.59	2,138.35	2,237.78	2,138.35
Minimum	-7,200.00	2,300.00	-3,600.00	-8,900.00
Maximum	33,800.00	37,500.00	35,300.00	33,600.00
Correct Choice				
Mean	7.27	10.74	10.49	6.93
Std. Error	1.95	1.94	2.03	1.94
Minimum	-14.00	-6.00	-6.00	-12.00
Maximum	25.00	30.00	29.00	26.00

Gender is coded 1 (0) for Male (Female). Language is coded 1 (0) for native (non-native) English speakers. In Panel B, Average (Std. Error) [Range] performance information is provided. *Total Score* is the total number of points earned throughout the experiment. *Correct Choice* is coded 1 (0) [-1] if the participant selects the shape that provides the most (second most) [fewest] points. Consistent with the rest of our analyses, we control for native English speaking to provide the means and standard errors in Panel B.

TABLE 3
ANCOVA Examining the Effect of Bonus and Feedback Distribution on Performance

Panel A: ANCOVA – Total Score as DV

Source	df	MS	**F-Stat**	**p-value**
Language	1	2.39×10^9	19.41	< 0.01***
Bonus	1	5.16×10^6	0.04	0.84
Feedback Distribution	1	6.94×10^6	0.06	0.81
Bonus*Feedback Distribution	1	4.47×10^8	3.64	**0.03****
Residual	102	1.23×10^8		

Panel B: Simple Effects – Total Score as DV

Source	**F-Stat**	**p-value**
No Bonus: *Distributed Early vs. Evenly Distributed*	2.30	**0.07***
Bonus: *Distributed Early vs. Evenly Distributed*	1.43	**0.12**

Panel C: ANCOVA – Correct Choice as DV

Source	df	MS	**F-Stat**	**p-value**
Language	1	1,481.19	14.59	< 0.01***
Bonus	1	2.31	0.02	0.88
Feedback Distribution	1	0.05	0.00	0.98
Bonus*Feedback Distribution	1	319.51	3.15	**0.04****
Residual	102	101.52		

Panel D: Simple Effects – Correct Choice as DV

Source	**F-Stat**	**p-value**
No Bonus: *Distributed Early vs. Evenly Distributed*	1.61	**0.10***
Bonus: *Distributed Early vs. Evenly Distributed*	1.57	**0.11**

Bolded p-values represent directional predictions and are thus one-tailed.

Total Score is the total number of points earned throughout the experiment. *Correct Choice* is coded 1 (0) [-1] if the participant selects the shape that provides the most (second most) [fewest] points.

TABLE 4:
ANCOVA Examining the Timing Effects of Bonus and Feedback Distribution on Performance

Panel A: ANCOVA - Summed Score of First Third as DV

Source	df	MS	**F-Stat**	**p-value**
Language	1	$4.73x10^8$	4.65	< 0.01***
Bonus	1	$2.94x10^6$	16.15	< 0.01***
Feedback Distribution	1	$5.88x10^6$	0.35	0.56
Bonus*Feedback Distribution	1	$4.60x10^6$	0.27	0.60
Residual	102	$1.69x10^6$		

Panel B: ANCOVA - Summed Score of Second Third as DV

Source	df	MS	**F-Stat**	**p-value**
Language	1	$2.19x10^8$	11.62	< 0.01***
Bonus	1	$6.74x10^5$	0.04	0.85
Feedback Distribution	1	$6.05x10^5$	0.03	0.86
Bonus*Feedback Distribution	1	$1.07x10^8$	5.70	< 0.01***
Residual	102	$1.89x10^7$		

Panel C: ANCOVA - Summed Score of Third Third as DV

Source	df	MS	**F-Stat**	**p-value**
Language	1	$3.08x10^8$	13.74	< 0.01***
Bonus	1	$6.99x10^4$	0.01	0.96
Feedback Distribution	1	$9.75\ x10^5$	0.04	0.84
Bonus*Feedback Distribution	1	$7.47\ x10^7$	3.34	0.07*
Residual	102	$2.24.x10^7$		

Summed Score for each third is the total number of points earned in rounds 1-12, 13-24, and 25-38 respectively.

TABLE 5
ANCOVA Examining the Effect of Bonus on Active Focus

Panel A: ANCOVA – Active Focus as DV

Source	df	MS	**F-Stat**	**p-value**
Language	1	0.29	0.17	0.68
Bonus	1	15.48	8.77	< 0.01***
Feedback Distribution	1	2.18	1.23	0.27
Bonus*Feedback Distribution	1	2.06	1.17	0.28
Residual	101	1.77		

Panel B: Simple Effects – Active Focus as DV

Source	**F-Stat**	**p-value**
Distributed Early: *Bonus vs. No Bonus*	8.43	< 0.01***
Evenly Distributed*: Bonus vs. No Bonus*	1.70	0.20

Bolded p-values represent directional predictions and are thus one-tailed.

Active Focus is a variable created using PCA on three post-experiment questions: (1) I tried to understand how the features in which I received feedback (i.e., hints) gave me points, (2) The feedback (i.e., hints) motivated me consider how features translated into points, and (3) To what extent did you consider the feedback (i.e., hints) you had received in prior rounds when making your decisions?

TABLE 6
ANCOVA Examining the Effect of Feedback Distribution on Forgetfulness

Panel A: ANCOVA – Forget as DV

Source	df	MS	**F-Stat**	**p-value**
Language	1	7.32	2.86	0.09*
Bonus	1	0.68	0.27	0.61
Feedback Distribution	1	6.56	2.56	0.11
Bonus*Feedback Distribution	1	4.61	1.80	0.18
Residual	102	2.56		

Panel B: Simple Effects – Forget as DV

Source	**F-Stat**	**p-value**
No Bonus*: Distributed Early vs. Evenly Distributed*	4.28	0.04**
Bonus*: Distributed Early vs. Evenly Distributed*	0.03	0.86

All p-values are two-tailed

Forget is the response to a post-experiment question: I forgot the hints soon after they were given to me.

TABLE 7
ANCOVA Examining the Effect of Feedback Distribution on Appropriateness of Feedback

Panel A: ANCOVA – Appropriate Feedback as DV

Source	df	MS	**F-Stat**	**p-value**
Language	1	2.90	1.82	0.18
Bonus	1	1.08	0.68	0.41
Feedback Distribution	1	2.05	1.28	0.26
Bonus*Feedback Distribution	1	2.34	1.47	0.23
Residual	102	1.59		

Panel B: Simple Effects – Appropriate Feedback as DV

Source	**F-Stat**	**p-value**
No Bonus*: Distributed Early vs. Evenly Distributed*	0.00	0.95
Bonus*: Distributed Early vs. Evenly Distributed*	2.78	0.10*

All p-values are two-tailed

Appropriate Feedback is a variable created using PCA on two post-experiment questions: (1) I felt I received an appropriate amount of feedback (i.e., hints) and (2) I felt the feedback (i.e., hints) was appropriately spaced throughout the task.