The Effects of Tournament Incentive Contracts and Relative Performance Feedback on Task Effort, Learning Effort, and Performance

by

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Abstract

When employees work hard, they exert more effort on job tasks (*task effort*); and when employees learn hard, they exert more effort to learn (*learning effort*). Task effort and learning effort are important causes of improved performance. This thesis investigates whether the use of tournament schemes motivates employees to work harder and learn harder, and also whether providing performance feedback in tournament schemes has any impact on task effort and learning effort.

This thesis has three goals. The first is to investigate the relationship between incentives, learning, and performance. The literature on whether learning interacts with incentives to improve performance is inconclusive, because no prior research has provided a good test of this question (as noted by Bonner and Sprinkle 2002; Bailey and Fessler 2011; Bailey et al. 1998, and as remains true today). The second goal is to investigate the motivational effect of tournament schemes on effort. The literature suggests that effort is difficult to observe directly or to quantify; as a result, it is hard to verify whether tournament schemes motivate employees' task effort and learning effort. This thesis uses an eye-tracking device to measure effort, by measuring eye position, eye movements, and pupil size. The third goal is to investigate the effect of performance feedback on task effort, learning effort, and performance in the tournament setting.

I posit and show evidence that both task effort and learning effort are higher in multiple-winner schemes than in either winner-takes-all schemes or piece-rate schemes. Task effort is directly positively associated with performance, while learning effort causes learning transfer to a job task, also yielding a positive effect on performance. I find that providing relative performance feedback in the tournament setting has no significant impact on task effort or learning effort.

These findings have practical value for many corporations, which are constantly re-evaluating the effectiveness of their incentive schemes and reporting systems while investing in learning initiatives to help employees transfer learned skills to job tasks. Organizations may use the insights of this thesis to help them design learning initiatives and motivate employees to transfer learned skills to their job tasks.

Dedication

To my family, especially my mom, for their love and support.

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I am sincerely grateful for the many people who have supported me throughout my time in the PhD program at Beedie. The completion of this PhD degree would not be possible without the support, inspiration, and encouragement I have received from my family, my supervisor, my thesis committee, my friends at Beedie, and my friends in life.

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I am also grateful for the support of my lifelong friends, especially Lenny Lin and Ken Yen. I have benefited from their quality of character in my life and we have shared fun time on the badminton court every Saturday over the past years. Their support and friendship have helped me get through the tough spots in my PhD program.

Finally, I cannot emphasize enough the importance of my family in supporting my decision to pursue this PhD degree. I dedicate this thesis to my mom, a sincere Christian, who has prayed for me and for my completion of this thesis on a daily basis.

Through her, I feel I am closer to God, who I believe has a great plan for my life. This includes charitable endeavours through which I hope to help others and give back to the community when I am able to.

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Executive Summary

This thesis investigates the motivational effects of tournament-based incentive schemes and the provision of relative performance feedback on employees' task effort, learning effort, and performance. Task effort and learning effort are important causes of improved performance. Both can be considered to be special cases of general effort (Bonner and Sprinkle 2002; Coate and Goldbaum 2006): It requires effort to perform a task, and (a different dimension of) effort to learn a skill. However, the literature suggests that we know very little about whether and how tournament schemes can affect effort to improve performance (Bonner and Sprinkle 2002) or about the effect of providing performance feedback in tournament-based schemes (Hannan et al. 2008). In light of these gaps, I investigate the effects of tournament-based schemes and of provision of relative performance feedback within those schemes on employees' effort (task effort and learning effort) and performance. Motivation, including motivation yields from tournament schemes such as bonuses awarded for performance increase, can improve initial performance on the job, learning effort, and the transfer of learned skills, making subsequent performance higher (Lazear and Rosen 1981). Lazear and Rosen (1981) suggest that tournament schemes will motivate employees to exert learning effort for relevant skill acquisition. Tournament theory (Lazear and Rosen 1981) suggests that tournament schemes have two dimensions of incentives: One for motivating task effort on job tasks, and another for motivating learning effort for relevant skill acquisition. Tournament theory also suggests that learning effort (as well as task effort) should have an impact on performance.

Achieving a better understanding of learning effort will be a particularly important contribution of this investigation, since organizations invest billions of dollars annually in learning initiatives in the hope of motivating more learning effort for better skill acquisition. These organizations hope that employees will apply their learned skills to their job tasks to improve their performance. If employees are motivated to make sufficient learning effort to acquire such skills, they will be able to transfer new skills to their jobs. However, if employees are not motivated to make sufficient learning effort to acquire such skills, they are unlikely to transfer new skills to their jobs. This would mean

that learning initiatives are not having the desired effect and that organizations are wasting billions of dollars by investing in them.

This thesis addresses the suggestion in Bonner and Sprinkle (2002) that further studies should investigate how learning and incentives can combine to improve performance. Bonner and Sprinkle (2002) assert that there is potential for such positive effects, but comment that no prior studies provide a good test of this question, because these studies show no evidence that training actually enhances skills. Bailey et al. (1998) find that incentive pay (i.e., piece-rate, goal-contingent pay) increases only initial performance on a repetitive task, not improvement from the baseline of this initial performance, which they conceptualize as "learning." A piece-rate scheme is a compensation that bases reward on employees' output, rewarding them for each unit of output they produce (Bonner et al. 2000). Bailey et al. (1998) suggest that future studies should provide learning opportunities to allow subjects to improve on their initial performance.

To investigate how learning interacts with incentives to improve performance, I used a two-stage framework: In the first stage, I determined the anticipated level of initial performance on a repetitive job task using tournament schemes, and in the second, I determined the level of performance after the same subjects had had a learning opportunity to acquire new skills that they could apply to improve their performance on the same job task. The difference in level of performance between the first and second stages represents the effect of learning.

I draw on tournament theory to support this investigation. In the first stage of the experiment, I investigated the impact of tournament schemes on task effort, and the impact of task effort on performance. I used two types of tournament schemes: multiple-winner schemes and winner-takes-all schemes. Kalra and Shi (2001) state that these are the two major types of tournament schemes in the literature, and define them as follows: "a multiple-winner format where the reward is shared equally and a winner-takes-all format where a single winner gets the entire reward" (p. 173). A tournament-based scheme is a compensation that bases reward on the relative ranking of employee's performance, rather than on their absolute performance. That is, employee's

compensation will depend on whether they perform well relative to their peers. I also investigated whether providing relative performance feedback, or feedback on how a subject is performing a task relative to other subjects, in these tournament schemes would affect task effort. For this investigation, I draw on social comparison theory (Festinger 1954), which suggests that relative performance feedback should have a motivational effect on subjects, because people have a tendency to compare themselves with others to better evaluate and improve their own performance. Overall, I tested three main hypotheses in the first stage:

1) Task effort is higher in multiple-winner schemes than in winner-takes-all schemes,

2) More task effort leads to higher performance, and

3) Relative performance feedback moderates the relationship between tournament schemes and task effort.

Thus, in the first stage, tournament schemes serve as an independent variable, task effort as a dependent variable, and relative performance feedback as a moderating variable. A moderating variable affects the direction of the relationship between an independent variable and a dependent variable (Bonner and Sprinkle 2002).

In the second stage of the experiment, I investigated the impact of tournament schemes on learning, which in turn affects subsequent performance. Specifically, motivation from tournament schemes increases learning effort, which leads to increased transfer of learned skills to the job task, making subsequent performance higher. I also investigated whether providing relative performance feedback in these tournament schemes would affect learning effort. The difference in performance from the first to the second stage represents the effect of learning. Further, I tested the effects of learning effort and learning transfer on performance. Thus, I tested three main hypotheses in the second stage:

4) Learning effort is higher in multiple-winner schemes than in winner-takes-all schemes,

5) Learning transfer mediates the relationship between learning effort and performance, and

6) Relative performance feedback moderates the relationship between tournament schemes and learning effort.

Throughout the experiment, I used an eye-tracker to measure task effort and learning effort. An eye-tracker is a device that measures subjects' eye position, eye movements, and pupil size. It determines the length of time that subjects focus their attention on a specific point and their pupil size when they do so, which reflects the cognitive load on the subjects' memory (Kahneman 1973); that is, when subjects work hard on a task that consumes much of their memory, their pupil size increases. I use these two measures to assess subjects' task effort. I design a job task that requires subjects to visually recognize similar symbols. Specifically, subjects need to fixate on a symbol to verify whether it is the same symbol they have seen previously. I measure the length of time that subjects fixate on these symbols (fixation time), and their pupil size when doing so.

An eye-tracker can also measure subjects' eye movements between any two points, and the length of time it takes them to move their eyes from one point to another. I use these two measures to assess subjects' learning effort. In a learning session, subjects will learn problem-solving skills to correct the order of letters in an anagram so as to form an English word—a problem-solving skill recognized in previous studies (Bonner 2008; Bonner et al. 2000; Fehrenbacher 2013). The specific kind of problem-solving skills investigated here relates to how to unscramble an anagram in a specific way to form an English word. To learn this problem-solving skill, subjects need to move every second letter in an anagram to the left to form an English word. As they do so, they will move their eyes to the left consciously for every second alphabetic letter in the anagram. If subjects do not learn to perceive the anagram and correct the letter order in this specific way, they will not form the English word effectively and will fail at the learning task. Practice is expected to improve their performance on this learning task, and this improvement is expected to persist to a similar task in a post-learning context. I measure the number of times that subjects move their eyes leftward between two

adjacent letters (i.e., the number of saccades that move from a letter to another in the left direction), and the total length of time they exhibit this kind of eye movement. A saccade is defined in the eye-tracking literature as a quick eye movement that connects two fixation points (Aaltonen et al. 1998; Rayner 1998).

I measured task effort on the basis of *effort duration* and *effort intensity*. Following Mauldin (2003), I define effort duration as subjects' total fixation time for a job task, and to effort intensity as pupil size change from baseline from the beginning to the end of a job task. I measured learning effort on the basis of *effort direction* or total fixation time while learning problem-solving skills, and *effort toward problem-solving* as the number of saccades subjects exhibited while learning problem-solving skills.

I used a customized Java-based computer program (designed by a contracted software engineer) to measure subjects' *learning transfer* to their job tasks. Learning transfer is the carrying-over of previously learned skills to new contexts (Lombardo 2007). When subjects can correctly recognize previously learned information in their job tasks and take an instructed action, it means that they can apply their learning to their job tasks. Subjects were required to indicate their recognition of previously learned information by clicking a button; I measured the number of times (the probability of retrieval) and the timeliness (the time taken to retrieve learned skills) with which subjects correctly clicked the button.

The first stage of the experiment shows that multiple-winner schemes motivate employees to exert more effort on job tasks than do either winner-takes-all schemes or piece-rate schemes. Specifically, effort intensity is higher in multiple-winner schemes than in either of the other types. Effort intensity is also found to be correlated with performance, while effort duration is not. In addition, I do not find that providing relative performance feedback in tournament schemes has a moderating effect on task effort.

The second stage of the experiment shows that multiple-winner schemes motivate employees to exert more learning effort for skill acquisition than do either winner-takes-all or piece-rate schemes. Specifically, effort direction, which is measured by fixation time on learning problem-solving skills, is higher in multiple-winner schemes than in either of the other types. Increased effort direction leads to more learning

transfer, thereby improving performance; in other words, increased effort direction enables employees to apply learned skills to job tasks more frequently and quickly, resulting in their improved performance.

I interpret these findings as showing that when employees have spent more fixation time learning problem-solving skills, they can apply these skills more effectively in their job tasks; and when they can do that, they can improve their performance. Consistently, Libby and Lipe (1992) suggest that learning requires time and purposeful attention. Similarly, Shell et al. (2010) assert that learning requires a person to exert conscious attention or effort, and involves storing information in memory. Further, they show that when employees have spent more fixation time learning problem-solving skills, they can apply these skills more quickly or efficiently in job tasks; this will also improve their performance. Finally, I do not find that providing relative performance feedback in tournament schemes has any effect on learning effort.

This thesis will have practical value for many organizations, which are constantly re-evaluating tournament-based incentive schemes and reporting systems (i.e., feedback mechanisms) (Boyle 2001; Harbring and Irlenbusch 2008; Hannan et al. 2013). Organizations invest billions of dollars in learning initiatives in the hope that employees will be motivated to exert more learning effort and transfer what they learn to the job, improving their performance. Thus, organizations can benefit from the findings of this thesis, which suggests ways (or incentives) to motivate employees to exert more learning effort and to transfer their skills.

This thesis makes two contributions to the management accounting literature. Various studies (Bonner and Sprinkle 2002; Bailey et al. 1998; Bailey and Fessler 2011; Hannan et al. 2008; Hannan et al. 2013) assert that there is potential for positive effects of matters within the purview of managerial accounting (specifically, incentives and feedback) on employees' task effort, learning, and performance improvement. The first contribution is methodological. This thesis provides a novel methodology using an eye-tracker to measure pupil dilation, providing a direct measurement of intensity of effort to verify the relationship between task effort and performance. This thesis shows that effort intensity has a stronger impact on performance than effort duration, which had no

significant effect. Thus, this study makes a methodological contribution to the literature on the direct measurement of task effort and which dimension of task effort leads to improved performance.

The second contribution is to clarify and provide evidence of the relationship between learning and performance. Bonner and Sprinkle (2002) suggest that prior studies have failed to discern the effect of learning on performance because they have not used the right training task to enhance skills (i.e., learning). Bailey et al. (1998) find that incentive pay (i.e., piece-rate or goal-contingent pay) improves only initial performance on a repetitive task, not subsequent improvement, or "learning," and Bailey and Fessler (2011) find that piece-rate incentive pay is unlikely to improve learning regardless of the task complexity. Prior research not only has not provided learning opportunities to allow subjects to acquire (i.e., learn) skills, but also has not used tournament schemes, another type of incentive pay (for example, bonuses on top of salary). In tournament schemes, employees' performance is ranked, and only the top-ranked employee(s) will receive the bonus. This is in contrast to piece-rate schemes, where employees' performance is not necessarily ranked and their additional earnings on top of salary are based on the units they produce. This thesis shows a positive effect of learning on performance when tournament schemes are used. I posit and show that multiple-winner schemes can motivate individuals to exert more learning effort than either winner-takes-all schemes or piece-rate schemes, and that increased learning effort leads to performance improvement. This means that tournament-based incentives (i.e., multiple-winner schemes) and learning can combine to improve performance. This thesis addresses concerns set out in Bonner and Sprinkle (2002), Bailey et al. (1998), and Bailey and Fessler (2011), and contributes to the management accounting literature.

Chapter 1.

Introduction and Problem Statement

Over the past decade, the management accounting literature on workplace performance has documented several important discussions of the negative performance consequences of tournament schemes that offer employees a low probability of winning (Bonner et al. 2008; Sprinkle 2003; Bailey and Fessler 2011; Hannan et al. 2008; Berger et al. 2013). Tournaments are common practice in organizations and involve individuals competing against each other for a limited number of rewards such as promotions or bonuses, and their relative performance determines tournament winners and non-winners (Berger et al. 2013; DeVaro 2006). That is, while tournament theory (Lazear and Rosen 1981) suggests a positive relationship between the use of tournament schemes and performance, some studies add a note of caution, arguing that when the probability of winning is too low, a tournament may fail to motivate employees to exert more effort. Ashton (1990) suggests that winner-takes-all schemes may not contribute to an organization's goal of improving employees' performance, because average performance of a group of employees will likely decline, and variance of individual performance will likely increase (p. 154). Decker (1992) supports this view and argues further that winner-takes-all schemes may not contribute to goal congruence between the agent and the principal, and also that they may have a negative effect for the principal. Hannan et al. (2008) likewise argue that winner-takes-all schemes may only motivate some employees who are the top performers, leaving many or most unmotivated.

Some theorists argue that this negative effect may be because winner-takes-all schemes or schemes offering a low probability of winning, that is, a high "win threshold," may induce a "give-up" phenomenon, meaning that a worker is unwilling to work harder and that their performance may actually deteriorate (Bonner and Sprinkle 2002). Berger

et al. (2013) observe in addition that participants give up when they are far behind others.

Given that learning effort is an input of improved performance, the give-up phenomenon also affects learning effort negatively. Bonner (2008) explains that people maximize expected utility (or net return) and that when people believe the cost of learning effort exceeds the benefit derived from learning, they may not be motivated to learn. (The cost of learning is, for instance, a function of effort; see Rosen and Lazear 1981[1]).

Despite the caution provided by these studies, winner-takes-all schemes seem to be a common approach in practice. Kelly and Presslee (2014) suggest that many firms reward only the top employees (e.g., top 10% to 20%) (see also Hannan et al. 2008; Newman and Tafkov 2011). Churchill (1992) reports on a survey that finds that a large proportion of firms reward the top 20% performers: 35% of firms use contests in which participants have a chance of 1 in 5 to win; 31% of firms use contests in which participants have a chance of 2 in 5 to win; 21% of firms use contests in which participants have a chance of 3 in 5 to win; and 5% of firms use contests in which participants have a chance of 4 in 5 to win.

Companies use tournaments not only to reward employees, but also to penalize them, in a practice called a *forced-ranking system* or "*rank and yank.*" Forced ranking can be used to create a *dismissal tournament* for employees (Kräkel 2008; Gürtler and Kräkel 2012). For instance, former General Electric CEO Jack Welch advocated the use of forced-ranking systems and required the bottom 10 percent of employees in the performance ranking to leave the company each year (Kräkel 2008). This is typical of forced-ranking system. A similar system is used by Enron where employees at the bottom 20 percent in terms of performance are required to leave the company (Kräkel

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[1] Opportunity costs should be already factored in an individual's expected utility, like tuition for education and forgone income when one decides to go to school.

2008), and by Infineon where the lowest 5 percent performers have to leave the company (Irlenbusch 2006; Harbring and Irlenbusch 2008)[2].

Forced-ranking systems are a common practice in the corporate world. Hannan et al. (2013) and Boyle (2001) note that as many as one-fourth of Fortune 500 firms and one-third of U.S. firms use forced-ranking systems. The *Wall Street Journal* (2012) shows that 60% of Fortune 500 companies use forced-ranking systems to tie part of employees' pay to performance (Dutcher et al. 2013). Kräkel (2008) and Boyle (2001) note prominent examples of this practice are Cisco Systems, Intel, General Electric, Hewlett Packard, American Express, and Goldman Sachs, etc. Forced-ranking practices and dismissal tournament schemes have generated controversy regarding the effectiveness of their winner-takes-all approach for motivating employee effort, and have motivated a search for a better competitive tournament scheme (Harbring and Irlenbusch 2008).

1.1. Problems

Prior studies (Libby and Lipe 1992; Hannan et al. 2008) have not used a tournament-only scheme and do not evaluate multiple measures of effort. This limits our understanding of the relationship between tournament schemes and effort, and of which aspects of effort have a stronger impact on performance. The prior studies (Libby and Lipe 1992; Hannan et al. 2008) have evaluated mixed schemes consisting of tournament and piece-rate, rather than tournament-only, schemes. A *tournament-only* scheme here is understood as a compensation scheme that bases reward solely on the relative ranking of employees' performance, rather than on their absolute performance. That is, employees' compensation will depend on whether they perform well relative to their

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[2] These prior studies (Irlenbusch 2006; Harbring and Irlenbusch 2008; Kräkel 2008; Gürtler and Kräkel 2012) did not report the effect of dismissal tournament on employees' average or overall performance in companies such as GE and Enron. So we cannot be sure about the effect of using dismissal tournament on employee performance.

peers. In contrast, a piece-rate scheme is one that bases reward on employees' output, rewarding them for each unit of output they produce[3] (Bonner et al. 2000)[4].

Libby and Lipe (1992) use a *mixed scheme* comprised of both tournament and piece-rate schemes; this is a common approach in experimental work in accounting and economics (p. 253). Similarly, Hannan et al. (2008) use a mixed scheme comprised of the tournament and "time point" scheme, in which participants get additional payments for every second that they complete the trial or task before the trial's 180 second time limit has expired in each of 12 trials, even if they are not winners (i.e., their performance from a total of 12 trials is not in the top 10 percent among all participants in their "winner-takes-all" scheme). It appears that Hannan et al. (2008) have used a mixed scheme rather than a tournament-only scheme in their study.

In the tournament model, the ideal compensation scheme should be based on *effort*. In the tournament model, effort is the input of performance, which in turn is an imperfect measure of effort; performance is a function of effort and luck (Lazear and Rosen 1981). Employees should be evaluated and compensated based on what they can control (i.e., effort), not what they cannot control (e.g., luck). Bonner (2008) suggests that effort has multiple dimensions: how hard a person works (i.e., effort intensity); how long a person works (i.e., effort duration). Yet it is not clear which dimension(s) of effort

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[3] The evaluation of employee output can be quantitative and qualitative. The qualitative measure involve the researcher's examination of the contents of the output (Bonner 2008). For the parsimony of the experimental design, this thesis focuses on the quantitative measure of output such as the number of correct outputs that subjects produce.

[4] Other than tournament and piece-rate schemes, quota schemes (or goal-contingent pay) are also used in corporations (Merchant and Van der Stede 2012). A quota scheme is a compensation that bases rewards on achievement of a performance goal. Some individual firms such as Sears Auto Services and Allstate Insurance use quota schemes (Merchant and Van der Stede 2012). I do not find evidence that the use of quota schemes is nearly as common as the use of tournament schemes for Fortune 500 corporations. Thus the findings from using tournament schemes should have more practical value for Fortune 500 companies than quota schemes. Further, there are potential lawsuits and complaints related to the use of quota schemes in practice (Merchant and Van der Stede 2012). "One mechanic, Jerry C. Waddy, who had worked in Sears's San Bruno, California, store, filed suit against Sears, claiming that he was fired for failing to meet his quota of 16 oil changes a day" (p. 199); a former employee at the Allstate insurance "claimed he was fired for not meeting a $600 monthly quota for life insurance premiums, filed a complaint with Maryland regulators charging that his manager had pressured him to ignore underwriting guidelines to close a sale" (p. 199).

will lead to more effective performance. Moreover, finding a direct measure of effort may not be an easy task. Studies show that effort is difficult to observe and quantify (Church et al. 2008; Newman and Tafkov 2011). Therefore, it is also hard to verify whether effort impacts performance, and the relationship between effort and performance has been assumed, not demonstrated, in the literature. Also, the relationship between tournament schemes and effort remains unclear.

A few scholars such as Bailey and Fessler (2011) and Bailey et al. (1998) suggest that incentive pay is unlikely to improve *learning*, which they define as rate of improvement from initial performance. Bailey and Fessler (2011) use an online jigsaw-puzzle assembly experiment task and state that the repeated performance of this task is plausible and that subjects (i.e., U.S. college students in their sample) are unlikely to possess varied skill levels for this task. They draw on cognitive theory of memory to argue that due to limited cognitive resources, an individual's effort may be better exerted directly on the task rather than on learning, and that because learning is a less salient objective, incentive pay is unlikely to improve learning regardless of task complexity; this implies the monetary effect on learning may not be very task-dependent. They use both piece-rate and fixed-pay[5] compensation in a repeated task, and find that the learning effect is the same for both. They conclude that relative to fixed-pay, incentive pay (i.e., piece-rate) can only induce more effort, not learning. Bailey et al. (1998) show that the literature provides mixed results on precisely how incentive pay improves learning. They suggest that in existing literature, there is no definitive guidance for choosing a compensation scheme and no consensus about the "best" scheme for improving learning. As they explain, prior research either does not provide a clear learning opportunity or does not reward subjects directly for learning. They decompose overall performance into two components: the *initial performance* and the *rate of improvement* from the initial performance, which they conceptualize as "learning." They suggest that the existing literature does not provide a clear picture of the motivational effect of incentives on these two components, and that it is not clear whether it is increased initial performance or learning that causes incentive pay to lead to higher overall performance.

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[5] Fixed-pay is like salary or a contracted lump-sum pay regardless of an employee's performance over a finite period of time.

They use the an Erector Set assembly experimental task, in which subjects are required to use parts provided to assembly the "crane of a wrecker". They find that incentive (i.e., piece-rate, goal-contingent) pay increases both the initial and overall performance, but not learning, and rationalize that if incentive pay does not reward learning directly, it might be easier to increase initial performance than subsequent performance. Both Bailey and Fessler (2001) and Bailey et al. (1998) did not provide learning opportunities to allow subjects to acquire skills necessary to perform the experimental task, yet they acknowledge its importance and call for future studies to do so. They also did not use tournament schemes, which are another type of incentive pay, that theoretically can motivate learning (Lazear and Rosen 1981; Hannan et al. 2008).

Prior studies on compensation models (Bailey and Fessler 2001; Bailey et al. 1998; Libby and Lipe 1992; Hannan et al. 2008) did not provide a direct measure of learning effort under incentives. This limits our understanding of the relationships between tournament schemes and learning effort and between learning effort and performance. Bonner and Sprinkle (2002) argue further that learning effort for skill acquisition and subsequent deployment of skill in the job (i.e., a case of learning outcome) should in principle have a positive effect on performance, explaining that "the positive effect of monetary incentives on performance would increase as skill-related training increases" (p. 330); however, they survey prior studies and find that none of them support this claim. Bonner and Sprinkle (2002) thus suggest that the prior studies have not employed the right task to enhance skills and as such no evidence showing that training enhanced skills in these prior studies.

Moreover, very few studies have examined the relationship between tournament incentives and learning effort. Libby and Lipe (1992) and Hannan et al. (2008) are the only two empirical studies to do so. Libby and Lipe (1992) appear to be the only study to do so in the context of a training program. Libby and Lipe (1992) argue that learning effort has a positive impact on learning outcome; subjects who spent more time studying would be able to recall and recognize more of the learned information. Hannan et al. (2008), in contrast, infer learning (effort) from performance improvement over time, and "predict that this performance differential will increase over time because the higher effort expended by participants compensated via a tournament incentive scheme will

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facilitate learning" (899) as do a large number of studies of learning in other contexts (Berger et al. 2013; Church et al. 2008; Sprinkle 2000; Mitchell and Silver 1990; Audia et al. 1996; Bloom et al. 1984; Foong et al. 2003; Christ et al. 2012; Waller 1988; Kellman et al. 2008; Campbell et al. 2011; Chow et al. 1988; Balafoutas and Sutter 2010; Chow 1983; Charness et al. 2010; Fisher et al. 2005). But because these studies did not use tournament-only schemes and did not measure learning effort in the context of a training program, we cannot be sure how tournament schemes impact learning effort directly.

The literature also suggests that we know little about the effect of providing *relative performance feedback* across different tournament schemes. Hannan et al. (2008) find that providing performance feedback can decrease performance under a winner-takes-all scheme, and call for further studies on relative performance feedback using other tournament schemes. In this thesis, I contrast the use of relative performance feedback under multiple-winner schemes and winner-takes-all schemes.

1.2. Research Questions

This thesis aims to address four research questions:

1) What is the effect of tournament schemes on task effort and performance?

2) Does providing relative performance feedback affect the relationship between tournament schemes and task effort?

3) What is the effect of tournament schemes on learning effort, learning transfer and performance?

4) Does providing relative performance feedback affect the relationship between tournament schemes and learning effort?

To address the first question, I draw on tournament theory (Rosen and Lazear 1981) to develop hypotheses about the relationship between tournament schemes and

task effort and about the relationship between task effort and job performance. Tournament theory is a useful lens to examine how tournament schemes can motivate employees to exert more effort on the task, thereby improving job performance. To answer the first question, I hypothesize a relationship between tournament schemes and effort level (H1) and a relationship between effort level and performance (H2).

To address the second question, I draw on *social comparison theory* (Festinger 1954) to develop hypotheses about the moderating role of relative performance feedback in the link between tournament schemes and task effort. Social comparison theory is a useful lens to explain how relative performance feedback can motivate employees to increase task effort and therefore performance, when there is a gap between their current performance and the required level of performance to attain a prize. To answer the second question, I hypothesize a moderating effect of providing relative performance feedback in the relationship between tournament schemes and effort level (H3).

To address the third question, I draw on tournament theory to explain how tournament schemes can motivate employees to exert more learning effort for relevant skill acquisition. Tournament theory suggests that employees want to improve future performance in order to change the tournament outcome (e.g. to become winners and win the prize). When a relevant learning opportunity becomes available, they will exert effort to learn and acquire a skill necessary to better perform a job task that follows after the learning opportunity. Further, I draw on arguments in prior studies to develop hypotheses about a mediating role of learning transfer in the relationship between learning effort and job performance. A mediator is correlated with an independent variable and a dependent variable, because it is a result of the former and a cause of the latter (Derfuss 2009). Among the previous work, first, tournament theory (Lazear and Rosen 1981) suggests that learning effort improves performance. Second, Bonner (2008) argues that increased learning effort in the form of rehearsal and repeated practice[6] will improve memory of knowledge, enabling employees to apply their learned skills to their job tasks. Third, Vera-Muñoz et al. (2001) suggest that executing if-then

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[6] This thesis adopts this view of this very specific form of learning effort.

rules can effectively solve specific work-related problems, thereby improving job performance. To answer the third question, I hypothesize a relationship between tournament schemes and learning effort level (H4) and a mediating effect of learning transfer in the relationship between learning effort level and performance (H5).

To address the fourth question, I draw on social comparison theory to argue that relative performance feedback can threaten employees' self-image if they underperform relative to their peers, and can motivate them to learn harder in the hope that they can apply their new skills to the job task in order to improve the outcome (i.e., win the prize). To answer the fourth question, I hypothesize a moderating effect of providing relative performance feedback in the relationship between tournament schemes and learning effort level (H6).

Summary table: the main hypotheses

Item	Hypothesis statement
	Stage 1
H1	Employees' task effort in multiple-winner schemes is higher than that in winner-takes-all schemes.
H2	More task effort leads to higher performance.
H3	Relative performance feedback increases employees' task effort more in multiple-winner schemes than in winner-takes-all schemes.
	Stage 2
H4	Employees' learning effort in multiple-winner schemes is higher than that in winner-takes-all schemes.
H5	Learning transfer mediates the relationship between learning effort and performance.
H6	Relative performance feedback increases employees' learning effort more in

	multiple-winner schemes than in winner-takes-all schemes.

1.3. Framework and Procedure

The use of a two-stage framework and experimental design will help me determine how learning effort for relevant skill acquisition improves job performance. First, I need to know the expected job performance for employees performing a job task without a learning opportunity for relevant skill acquisition. To determine this, I start with an experimental stage in which employees do not get a learning opportunity prior to undertaking the task. I use this stage to investigate the impact of tournament schemes on task effort and performance. Next, I also need to evaluate how much performance improves after employees get a learning opportunity to acquire relevant skill acquisition. So I set a second stage in which employees get such a learning opportunity prior to undertaking the task. In the second stage, I investigate the impact of tournament schemes on learning effort and also whether learning effort impacts performance.

Thus, the first stage focuses on the effect of tournament schemes on task effort, which affects performance. In it, I draw on tournament theory to examine the link between tournament schemes and task effort, and draw on tournament theory (Lazear and Rosen 1981), Kahneman (1973), and Bailey and Fessler (2011) to examine the link between task effort and performance. I also examine the moderating role of relative performance feedback in the link between tournament schemes and task effort. I draw on social comparison theory (Festinger 1954) to predict and explain this moderating effect of relative performance feedback.

The second stage focuses on the effect of tournament schemes on learning effort, which affects learning transfer and job task performance. In the second stage, I draw on tournament theory to examine the link between tournament schemes and learning effort, and on tournament theory (Lazear and Rosen 1981), Kahneman (1973), and Bailey and Fessler (2011) to examine the link between learning effort and performance. Further, I draw on tournament theory (Lazear and Rosen 1981), Bonner

(2008), and Vera-Muñoz et al. (2001) to explain the mediating role of learning transfer in the link between learning effort and performance. I also examine the moderating role of relative performance feedback in the link between tournament schemes and learning effort, drawing on social comparison theory (Festinger 1954) to predict and explain this moderating effect.

1.4. Importance and Application

Tournament incentives are a common practice in many labour market settings (McGregor 2006; Rankin and Sayre 2011; Ashton 1990; Sprinkle 2003; Berger et al. 2013; Casas-Arce and Martínez-Jerez 2009; Newman and Tafkov 2011; Hannan et al. 2013). Similarly, McGregor (2006) documents that one-third of US corporations and one-fourth of Fortune 500 companies use tournaments when promoting or firing employees and Dutcher et al. (2013) show that Fortune 500 companies employ tournament-based promotion for employees. In line with this, other studies show that tournament schemes play an important role in providing incentives in most companies that have hierarchical levels (Rankin and Sayre 2011; Bushman and Smith 2001). The prevalence of tournament schemes in the corporate world means that it is important to investigate the relationship between tournament schemes and the effort expended by employees on job tasks.

Many Fortune 500 firms spend billions of dollars on instructional programs to improve workers' productivity (Bonner 2008; Wexley and Latham 2002; Salas and Stagl 2009). As of 2009, US firms were investing over $126 billion annually in learning initiatives, more than double the figure for a decade previously (Salas and Stagl 2009). Yet returns from these investments are low (Georgenson 1982; Swanson 2001; Yamnill and McLean 2001). Studies show that not more than 10 percent of the investment in learning initiatives are capitalized, in terms of the organizational benefit, in the form of

learning transfer to the job tasks in the operational environment[7] (Georgenson 1982; Swezey and Llaneras 1997; Salas and Stagl, 2009; Swanson 2011). Organizations utilizing tournament schemes and learning initiatives can benefit from the findings of this thesis, gaining a better understanding of the effect of tournament schemes on learning effort and also of whether learning improves performance; this can aid in the continuous improvement of these schemes.

Studies show that companies care about motivating learning and skill acquisition. Kelly (2010) states that 60 percent of Fortune 1000 companies have used the "balanced scorecard," which Kaplan (2008) suggests has a gap where the employee learning and growth perspective is concerned and has viewed as "the black hole" of the balanced scorecard, meaning that none of its generic measures, such as employee satisfaction and morale or turnover, connects between improvements in human capital and improved financial performance of firms, and only a few scholars had investigated this gap.

There is a growing interest among researchers in the field of management accounting in the effects of tournament-based incentives and relative performance feedback on job performance (Hannan et al. 2008; Hannan et al. 2013; Berger et al. 2013). Hannan et al. (2008) point out that while it is important to understand how incentives and feedback can combine to improve performance and how changes to incentives may impact changes to feedback, it is not an easy task.

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[7] Salas and Stagl (2009) assert that "only 10% of training expenditures transfer to the job (Georgenson, 1982) and a meagre of 5% of solutions are evaluated in terms of organizational benefits (Swanson, 2001)" (p. 59). "Many training programs are based upon the assumption that what is learned during training will transfer to new situations and settings, most notably the operational environment. Although U.S. industries are estimated to spend upwards of $100 billion annually on training and development, only a fraction of these expenditures (not more than 10%) are thought to result in performance transfer to the actual job situation (Georgenson, 1982). Researchers, therefore, have sought to determine fundamental conditions or variables which influence transfer-of-training, and to develop comprehensive theories and models that integrate and unify knowledge about these variables" (Swezey and Llaneras 1997, p. 532).

1.5. Contributions to the Literature

This thesis addresses the concerns expressed by Bonner and Sprinkle (2002) that "much additional research is needed to understand how training and monetary incentives combine to affect performance, especially since training is thought to be a significant determinant of performance in many accounting-related tasks" (Bonner and Sprinkle 2002, p. 330).

To address the relationship between incentives and learning, I use tournament schemes. Tournament theory suggests that there is a relationship between tournament schemes and learning of skills. Employees can apply learned skills to a job task to improve performance. A contest provides incentives for individuals to acquire skills before they perform a job task (Lazear and Rosen 1981).

Measurement of effort is important in the tournament model. For instance, tournament theory (Lazear and Rosen 1981) suggests that the ideal compensation should be based on effort. In the tournament model, effort is the input of performance, which in turn is an imperfect measure of effort (Lazear and Rosen, 1981; Irlenbusch 2006; Schwartz et al., 2007). Performance is a function of effort and luck (Lazear and Rosen 1981), and employees should be evaluated and compensated based on what they can control for (i.e., effort), not what they cannot control (i.e., luck). Assuming effort leads to performance perfectly, if direct measures of effort are feasible, basing compensation on effort would be the best. Bonner and Sprinkle (2002) suggest that it is important to understand the various components of the effort construct to determine how to maximize the effectiveness of monetary incentives and design better compensation schemes. They note that while firms may restructure incentive schemes in an attempt to enhance performance, if restructured aspects of incentive schemes do not target the key dimensions of effort, restructuring may not be effective.

1.5.1. First Contribution

The first contribution of this thesis is methodological: It provides a direct measurement of effort to verify the relationship between effort and performance. Its novel methodology, using an eye-tracker, measures pupil dilation, which reflects the intensity of effort, and also measures effort duration or total fixation time for the task. This approach shows the advantage of using effort intensity to investigate the relationship between effort and performance, which has been assumed in the literature, but not yet verified empirically (Mauldin 2003).

Prior studies (Church et al. 2008; Hannan et al. 2008; Berger et al. 2013) often infer effort on the basis of performance and assume effort is equivalent to performance. These prior studies have not measured effort directly; and certainly, it can be costly to do so. For instance, Fehrenbacher (2013) mentions costs associated with gathering information and measuring employee effort.[8] Other studies (Lazear and Rosen 1981; Sprinkle 2000; Church et al. 2008; Mauldin 2003; Newman and Tafkov 2011) indicate that it is difficult to directly observe effort without the aid of a technological device. Perhaps because prior studies did not use appropriate technology to derive an accurate measurement of effort, we cannot be sure about the relationship between effort and performance or about which dimension of effort would lead to more effective performance.

A few studies do suggest ways to directly measure effort. Mauldin (2003) points out that effort duration is the most commonly used measure of effort in prior research. Other studies also promote using effort duration (Catrambone and Yuasa 2006; Cloyd 1997; Sprinkle 2000; Foong et al. 2003; Fisher et al. 2005; Chua 2010). Mauldin (2003) and Towry (2003) suggest that effort intensity is less easily observable, which offers an opportunity for future research.

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[8] "Costs involved when observing the employee (information costs) typically deter the employer from gathering perfect information about the employee's effort level, which is why shirking is difficult to observe" (Fehrenbacher 2013, p. 18).

My novel methodology using an eye-tracker measures pupil dilation, which reflects intensity of effort. I use this measure of effort intensity to evaluate assumptions about the relationship between task effort and performance. By benchmarking with effort duration, this thesis shows the utility of using effort intensity to verify the relationship between effort and performance (Mauldin 2003), and demonstrates that effort intensity has a stronger impact on performance than effort duration does. In this way, this thesis makes a methodological contribution to the literature on the direct measurement of effort and on which dimension(s) of effort lead(s) to performance. The eye-tracking device provides a detailed measurement of effort that is not accessible with conventional methodologies.

Without direct measurement of effort, our understanding of the relationship between tournament schemes and effort will be limited. By providing a direct measurement of effort intensity and using tournament schemes, this thesis allows a better theoretical understanding of the motivational effect of tournament schemes on task effort.

1.5.2. Second Contribution

The second contribution of this thesis is to clarify and provide evidence of the relationship between learning and performance. Bonner and Sprinkle (2002) point out that prior studies have failed to discern the effect of learning on performance because the training task in these studies does not seem to enhance skill. Bonner and Sprinkle (2002) comment: "the task employed by Baker and Kirsch (1991), immersing one's hand in ice water for as long as possible, appears to be far more sensitive to effort than to skill, so that training likely did not have much of an effect on performance" (Bonner and Sprinkle 2002, p. 330). If the right training tasks are employed to enhance skill, Bonner and Sprinkle (2002) argue learning should improve performance. Further, Bonner and Sprinkle (2002) survey prior studies and find that none of them provide a good test of how learning interacts with incentives to affect performance. The few scholars who have investigated this matter infer learning from performance; for instance, Bailey and Fessler (2011) and Bailey et al. (1998) decompose overall performance into two components: the *initial performance* and the *rate of improvement* from the initial performance, which

they conceptualize as "learning," and find that incentive pay (i.e., piece-rate, goal-contingent pay) can only induce more effort for initial performance, not learning. They acknowledge the importance of providing learning opportunities to allow subjects to acquire (i.e., learn) skills to enhance performance, and call for future studies to do so. The lack of empirical research on the effect of learning on performance by studies like these (and thus of evidence showing that training/learning enhance skills) means that we cannot be sure whether learning improves performance or whether and how it interacts with incentives to affect performance.

This thesis shows a positive effect of learning on performance when tournament schemes are used, which prior studies such as Bailey et al. (1998) and Bailey and Fessler (2011) did not use. I use the two types of tournament schemes in the literature (Kalra and Shi 2001): multiple-winner schemes and winner-takes-all schemes. Kalra and Shi (2001) define winner-takes-all schemes as those that reward a single winner, whereas multiple-winner schemes are those that reward multiple winners such that every winner gets an equal share of the reward.[9]

I will show that multiple-winner schemes can motivate individuals to exert more learning effort than winner-takes-all schemes; and that increased learning effort leads to performance improvement. This means that tournament-based incentives and learning can combine to improve performance. In this way, this thesis addresses the concerns in Bonner and Sprinkle (2002), Bailey et al. (1998), and Bailey and Fessler (2011). In this regard, this thesis contributes to management accounting research for the positive effects of tournament schemes and learning on task effort, learning effort, and performance.

The remainder of this thesis is organized as follows. In Chapter 2, I discuss further the relevant literature and develop my hypotheses. In Chapter 3, I describe the experimental method used to test the hypotheses. In Chapter 4, I analyze the

[9] In a multiple-winner scheme, prizes may not have to be equal; instead, there can be distinct prizes. However, their effect on performance should not be different. Dechenaux et al. (2012) note that multiple but distinct prizes do not result in higher effort or performance than multiple but identical prizes. For simplicity, I make prizes equal among winners in the multiple-winner scheme.

experiment results. In Chapter 5, I discuss the findings of the analysis. In Chapter 6, I provide conclusions and review my contributions to the management accounting literature.

Chapter 2.

Theory and Development of Hypotheses

2.1. Introduction

In this chapter, I support and develop the model and hypotheses about the effect of tournament schemes on task effort, learning effort, and performance. I use a two-stage framework to test the hypotheses. In the first stage, I investigate the effect of tournament schemes on performance without any learning opportunity, and in the second stage, I investigate the effect of tournament schemes on performance with a learning opportunity. I use this two-stage framework to investigate how tournament schemes motivate learning effort, resulting in performance improvement.

[Insert Figure 1]

The tournament model is appropriate for this two-stage framework. Tournament theory (Lazear and Rosen 1981) suggests that tournament incentives have two dimensions: one for motivating effort expended on the job task, and another for motivating learning effort for relevant skill acquisition. For instance, tournament theory (Lazear and Rosen 1981) suggests that "two dimensions of incentives need to be distinguished: one is investment or skill acquisition[10] prior to the time a work activity is entered and the other is the effort expended, after skills have been acquired, in a given work situation or play of the game" (p. 2). In other words, employees can improve

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[10] "All workers are born unskilled, and they make skill investment decisions before entering the labour market" (Fang and Moro 2011, p. 152).

performance by increasing task effort, by applying their learned skills to a job task, or both. In the same vein, Gibbons and Waldman (1999) comment that tournament incentives have two dimensions: one for motivating effort, and another for motivating employees to acquire relevant skills.

In this theoretical review, for the first stage of this thesis, I conceptualize and define *tournament schemes* and *task effort.* I review *tournament theory* (Lazear and Rosen 1981) and explain the link between tournament schemes and task effort. Tournament theory is a useful lens to examine this relationship: It asserts that all other things being equal, employees in a tournament situation choose their effort level based on the probability of winning. I then define job performance, and draw on tournament theory (Lazear and Rosen 1981), Kahneman (1973), and Bailey and Fessler (2011) to explain the link between task effort and job performance.

Next, I define *relative performance feedback*, and draw on *social comparison theory* (Festinger 1954) to explain the moderating role of relative performance feedback on the link between tournament schemes and task effort. Social comparison theory helps to explain the role of relative performance feedback in the tournament setting. It asserts that when relative performance feedback indicates that the prize is unattainable, such feedback will threaten employees' self-images; conversely, when relative performance feedback indicates the prize is attainable, such feedback will improve employee's self-images. To avert this threat to their self-images, employees are willing to exert more effort. Therefore, feedback may motivate employees to exert more or less task effort, depending on the nature of the feedback.

For the second stage of this thesis, I conceptualize and define *learning effort*, and use tournament theory to investigate the relationship between tournament schemes and learning effort. I explain how tournament-based schemes motivate employees to exert learning effort for relevant skill acquisition in the hope of increasing their chance of winning a tournament prize. I define *learning transfer*, and draw on tournament theory (Lazear and Rosen 1981), Bonner (2008), and Vera-Muñoz et al. (2001) to provide the premises in my argument for the mediating role of learning transfer in the relationship between learning effort and job performance. I argue that more learning effort enables

more learning transfer, resulting in higher performance. First, tournament theory (Lazear and Rosen 1981) suggests that learning causes performance change. Second, Bonner (2008) argues that rehearsal and repeated practice strengthen the memory of the knowledge or skill, which enables individuals to retrieve such knowledge from memory. Third, Vera-Muñoz et al. (2001) assert that applying specific *if-then rules* can solve work-related problems better than applying broad rules can. Based on these three studies, I argue that learning transfer mediates the relationship between learning effort and performance.

I use social comparison theory to investigate the moderating role of relative performance feedback in the relationship between tournament schemes and learning effort. Social comparison theory suggests that all else equal, employees want to perform as well as their peers. If every employee has a learning opportunity that he or she can use to improve performance, all employees will exert as much learning effort as their peers, so that they can maintain or improve their performance ranking; conversely, if employees do not learn as much as their peers, their relative performance ranking will likely slip. This may be less of a concern for the top performers, because they can still remain at the top even if their relative performance ranking slips a bit; but it will be more of a concern for average performers or performers who are not ranked high enough, because they may lose a chance to win a prize. The theory also asserts that employees anticipate whether relative performance feedback will indicate whether the prize is attainable. Favourable performance feedback indicates the prize is more attainable, while unfavourable performance feedback indicates it is (more) unattainable. Therefore, performance feedback motivates employees to exert more or less learning effort, depending on whether they have any hope of winning a tournament prize.

2.2. Hypothesis Development

2.3. Stage one: Pre-Learning Period

2.3.1. Tournament Schemes

In tournament, performance ranks are determined based on contestants' output. Based on their ranks, the tournament divides contestants into two groups: winners and non-winners. A winner will get a prize, whereas a non-winner will not (Lazear and Rosen 1981). Because tournament incentives determine the final rank of contestants only when the competition concludes, the contestants' final rank is uncertain while the competition is ongoing. This induces contestants to sustain their effort until the competition is over (Berger et al. 2013). In other words, contestants exert and sustain their effort to increase or maintain their chance of winning a tournament prize until the completion of the tournament (Lazear and Rosen 1981; Berger et al. 2013).

Competition for a tournament award is the central incentive the tournament uses to motivate effort (Lazear and Rosen 1981). Overall research evidence supports the claim that c*ompetition* reduces shirking and increases effort (Devers et al. 2007)[11], and a tournament incentive is a competition in which contestants compete for a limited number of prizes. Tournament theory (Lazear and Rosen 1981) suggests that firms often use the *intra-firm promotion contest*, which aims to motivate more effort among contestants in the same firm. For example, they argue that in organizations that offer differentiated pay at distinct promotion or position levels (i.e., junior accountants, immediate accountants, assistant controllers, controllers, directors), the existence of high-paying managerial positions provides an incentive for all employees to strive to achieve one of those positions. Similarly, Konrad (2007) finds that organizations often base promotion decisions on relative performance, and reward only a small set of their best-performing employees. Other studies also show that organizations commonly use tournament-

[11] However, some studies find that greater pay dispersion negatively affects group coordination, indicating that differentiated pay among team members can have "substantive consequences for how the team functions as a group" (p. 1024).

based promotions that involve only a limited number of promotions to higher managerial positions (Clark and Riis 1998; Zábojník 2012; Dutcher et al. 2013; Berger et al. 2013).

Cason et al. (2010) and Kalra and Shi (2001) suggest that the majority of tournament studies either use winner-takes-all schemes or multiple-winner schemes that have fixed rewards. Kalra and Shi (2001) document various incidences of multiple-winner tournaments in the corporate world[12], showing that the winner-takes-all approach, though it tends to prevail in business, is not the only option used; allowing multiple winners to share the prize equally may be perceived as advantageous.

Winner-takes-all and multiple schemes differ with respect to the probability of winning, due to the number of winners in each scheme. In winner-takes-all schemes, the probability of winning is 1/n, because there can only be a single winner out of a pool of n competitors. For a large pool of individuals, the value of 1/n can be very low or close to zero. In multiple-winner schemes, in contrast, the winning probability is m/n because there are *m* winners out of a pool of *n* competitors. For a large pool of individuals, the probability value of m/n will not necessarily be very low, assuming m is not small compared to the n.

Both winner-takes-all and multiple-winner schemes are used in practice in various contexts. For instance, tournament theory (Lazear and Rosen 1981) posits the president or CEO position as the prize that vice-presidents compete for. This is typical of winner-takes-all schemes. Matsumura et al. (2006) examine the effectiveness of a postal service provider's efforts in South Korea to motivate 214 stores to increase profit. The

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[12] "In a contest conducted by the computer system division of Toshiba, the top two sales representatives were given $40,000. The second prize of $5,000 was given to 60 employees. Another 100 employees received an award of $500 (Business Wire 1997). The American Express establishment service awards their top 75 employees with a "lavish jaunt" including cash (Sales and Marketing Management 1998). Merrill Lynch awards their top 100 brokers with trips to London; the second award of new computers is given to 95 brokers; and 175 brokers are awarded the third prize of $1,000 (Wall Street Letter 1995). These anecdotes reveal puzzling differences both in the number of winners that are given rewards and in the variations in the amounts awarded between ranks achieved in the contest. These stylized facts raise the question of what the optimal sales contest design should be to induce maximum effort from the sales force" (Kalra and Shi 2001, p. 171).

tournament scheme recognized the top 50 percent of all stores as winners, which is an example of a typical proportion in multiple-winner schemes.

I follow Hannan et al.'s (2008) approach to designing a winner-takes-all scheme[13]; they recognize the top 10 percent of participants as winners[14], in contrast to a typical winner-takes-all scheme, in which the winner will have to outperform all other participants. Several studies assert that a typical winner-takes-all scheme should have only one winner (Waldman 2007; Barnes et al. 2004; Kalra and Shi 2001; Hannan et al. 2008). For instance, Waldman (2007) states that "the tournament ends when a single winner remains" (p. 14). Hannan et al. (2008) state that "the winner of the tournament receives the highest prize (such as bonus or promotion)" (p. 894).

I follow Harbring and Irlenbusch's (2003; 2008) approach to designing a multiple-winner scheme. They recognize half (the top 50 percent) of the participants as winners, and find that this kind of tournament scheme induces the highest productive effort. Specifically, they find that subjects' indicated productive effort level is higher when half of the competitors are winners than when the fraction of winners is one-third or two-thirds. Based on Harbring and Irlenbusch (2008), I identify half of the participants as winners in multiple-winner schemes. This means the winners in multiple-winner schemes have to rank above the top 50 percent of all participants.

2.3.2. Task Effort

Bonner and Sprinkle (2002) suggest that effort has four dimensions: *effort intensity*, *effort duration*, *effort direction*, and *effort toward problem-solving*. I use effort intensity and effort duration as my two measures of effort expended on a symbol-

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[13] In my study, participants are informed that they will get a bonus if their rank is higher than the top 10 percent of all previous participants in their group.

[14] Vandegrift and Holaday (2012) suggest that the group size in a tournament scheme does not matter if the proportion of winners is set as a percentage. "An individual's expected payoff for added effort is the same if the top 20% receive awards regardless of whether there are 10 competitors or a hundred" (p. 185).

matching task, following Malmi and Brown (2008). Effort duration is the conventional measure of task effort in prior research (Mauldin 2003); theoretically, effort intensity using pupil size will be a better measure of task effort than effort duration, because it essentially captures total cognitive resources applied toward a task[15] (Kanfer 1990; Bonner and Sprinkle 2002). In this thesis, because there is only one required activity (to match a symbol with an identical one a person has seen previously), effort direction is not used to measure task effort. Regarding effort intensity, the more intensive the visual attention participants devote to matching symbols, the more likely is higher performance. For effort duration, the more time participants spend on matching symbols, the more likely is higher performance.

Effort intensity

Effort intensity refers to the amount of attention an individual devotes to a task, or how hard the person works (Bonner and Sprinkle 2002). Kahneman (1973) suggests that *the intensity of visual attention* is identified with effort[16], and notes that in his work related to a capacity theory, the terms "exerting effort" is often synonymous with "paying attention."[17] Kahneman (1973) surveys a number of eye-tracking studies, and concludes that pupil size increases with the difficulty level of a task. Kahneman (1973) recommends dilation of the pupil as the best single index and the most useful autonomic indicator of effort. Kahneman and Beatty (1966) found that pupil dilation reflects cognitive load on memory, and increases when subjects respond to the presentation of a

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[15] One may argue that the same level of effort intensity but longer effort duration would use more cognitive resources, making effort duration also relevant for the total cognitive resources. Even in this case, effort intensity seems to be more important and sensitive to the total cognitive resources than effort duration does; effort duration is dependent on effort intensity, not the other way around.

[16] "The intensive aspect of attention is identified with effort" (Kahneman 1973, p. 12).

[17] "Capacity theory is a theory of how one pays attention to objects and to acts. In the present work, the terms "exert effort" and "invest capacity" will often be used as synonymous for "pay attention"" (Kahneman 1973, p. 8). One may argue that exerting effort and paying attention may not be the same (i.e., one can exert intensive effort without great attention). However, for present purposes this may not contradict Kahneman (1973)'s capacity model for visual attention, which suggests that the inverse is still true: paying attention is identified with effort (i.e., one cannot pay great attention without exerting intensive effort).

telephone number. They required participants to memorize a string of digits or a list of words, or to transform a string of digits (adding one to each digit), and then to immediately recall them. Pupil dilation increased when each digit was presented and decreased when each digit was reported back. This implies that dilation of pupils happens even when there is no visual attention, which is acknowledged in Kahneman (1973): "The relation between attention and pupillary dilation is maintained even in the absence of specific task instructions: Libby, Lacey, and Lacey (1973) observed dilations of the pupil when the subject merely looked at pictures. The largest dilations occurred while looking at "interesting" and "attention-getting" pictures" (Kahneman 1973, p. 19). In this sense, pupil dilation reflects the cognitive load on memory, which may function on its own without visual stimulus.

Kahneman and Beatty (1966) found that pupil dilation increased more when the task was more demanding (e.g. when a person was solving mathematical multiplications or when a person was memorizing words, as opposed to numbers) (see also Hess and Polt 1964; Kahneman 2011). Hyönä et al. (1995) investigate changes in pupil dilation during translation tasks with two levels of difficulty, and show that pupil dilation increases during the translation task compared with the pre-trial baseline, and increases more with difficult words than with easy ones. Hyönä et al. (1995) demonstrate that pupillary response reflects cognitive load when participants translate languages. In the same vein, Just and Carpenter (1993) state that the pupillary response indicates how hard the brain works.

Kahneman (1973) further suggests that attention requires selection of stimuli or objects. Similarly, Birnberg et al. (2006) refer to visual attention as the allocation of attention to information (p. 123). Kahneman's (1973) psychological view of selective attention (the visual recognition of specific stimuli) and how it relates to the activation of cognitive structures is associated with energy release from neurons during cognition. He explains that appropriate input from the outside world is key to releasing energy contained in a cognitive structure, and causes it to generate outputs, which then serve as a key to activate other (neural and cognitive) structures. Libby and Lipe (1982) follow Kahneman's (1973) view and suggest that visual attention is the input of energy release from neurons for the conduct of mental activities. Russo and Dosher (1983) define effort

as the amount of cognitive resources (e.g. memory, judgement) required for performing a task.

I follow Kahneman's (1973) view, and recognize that effort is the intensity of visual attention. In this thesis, effort intensity refers to the intensity of visual attention a participant devotes to a symbol-matching task during a fixed period of time. A symbol-matching task requires visual attention, since participants need to match a presented symbol with a symbol that they saw earlier. This symbol-matching task requires and consumes their cognitive resources (e.g., memory). In response, their pupil size increases, which reflects the cognitive load on their memory. The eye-tracker measures average pupil diameter when a participant fixates on the symbol-matching area. Hyönä et al. (1995) suggest that the pupil dilation should be compared with a baseline, for instance, with pupil dilation in the initial period (the beginning of the task, as compared to the end[18] of the same task). The more intensely they devote and sustain their visual attention to the symbol-matching task, the more their pupil size increases from the baseline.

Effort duration

Effort duration refers to the length of time an individual devotes cognitive and physical resources to a task or how long the person works (Malmi and Brown 2008; Mauldin 2003). Bonner (2008) describes effort duration as the length of time spent on information search and evaluation. Several studies have used time to measure effort duration; since it is duration, the only way to measure it would be time. For instance, Tafkov (2013) measures effort as amount of time spent solving problems. Tafkov (2013) finds that participants under performance-based incentives spend more time solving problems. Cloyd (1997) examines the joint effects of prior knowledge and accountability on performance in a tax research task, and finds that when an information search is available, increased effort duration (i.e., time) improves search effectiveness, defining

[18] Given that tournament schemes motivate subjects to exert and sustain their effort until the conclusion of the tournament (Berger et al. 2013), one might expect the end of the task to be an appropriate place to take a measurement against baseline.

time as minutes spent performing the information search and post-search evaluation phases of the experimental task. Cloyd (1997) argues that accountability is expected to improve performance through increased task effort (as measured by time or effort duration).

In this study, effort duration refers to the length of fixation time participants spend looking at a specific area in the symbol-matching activity. The eye-tracker measures the length of time that a participant fixates on the symbol-matching area.

2.3.3.   Tournament Schemes and Task Effort

Tournament theory (Lazear and Rosen 1981) proposes that employees choose their effort level in a tournament scheme based on two conditions: *reward spread* and *probability of winning* (Vandegrift et al. 2007). When the reward spread is constant, participants make their effort choice based on the probability of winning. Tournament theory (Lazear and Rosen 1981) provides a cost-and-benefit analytical framework to guide the prediction of the employees' effort level. In particular, they show that if the probability of winning increases, the expected payoff is higher and the perceived marginal benefit of effort increases, motivating employees to exert more effort. The perceived marginal benefit of effort may also be understood as the incremental benefit of exerting additional effort. When the probability of winning is higher, the person will more likely win the prize if s/he exerts additional effort. For instance, when a runner is very close the finish line while running slightly ahead of other runners, s/he will probably maintain his/her pace or even speed up. This runner has no reason to slow down, unless s/he is very tired.

By the same logic, when the probability of winning decreases, the expected payoff is lower, and the perceived marginal benefit of effort decreases. As a result, employees exert less effort or even give up. For instance, Konrad (2007) argues that once the probability of winning is low enough in a tournament scheme, it may not be motivational, using an analogy: The majority of economists have no real chance of

winning a Nobel Prize, so that working with the aim of winning this prize could demotivate people or induce them to give up on their research work.

Harbring and Irlenbusch (2008) suggest that an increased probability of winning motivates individuals to exert their optimal effort, and argue that employees may perceive the *fraction of winners*, that is, the ratio of the number of winners to the number of contestants, as the probability of winning in equilibrium. They draw on *achievement motivation theory* (Atkinson 1958) to enhance tournament theory (Lazear and Rosen 1981) by explaining the link between the fraction of winners and the effort level. In tournament theory, effort level should be optimal when the probability of winning is one, or close to one. However, they find that in fact effort is lower when the fraction of winners becomes larger. For example, they find that effort is lower when the fraction of winners is two-thirds than when it is one-half. They use achievement motivation theory to rationalize the observation that, at some points, effort does not increase linearly with the fraction of winners. In this sense, achievement motivation theory posits an inverted-U relationship between motivation and self-efficacy (or expectancy) (Vancouver et al. 2008).

Achievement motivation theory suggests that effort intensity has three factors: 1) *subjective expectancy of success*, 2) *incentive value of success*, and 3) *motivation to achieve success*. The subjective expectancy of success is represented by the probability of winning. The incentive value of success is represented by (1 - the probability of winning); the rationale for its effect is that as the perceived difficulty of a task increases, subjects take more pride in accomplishing it. The motivation to achieve success is represented by the award spread, which is the prize difference between the winner(s) and non-winner(s); when the award spread is large, it motivates subjects to exert more effort in order to win a larger prize.

Achievement motivation theory suggests that effort intensity is highest when the expected value of [(probability of winning) * (1 - probability of winning) * spread] is maximal. For a given prize spread, effort is maximal when the probability of winning is 50 percent. Based on this theory, Harbring and Irlenbusch (2003; 2008) show that effort is higher in tournaments where the fraction of winners is one-half than when it is one-third

or two-thirds. When the fraction of winners is one-third, they argue that one-third of individuals may quit, while the remaining two-thirds would exert the maximal effort, and when the fraction of winners is two-thirds, effort level will be lower compared to when it is not only one-half but also one-third (Orrison et al. 2004; Irlenbusch 2003). In this case, they argue that the challenge is not sufficient to induce employees' optimal effort.

Tournament theory (Lazear and Rosen 1981) proposes that a tournament will motivate individuals to exert more effort than a piece-rate scheme. In piece-rate schemes, employees' absolute performance, as determined by their units of output, is an important criterion for the rewards they will earn. Tournament incentives eliminate *common risks* (that is, the common variation to absolute performance that affects all employees performing the same task) to employees' absolute performance and therefore motivate employees to exert more effort in a given task. Tournament theory (Lazear and Rosen 1981) models output as a function of effort and common risk: Employees can control the effort they put into the task, but they do not have control over common risk. After excluding common risks to every employee, a tournament-based scheme can reveal who really exerts the most effort and give that person a higher performance ranking and compensation. In anticipating this, employees would be motivated to work harder under a tournament scheme than they would under a piece-rate scheme.

Tournament theory (Lazear and Rosen 1981) suggests that common risk can take the form of activity-specific measurement errors. Examples include biased performance evaluations or machine-generated errors[19] in the calculation of employees' income. For instance, when a superior always gives employees bad performance evaluations, their income will be negatively impacted. Risk-averse employees would dislike bearing this common risk to their income, and as a result would prefer tournament schemes that eliminate this common risk.

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[19] "[Workers] J and K may have the same supervisor whose biased assessments affect all workers similarly. This is similar to monitoring all workers by a mechanical counting device that might run too fast or too slow in any given trial" (Lazear and Rosen 1981, p. 857).

For instance, assume workers are paid by the hour, as calculated by a monitoring device (i.e., a time clock). When the monitoring device is defective, it will add uncertainty to every worker's income. Risk-averse employees will dislike this risk or uncertainty regarding their income. Their effort level will remain the same, yet their income will be volatile. Risk-averse employees would then prefer tournament schemes that eliminate this risk, or would require a higher compensation for this increased risk (assuming that the defective time clock cannot be fixed as immediately as risk-averse employees would, presumably, ideally like).

Common risk can also take the form of firm-wide risk, for instance an economic downturn, in which employees' outputs decline in absolute terms if the firm is not doing well, and all employees' income is negatively affected, even if their effort level is the same as before the downturn. However, these employees' outputs do not decline in relative terms compared to their colleagues' outputs in the same firm. Risk-averse employees will not want to bear this firm-wide risk to their income, and will again prefer tournament schemes.[20]

Tournament theory (Lazear and Rosen 1981) argues that risk-averse employees will prefer a tournament scheme to a piece-rate scheme because of the elimination of common risks to their income. Tournament schemes reduce the risk borne by risk-averse employees. Due to this elimination of common risk to employees' income in tournament schemes as opposed to piece-rate schemes, risk-averse employees are willing to exert more effort to perform the same task. Gong et al. (2011) also suggest that, in general, tournament schemes will induce more effort and performance than piece-rate schemes—assuming there are some risk-averse employees in the workforce, tournament schemes will motivate them to exert more effort, and even if all other employees' efforts remain the same, the average performance of all employees will improve.

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[20] Lazear and Rosen (1981) note that the common risk does not affect risk-neutral employees, who would be indifferent between a tournament scheme and a piece-rate scheme in the same situation.

Also based on tournament theory and prior studies (Hannan et al. 2008; Harbring and Irlenbusch 2008), and specifically the research perspectives presented above, I argue that employees in multiple-winner schemes will exert more effort than those in winner-takes-all schemes, because the probability of winning in multiple-winner schemes is higher than the probability in winner-takes-all schemes due to the higher fraction of winners.

I use two measures of effort expended on the task. The first measure of task effort is effort intensity as measured by changes in pupil dilation from a baseline. The second is effort duration as measured by fixation time on the symbol-matching area.

For the comparison between multiple-winner schemes and winner-takes-all schemes with two measures of task effort, I set two sub-hypotheses:

H1a: Employees' effort intensity in multiple-winner schemes is higher than that in winner-takes-all schemes.

H1b: Employees' effort duration in multiple-winner schemes is higher than that in winner-takes-all schemes.

For the comparison between multiple-winner schemes and piece-rate schemes with two measures of task effort, I set two sub-hypotheses:

H1c: Employees' effort intensity in multiple-winner schemes is higher than that in piece-rate schemes.

H1d: Employees' effort duration in multiple-winner schemes is higher than that in piece-rate schemes.

For the comparison between winner-takes-all schemes and piece-rate schemes with two measures of task effort, I set two sub-hypotheses:

H1e: Employees' effort intensity in winner-takes-all schemes is higher than that in piece-rate schemes.

H1f: Employees' effort duration in winner-takes-all schemes is higher than that in piece-rate schemes.

2.3.4. Job Performance

Job performance is the extent to which an employee takes actions that contribute to the attainment of an organization's objectives (Campbell et al. 1993). Job performance defined this way can be perceived by the employee's superior or the firm as an objective measure of his/her performance. If an organization's objectives can be broken down into individual actions (and viewed as their product), performance implies proficiency in the actions relevant to the job (Campbell 1993). For instance, if the job requires problem-solving, the more that the person in the job correctly solves problems, the more likely it is that they will further the organization's objectives—this is *good performance*. *Poor performance*, in contrast, implies that employees' actions are not helping attain the organization's objectives, or that they are not proficient in key actions relevant to the organization's objectives.

Campbell et al. (1993) propose a classification of performance into eight dimensions.[21] Of these dimensions, I focus on one, the dimension of *job-specific task proficiency*. Kyllonen et al. (2005) define this as proficiency at "core tasks central to one's job" (p. 160); that is, by definition, the focus is shifted from general performance at the job level to ability at the job's core tasks. Assume, for example, that a translation shop's objective is to produce as many high-quality outputs (translations) as possible. A translator's job would then be to produce as many high-quality translations as s/he can; there need not be a trade-off between quality and quantity when it is easy to achieve perfect translations in a symbol-matching task, and one just needs to produce more of these; and in a case like this, translation quality as measured by the number of correct

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[21] Namely, (1) job-specific task proficiency, (2) written and oral communication proficiency, (3) demonstration of effort, (4) maintenance of personal discipline, (5) facilitation of peer and team performance, (6) supervision/leadership, (7) management/administration, and finally (8) non-job-specific task proficiency (Latham and Stuart 2007, p. 108).

translations in a symbol-matching task can be a binary variable (i.e., either of a mistake or a correct response). Performance would involve taking actions that lead to more high-quality translations; proficiency would be the ability to take these actions; and performance evaluation would measure the extent to which the translator has taken the right actions. For a translation task, it would be appropriate to define job performance as the number of correct translations (Anderson and Dekker 2009).

2.3.5.   Effort and Job Performance

Tournament theory posits that performance is a function of effort (Sloof and Praag 2010; Casas-Arce and Martínez-Jerez 2009; Lazear 1995). Similarly, Kahneman (1973) suggests that greater intensity of visual attention (which is related to effort) leads to improved performance.

Bailey and Fessler (2011) suggest that the link between effort and performance is strong in a routine production task, where an individual can easily see an immediate increase in the output as a result of increased effort. In a puzzle-solving task[22], in contrast, they argue that the link is weaker since an individual needs to exercise some judgement and expertise or to apply learned skills, and an individual may increase effort without immediate impact on performance.[23] Similarly, Hartmann and Slapničar (2012) and Bonner et al. (2000) suggest that the relationship between effort and performance is stronger for jobs with lower task uncertainty (like routine tasks). Taking its lead from these researchers, this thesis uses a routine production task to test the causal relationship between task effort and performance: a symbol-matching activity in which one correct translation is recognized as one unit of performance. In this way, translation quality can be treated as a binary variable (either a mistake or a correct response), not a gradient variable.

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[22] Bailey and Fessler (2011) mention that "puzzle-solving tasks are higher in complexity than routine production tasks" (p. 191).

[23] "In the case of a puzzle, however, one cannot move forward until achieving an insight, which depends upon expertise or experience. Thus, variable financial incentives are less likely to directly influence performance for complex tasks, such as puzzles" (Bailey and Fessler 2011, p. 192).

Note that there may still be various cases in which higher effort duration does not lead to higher performance. Assume workers are paid by the hour, as per a time clock. Workers can simply show up at the workplace for their assigned hours, but this does not mean that they are actively working in those hours. In such a situation, it is far from clear whether allocating more of their time to the job will lead to higher performance. That is, time may be a noisy measure of effort duration; and it does not capture effort intensity (Cloyd 1997). Both effort duration and effort intensity have been said to be key dimensions of task effort; and it is important to understand the degree to which each of them actually leads to higher performance. I test each relationship with performance in the following hypotheses. This test gives me an opportunity to investigate which dimension of effort would lead to more effective performance. The comparison between these two dimensions of effort allows me to make a methodological contribution to the literature.

H2a: More effort intensity leads to higher job performance.

H2b: More effort duration leads to higher job performance.

2.3.6.   Relative Performance Feedback

Feedback is a management control tool that allows firms to set a standard for performance, to which employees compare and monitor their actual performance. Ramaprasad (1983) defines feedback as information about the gap between the *actual level* and *aspirational (reference) level* of performance, using the example of spending, in which the reference level is the budgeted expenditure, the actual level is the actual expenditure, and the gap is overspending.

Ramaprasad (1983) suggests that feedback is meant to alter an individual's behaviour. In the case above, providing the employee feedback on his overspending helps reduce his future spending (Ramaprasad 1983). Similarly, Kluger and DeNisi (1996) argue that behaviour is regulated by comparing performance as per feedback to the aspiration level of performance: Providing performance feedback will motivate

employees to minimize the gap. Latham (2004) likewise suggests that feedback allows employees to assess whether they are making progress toward a performance goal by comparing their current performance with the goal.

Jordan and Audia (2012) suggest that decision-makers such as managers use performance feedback to choose ways to solve problems in order to improve their performance. Merchant and Van der Stede (2012) describe managers using performance feedback to make a comparison between their actual performance and a pre-set standard; this motivates the managers to take corrective action and helps them understand the kind of corrective action needed and form a plan to adjust their actual performance and achieve the performance level desired by the organization.

Relative performance feedback is feedback that informs employees about the performance ranking they have attained in comparison with their peers (Hannan et al. 2008); that is, it is a source of social comparison information (Luft and Shields 2010; Ferris and Mitchell 1987). It motivates individuals to benchmark their performance with comparable others in the same compensation scheme, and observe whether they perform better or worse than the peer average (Azmat and Iriberri 2009). This can then motivate them to exert more effort in order to close the gap between their current performance and the desired performance goal. Moreover, in a tournament, it also allows contestants to infer others' effort from their relative performance (Holmstrom 1982). Frederickson (1992) argues that "providing agents with RPI [relative performance information] provides the cue that competing with one another is the appropriate behaviour" (p. 653).

2.3.7. The Moderating Role of Relative Performance Feedback on the Link Between Tournament Schemes and Task Effort

Social comparison theory (Festinger 1954) posits that individuals are driven to compare themselves to others to better evaluate their own ability to win a prize in a tournament (Hannan et al. 2008). When they do not perform as well as others, their self-image suffers. Ferris and Mitchell (1987) is the first study to investigate relative

performance feedback and its impact on performance. They find that comparisons among contestants can have a positive effect on employees' effort and performance (Berger et al. 2013) by motivating them to keep up with comparable others, that is, to perform as well as those others in a given task, since when they underperform relative to others, their self-image suffers (Hannan et al. 2008; Tesser and Campbell 1980). To avoid this deterioration of their self-image, employees are willing to exert more effort on the task.

Birnberg and Shields (2006) suggest that in a tournament, an employee would compare his or her performance to an objective information (e.g., performance standards). In a tournament, the objective measure of performance is relative performance ranking, and the performance standard or goal is the winner's prize (Birnberg et al. 2006). Relative performance feedback provides information on the gap between one's performance and the performance threshold for winning. This helps individuals assess their likelihood of winning a tournament prize as well as the amount of effort needed to win.

Hannan et al. (2008) argue that relative performance feedback will increase effort as long as the feedback indicates the prize is attainable. Similarly, Locke and Latham (1992) and Luft and Shields (2010) suggest that relative performance feedback will increase effort if it indicates the probability of winning is high. If relative performance feedback indicates the prize is attainable, damage to their self-image may result if they do not attain it; to avoid this, they will be willing to exert more effort.

Conversely, studies also show that relative performance feedback can decrease effort if it indicates the prize is unattainable. Newman and Tafkov (2014) report that feedback providing discouraging messages can cause employees to exert less effort. Smither and Walker (2004) also suggest that too much discouraging feedback cause individuals to lose faith in their ability to make a difference, so that they simply give up. Bandura and Cervone (1986) explain that negative feedback leads to negative self-evaluation, thereby causing employees to make less effort.

As the above-cited studies show, the effect of feedback in tournament schemes would depend on the winning threshold. For instance, when the winning threshold is very

high, performance feedback would likely indicate that the prize is unattainable. This is not likely to motivate individuals to exert more effort. The winning threshold is high in winner-takes-all schemes, given that only one person can win the prize. Unsurprisingly, Hannan et al. (2008) find that in a winner-takes-all scheme, providing relative performance feedback can decrease performance.[24] Hannan et al. (2008) suggest that this may be because in this case, performance feedback makes employees worry about their performance due to the perception that the goals are unattainable. In contrast, when the winning threshold is moderate or when some large proportion of the participants can be winners, performance feedback would likely indicate that the prize is attainable, motivating individuals to exert more effort. Specifically, setting the performance goal at the median of all participants—where half of the participants will be winners—can motivate most employees to exert more effort. For instance, Behn (2012) argues that social comparison may motivate employees to stop working, except if feedback informs them that they are far above the median. Kavussanu and Harnisch (2000) examine self-esteem in children and find that a child's self-esteem is not threatened by comparison as long as the child finds himself or herself to be at least of average ability.

I argue that relative performance feedback in multiple-winner schemes will likely indicate to the individual that the prize is attainable, whereas such feedback in winner-takes-all schemes will likely indicate the prize is unattainable. As a result, providing relative performance feedback should motivate individuals to increase effort more in multiple-winner schemes than in winner-takes-all schemes.

For the comparison between multiple-winner schemes and winner-takes-all schemes with two measures of task effort, I set two sub-hypotheses:

H3a: Relative performance feedback increases employees' effort intensity more in multiple-winner schemes than in winner-takes-all schemes.

[24] In particular, they find that, on average, individuals earn 2230 points in a winner-takes-all scheme and 1773 points in a winner-takes-all scheme with fine relative performance feedback. That is a 20 percent decrease in performance from the former scheme to the latter. If an individual's performance is in the 82nd percentile, the fine relative performance feedback will notify him or her that his or her performance is in the 80–90th percentile.

H3b: Relative performance feedback increases employees' effort duration more in multiple-winner schemes than in winner-takes-all schemes.

For the comparison between multiple-winner schemes and piece-rate schemes with two measures of task effort, I set two sub-hypotheses:

H3c: Relative performance feedback increases employees' effort intensity more in multiple-winner schemes than in piece-rate schemes.

H3d: Relative performance feedback increases employees' effort duration more in multiple-winner schemes than in piece-rate schemes.

For the comparison between winner-takes-all schemes and piece-rate schemes with two measures of task effort, I set two sub-hypotheses:

H3e: Relative performance feedback increases employees' effort intensity more in winner-takes-all schemes than in piece-rate schemes.

H3f: Relative performance feedback increases employees' effort duration more in winner-takes-all schemes than in piece-rate schemes.

2.4. Stage Two: Post-Learning Period

2.4.1. Learning Effort

Learning effort has also been referred to as *encoding effort* (Libby and Lipe 1992). *Encoding* is a process that involves selecting information, organizing it in short-term memory, and inscribing it in long-term memory (Mayer 1993; Bonner 2008). Learning effort is distinct from task effort in that can lead to delayed, not immediate, increase in performance by allowing the acquisition of procedural knowledge and skills

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facilitating better problem-solving performance (Bonner and Sprinkle 2002[25]; Coate and Goldbaum 2006). This kind of learning effort is skill-based learning effort (Straus et al. 2011).

Bonner (2008) proposes three steps in the learning process. First, an individual must have the sensory capacity, for instance visual or auditory capacity, to process information. This thesis employs an individual's visual capacity, as is reflected henceforth. Without the (visual) ability to process information, no information can enter sensory memory, which is where the incoming (visual) information is stored before it transits to short-term memory.

Second, an individual must *attend* (pay attention) to the relevant dimension of information with their visual and cognitive organs, in order to select information and move it to *short-term memory* for further processing. People allocate their visual attention to stimuli that differ in various attributes, such as shape, colour, size, and number. People process information first in short-term memory, and then encode it to *long-term memory,* where information is permanently stored for later use at an unspecified time (Waller and Felix 1984).

Third, an individual must *rehearse* or *repeat* the learned content (skill/action/material). This helps encode information in long-term memory (Bonner 2008; Dias 1994). Rehearsing or repeating learning activity or material involves building a close relation or tight connection between current information and prior knowledge that has already been stored in long-term memory (Brewster 2011). One way of rehearsing is to identify the difference between new information and prior knowledge (e.g., an unexpected trend in earnings per share or EPS), especially when incoming information does not fit the expectation, and elaborate on this difference, a process that requires multiple interpretations of the same information such as whether the unexpected information is due to noise in the data or events that have not been accounted for. The

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[25] "Greater effort refers either to effort directed toward current performance of the task, which is thought to lead to immediate improved performances, or effort directed toward learning, which is thought to lead to delayed improved performances (improved performance on later trials)" (Bonner and Sprinkle 2002, p. 306).

incremental information is then what individuals would save in long-term memory (Birnberg and Shields 1984). Sternberg and Williams (2010) point out that it requires effort to encode information to long-term memory, since for effective rehearsal, individuals should not merely mindlessly repeat, but should exert effort to organize and process information in short-term memory and then encode selective information to long-term memory.

In the encoding process to long-term memory, Kahneman (1973) suggests that people can assign different meanings to the same item. For instance, the letter "a" could be organized through different codes or *identity meanings*: The pair of letters "a, a" could have a *physical identity*, the pair of letters "a, A" could have a *name identity*, and the pair of letters "a, U" could have a *rule identity* (i.e., both a and U are vowels). Birnberg and Shields (1984) similarly, but more broadly, suggest that people attach their own meanings to the information they memorize. For instance, a 4 percent error rate can belong to any of (at least) three categories: 1) a specific error rate, 2) a range from 4 percent to 6 percent error rate, and 3) evaluation as a high or low error rate or comparison to some other rate.

As noted in section 2.3.2 above, Bonner and Sprinkle (2002) suggest that effort has four dimensions: *effort intensity*, *effort duration*, *effort direction*, and *effort toward problem-solving*. In this thesis, I use effort direction and effort toward problem-solving as two measures of learning effort for relevant skill acquisition. Effort direction essentially captures a subject's choice among tasks (Bonner and Sprinkle 2002): When subjects focus on a given task as opposed to other tasks or as opposed to doing something else such as daydreaming, they are making a choice about what to focus on. Kanfer (1998) suggests that measures of effort direction (e.g., task choice) can be used to investigate subjects' decisions between mutually exclusive courses of action in an experimental context. Bonner and Sprinkle (2002) suggest that monetary incentives might have an effect on effort direction.

Effort toward problem-solving reflects and captures the trained behaviour. Baldwin and Ford (1994) suggest that training creates and models a specific behaviour and cognitive processes that are important for performing a job or handling problems in

a job context. The objective of training in a skill is for trainees to reproduce a certain behaviour as closely as possible. Novick and Sherman (2010) show that among subjects trained to re-order the letters in an anagram to form an English word, highly skilled solvers have practiced and memorized letter orders in anagram solutions. Holmes (2001) suggests that coding of letter positions is important to recognize an acceptable English word. For instance, subjects may confuse a word such as *trial* with *trail*, if they fail to encode letter order correctly.

In the present study, effort direction refers to the length of fixation time an individual spends rehearsing and encoding key learning information. Effort toward problem-solving refers to the number of rehearsals individuals have for the key learning information.

Effort direction: Fixation time on patterns when individuals exhibit leftward eye movements

Effort direction refers to which task effort is directed toward, that is, that an individual chooses to engage in, or what an individual does (Bonner and Sprinkle 2002; Bonner 2008). Theeuwes (2012) finds that readers spend less time fixating on high-frequency words than low ones, because the former require less processing time to learn. High-frequency words are common words or words that are used frequently. Similarly, Henderson and Ferreira (1990) suggest that fixations reflect information processing, and that high-frequency words receive fewer fixations than low-frequency words. In other words, when individuals encounter two types of information for learning purposes—low- and high-frequency words—they will pay more attention to the former than the latter.

Various researchers have tried to determine how individuals choose effort direction. For instance, Ullrich and Tuttle (2004) investigate how monetary incentives affect subjects' effort direction, which they conceive as effort allocation (i.e., time) among different tasks. They investigate how managers allocate their time to rewarded areas of the "balanced scorecard," and find that managers would spend more time on nonfinancial areas, as opposed to financial areas, when nonfinancial areas are

rewarded. However, Ullrich and Tuttle (2004)[26] suggest that very few studies have investigated how effort direction can be influenced; Bonner and Sprinkle (2002) comment that this could be because experiments typically use one task only, which offers only a limited setting to investigate how effort direction can be influenced. Ullrich and Tuttle (2004) imply that effort direction involves with mutually exclusive tasks or areas; that is, one can choose to engage in one area or the other, but not both. For instance, the "balanced scorecard" has separate sections for nonfinancial and financial areas; one cannot evaluate both areas at the same time, much as one cannot look both right and left at the same time. However, divided allocation of attention or effort among tasks or areas can be observed.

In the present thesis, effort direction refers to which learning activity an individual chooses to engage in or spend time on. In the experiment, participants are presented with anagrams (scrambled letters that follow a specific set of pattern; henceforth, "patterns"[27]) and common English words, that is, high-frequency words such as *bump*, *pencil*, *painting* (the "patterns" that derive from the English words above are *ubpm*, *epcnli*, *apniitgn*), viewed in this context as low-frequency *non-words* (White 2003; Theeuwes 2012). In line with prior research, I argue that patterns will attract more visual attention than common English words will, since participants will need to spend more learning time on the patterns than on the common English words to yield a meaning.

Henderson and Ferreira (1990) suggest that high-frequency words require less processing and receive fewer fixations than low-frequency non-words, as noted above, and White (2003) states that linguistic factors influence which words are skipped: A subject is more likely to skip high-frequency words than low ones because the former is more predictable within the context of the sentences, and the latter is more difficult to process. Novick and Sherman (2010) find that anagram solutions (i.e., common English words) are easy for English-speaking subjects at all skill levels to memorize, and claim

[26] Ullrich and Tuttle (2004) report "these studies do not directly address whether comprehensive control systems influence effort direction" (p. 91).

[27] In this study, "patterns" are scrambled letters that follow a specific set of pattern, meaning each pattern can only be unscrambled to form a word; a general anagram, in contrast, can be unscrambled to form more than one word. For instance, the English words, listen and silent, have the same set of alphabetic letters.

that it is highly implausible that highly skilled solvers memorized the solutions but less skilled solvers did not. That is, memorizing a small number of common English words or known words in one's own language is trivial.

In this thesis, on the basis of the previous work in this area (low- and high-frequency words and non-words), I will use an eye-tracker to measure the fixation time on patterns where participants should pay most of their attention. Because my participants learn a specific way to unscramble the letter order in a pattern to form an English word (namely, move every second letter in a pattern, in pairs, leftward), I measure fixation time on patterns when participants exhibit leftward eye movements.

Effort toward problem-solving: Number of leftward saccades

Effort toward problem-solving means effort on a specific action that can be shown to have a beneficial effect toward solving problems on a job task. In this thesis, it refers to the number of times an individual conducts a specific letter movement order to unscramble a pattern to form an English word, a skill that s/he can apply on the job task. The specific order involves moving every second letter in a pattern, in pairs, to the left. Novick and Sherman (2010) show that subjects can be reliably trained to solve anagrams by following a certain letter order. They use an anagram task on a computer. They find that highly skilled solvers solve anagrams very quickly, and interpret this as showing that these solvers either have practiced the letter order in an anagram intensively in the experiment or have memorized the anagram solutions to particular letter orders.

In this thesis, effort toward problem-solving is measured by the number of leftward *saccades* on patterns. A saccade is an eye movement between two fixation points (that is, points on which a person stares or fixates). Subjects will see patterns with their pattern solutions on the right-hand side of each pattern on a computer screen. They will be instructed to move every second letter in a pattern mentally to form an English word, and also to verify whether the unscrambled pattern matches mentally and visually with the presented solution on the same screen, as a way to develop their problem-solving skills; in doing so, they should necessarily exhibit leftward saccades. More

practice moving the letters is taken to constitute more rehearsal of the learning task. Kahneman (1973) suggests that it requires effort to learn how to associate patterns with words.

2.4.2. Tournament Schemes and Learning Effort

Tournament theory (Lazear and Rosen 1981) suggests that employees can control their performance by the level of effort they invest in learning for relevant skill acquisition prior to performing a job task. If prior to performing a job task, employees know the criteria for winning the prize, and if learning helps to improve performance, employees will invest effort in such learning. Tournament incentives can motivate employees to exert effort to acquire (i.e., learn) skills needed to improve performance (Lazear and Rosen 1981; Libby and Lipe 1992; Prendergast 1993; Hannan et al. 2008).

One tournament-based approach to motivating employees to exert more learning effort is to offer a large or valuable reward (Lazear and Rosen 1981). Another approach is to set a high fraction of winners or a high probability of winning. Harbring and Irlenbusch (2003) argue that an increased fraction of winners or a higher probability of winning[28] is in this sense equivalent to large award, in that both motivate employees to invest more effort in learning (Hannan et al. 2008; Bonner 2008; Libby and Lipe 1992). Since the probability of winning is higher in multiple-winner schemes than in winner-takes-all schemes, I argue that learning effort will be higher in multiple-winner schemes as well.

In addition, tournament theory (Lazear and Rosen 1981) suggests that tournament schemes reduce the risk borne by risk-averse employees. Therefore, these

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[28] Like tournament theory, equity theory implies that the probability of getting the reward is important for the occurrence of learning and its transfer. For example, based on equity theory, Noe (1986) explains that "if an individual feels that by attending training he [or she] is likely to gain equity in pay or other sought-after rewards, there is a greater chance that learning would occur, and such learning would transfer to the job" (Yamnill and McLean 2001, p. 199).

employees should be willing to exert more learning effort in tournament schemes than in piece-rate schemes.

I use two measures of learning effort: effort direction (i.e., fixation time on patterns) and effort toward problem-solving (i.e., the number of leftward saccades).

For the comparison between multiple-winner schemes and winner-takes-all schemes with two measures of learning effort, I set two sub-hypotheses:

H4a: Employees' effort direction in multiple-winner schemes is higher than that in winner-takes-all schemes.

H4b: Employees' effort toward problem-solving in multiple-winner schemes is higher than that in winner-takes-all schemes.

For the comparison between multiple-winner schemes and piece-rate schemes with two measures of learning effort, I set two sub-hypotheses:

H4c: Employees' effort direction in multiple-winner schemes is higher than that in piece-rate schemes.

H4d: Employees' effort toward problem-solving in multiple-winner schemes is higher than that in piece-rate schemes.

For the comparison between winner-takes-all schemes and piece-rate schemes with two measures of learning effort, I set two sub-hypotheses:

H4e: Employees' effort direction in winner-takes-all schemes is higher than that in piece-rate schemes.

H4f: Employees' effort toward problem-solving in winner-takes-all schemes is higher than that in piece-rate schemes.

2.4.3. Learning Transfer

Learning transfer refers to the carrying-over or application of previous learning or learned skills to new contexts (Lombardo 2007; Goldstein 1993). Learning transfer is said to occur when knowledge or skill acquisition in one situation affects subsequent performance in another situation. Lewis et al. (2005) claim that the use of this term is consistent with the work of Singley (1989), who suggests that learning transfer occurs in a setting where tasks have similar elements and where strategies used in one task can be applied to another. In the same vein, Wexley and Latham (2001) suggest that an effective job training program should have the same essential characteristics as the job, so that the trainee can work the same way they will on the job. Wexley and Latham (2002) suggest that when a trainee returns to work, the supervisor should ensure that the trainee has a chance to apply acquired skills from the training program.

Learning transfer can take the form of *pattern recognition*, which occurs when there is a match between presented information and a solution in memory (Shell et al. 2010; Novick and Sherman 2010). Kahneman (1973) suggests that the fundamental process of recognition of previously seen information is the matching of patterns between this prior knowledge and the new information being presented. When participants can recognize patterns that they have memorized and that reappear in a new context, this is considered to be a case of learning transfer.[29]

In accordance with Bonner (2008), this thesis has two measures of recognition performance: the *probability of retrieval* and the *time taken to retrieve* (i.e., the inverse of the speed of retrieval) (Kahneman 1973; Bonner 2008).

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[29] Moursund (2004) emphasizes that the human brain is good at pattern-matching. For instance, he suggests that a baby learns very quickly to recognize his or her mother's face and retains this knowledge, enabling the baby to recognize the mother despite changes in facial makeup, hairdo, etc. Moursund (2004) further suggests that people recognize that a creature is a dog, even if it is a dog that they have never seen before, based on the composite of other dogs they have seen.

Probability of retrieval (a dimension of learning transfer)

The probability of retrieval for previously learned information reflects and is dependent on the number of relevant items an individual can retrieve from memory, that is, the number of times an individual can correctly recognize previously learned information over a short period of time when the same information reappears in a new situation.

In this thesis, probability of retrieval assesses whether an individual can correctly recognize previously learned patterns when they reappear in a new context. S/he indicates his/her recognition of patterns by clicking a button. If an individual always correctly recognizes previously learned patterns (as indicated by the correct button clicks), the probability of retrieval is one, and if the individual never recognizes a previously learned pattern, zero.

Time taken to retrieve (a dimension of learning transfer)

The time taken to retrieve previously learned information reflects the timeliness of the correct recognition of it, that is, the speed by which an individual can correctly recognize previously learned information when the same information reappears in a new situation.

In this thesis, time taken to retrieve assesses whether an individual can quickly (in seconds) and correctly recognize previously learned patterns when they reappear in a new context. S/he indicates his/her recognition of patterns by clicking a button. If an individual always correctly and quickly recognizes previously learned patterns (as indicated by the correct button clicks), then the time taken to retrieve per pattern is close to zero (a small positive number in seconds). In contrast, if an individual never correctly and quickly recognizes the patterns, then the time taken to retrieve per pattern is a large positive number in seconds. The calculation of the time taken to retrieve per pattern only accounts for correct responses (as indicated by correct button clicks).

2.4.4. Learning Effort and Learning Transfer

The literature suggests that there is a positive relationship between learning effort and learning transfer. The rationale is that more learning effort will strengthen memory of knowledge, so that employees can better apply their learned skills to the job task. For instance, Bonner (2008) states that encounters with information determine memory of knowledge, which in turn determines the probability and speed of information retrieval. Bonner (2008) argues that more or repeated rehearsal or practices will help to encode information to long-term memory, facilitating information retrieval from memory. Based on Bonner (2008), I argue that more rehearsal of patterns will help employees to correctly recognize those patterns when they reappear in a new context.

2.4.5. Learning Transfer and Job Performance

Procedural knowledge consists of a list of *if-then rules*, with an "if" condition and a "then" action. The "if" condition specifies the condition the rule should activate. It includes declarative knowledge, such as the meanings of words, the laws of physics, or knowledge of mathematics (Shell et al. 2010). The "then" action specifies the action an individual would take if the "if" condition is met. It includes solution plans to deal with work-related problems. Shell et al. (2010) state that an individual may schematize the if-then rule as "if something happens, then take a planned action." Procedural knowledge occurs when an individual automatizes a skill (Wexley and Latham 2002).

The reason applying procedural knowledge can improve performance may be that it can provide better solutions to work-related problems than can broad rules (Vera-Muñoz et al. 2001). Procedural knowledge stems from specialized domain experience, and procedural rules can thus be used to better solve work-related problems, thereby improving performance. Prior to performing a task, employees can develop procedural knowledge and generate a task-specific solution for each work-related problem. Then, applying this procedural knowledge to the job task can give those employees an advantage in problem-solving when the same work-related problems reappear on the job.

Despite the fact that procedural knowledge stems from specialized domain experience, people may apply it in general contexts. Baumeister et al. (2007) suggest that if-then rules often guide people in daily life. For instance, they may help an individual decide whether to take a walk after dinner: If there is still daylight, then take a walk. Such rules may also, for instance, help an individual decide to press the brake pedal to stop a car when there is a red light or a stop sign (Bonner 2008). If-then rules are also used in accounting tasks: For instance, if employees need to make a decision between paying cash now versus later, they can use the opportunity cost of capital,[30] rather than historical interest rates, to discount future cash flow (Vera-Muñoz et al. 2001).

In this thesis, individuals will have a chance to develop if-then rules for dealing with patterns in a learning session. Specifically, participants are instructed as follows: "If the first half of a pattern reappears in a new context, then you can click a button (which will be available in a new context) to indicate your recognition of the pattern. If you click the button correctly, the button will complete the second half of the pattern automatically." Those who have invested more effort in developing procedural knowledge (i.e., if-then rules) with respect to patterns will have an advantage in unscrambling patterns in such a job task over those who have not done so.

2.4.6. Learning Transfer as Mediator Between Learning Effort and Job Performance

My argument that learning transfer mediates the relationship between learning effort and performance change is based on three premises. First, tournament theory (Lazear and Rosen 1981) suggests that learning effort for relevant skill acquisition causes performance change. The rationale is that employees invest effort in relevant

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[30] Vera-Muñoz et al. (2001) suggest that "management accountants have procedural knowledge in measuring opportunity costs because they routinely consider opportunity costs. Financial auditors, on the other hand, do not consider opportunity cost on a routine basis" (Selby 2012, p. 7).

skill acquisition in the hope of transferring their learning to the job task to improve performance. Second, Bonner (2008) suggests that learning transfer is associated with learning effort: Learning effort strengthens memory of knowledge, so that individuals can retrieve such knowledge from memory. Third, Vera-Muñoz et al. (2001) suggest that applying if-then rules improves performance by helping individuals to better solve work-related problems. Based on Vera-Muñoz et al. (2001), I argue that applying if-then rules through learning transfer improves performance, and develop hypotheses concerning the mediating effect of learning transfer in the relationship between learning effort and performance.

Learning transfer has two dimensions: the probability of retrieval and the time taken to retrieve learned skills. I set four sub-hypotheses related to these dimensions, as follows:

H5a: The link between effort direction and job performance is mediated by the probability of retrieval.

H5b: The link between effort direction and job performance is mediated by the time taken to retrieve learned skills.

H5c: The link between effort toward problem-solving and job performance is mediated by the probability of retrieval.

H5d: The link between effort toward problem-solving and job performance is mediated by the time taken to retrieve learned skills.

2.4.7. The Role of Relative Performance Feedback in the Link Between Tournament Schemes and Learning Effort

Social comparison theory (Festinger 1954) posits that individuals want to avoid negative social comparison with others. When individuals underperform relative to others, their self-image may suffer. To avoid suffering due to loss of self-image, they are

motivated to perform as well as others. Matuszewski (2010) makes similar observations; likewise, Berger et al. (2013) suggest that if new competitors entering a tournament subsequent to the first in a series have a higher ability than previous competitors, it will motivate the incumbent individuals to increase their future performance in order to maintain their relative performance ranking.

Hannan et al. (2013) suggest that subjects often can anticipate feedback information before it is provided, and respond accordingly (Hannan et al. 2013). Assume that a learning opportunity is provided to all employees, and that learning can improve performance. If participants anticipate that their peers[31] will exert a learning effort for relevant skill acquisition to increase their performance ranking, then they themselves have to do the same if they are to maintain or improve their performance ranking relative to their peers. Moreover, if participants benchmark with the minimum performance threshold for winning a prize, they will be motivated to learn as much as is needed to achieve the minimum performance threshold to win the prize.

The effect of feedback in tournament schemes will depend on the winning threshold: When the threshold is very high, performance feedback will likely indicate that a prize is unattainable, even if participants exert much more learning effort for relevant skill acquisition, and so much learning effort may not make a difference to the outcome (i.e., who wins the prize). In this case, participants may be unmotivated (see Hannan et al. 2008). In contrast, when the winning threshold is moderate (e.g., when half of participants will win the prize), performance feedback will likely indicate that a prize is attainable. Participants in this situation will generally anticipate that they can make a difference to the outcome (i.e., win the prize) as long as they exert more learning effort for relevant skill acquisition. This can motivate participants to learn as much as possible.

I argue that relative performance feedback in multiple-winner schemes will likely indicate the prize is attainable, whereas such feedback in winner-takes-all schemes will likely indicate the prize is unattainable. As a result, providing relative performance

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[31] Newman and Tafkov (2011) suggest that "unless a firm and its employee have explicit knowledge ex ante regarding employees' abilities, it is typically assumed that all employees are of equal ability" (p. 7).

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feedback will motivate individuals to increase learning effort more in multiple-winner schemes than in winner-takes-all schemes.

For the comparison between multiple-winner schemes and winner-takes-all schemes with two measures of learning effort, I set two hypotheses:

H6a: Relative performance feedback increases employees' effort direction more in multiple-winner schemes than in winner-takes-all schemes.

H6b: Relative performance feedback increases employees' effort toward problem-solving more in multiple-winner schemes than in winner-takes-all schemes.

For the comparison between multiple-winner schemes and piece-rate schemes with two measures of learning effort, I set two hypotheses:

H6c: Relative performance feedback increases employees' effort direction more in multiple-winner schemes than in piece-rate schemes.

H6d: Relative performance feedback increases employees' effort toward problem-solving more in multiple-winner schemes than in piece-rate schemes.

For the comparison between winner-takes-all schemes and piece-rate schemes with two measures of learning effort, I set two hypotheses:

H6e: Relative performance feedback increases employees' effort direction more in winner-takes-all schemes than in piece-rate schemes.

H6f: Relative performance feedback increases employees' effort toward problem-solving more in winner-takes-all schemes than in piece-rate schemes.

2.4.8.   Summary

In this thesis, I investigate the effect of tournament schemes on task effort. Tournament theory (Lazear and Rosen 1981) suggests that employees will choose their level of effort based on the probability of winning, and multiple-winner schemes offer a higher probability of winning than winner-takes-all schemes. Therefore, I argue that task effort will be higher in multiple-winner schemes than in winner-takes-all schemes. Tournament theory also suggests that risk-averse employees will dislike the common risk to their absolute performance. These employees would therefore prefer tournament schemes, which eliminate this common risk. Therefore, I also argue that task effort will be higher in multiple-winner and winner-takes-all schemes than in piece-rate schemes. Moreover, in the routine production context of the symbol-matching task, I argue that there is a significant positive relationship between task effort and performance.

In addition, I examine the moderating effect of providing relative performance feedback on task effort in the tournament setting. Social comparison theory (Festinger 1954) suggests that relative performance feedback motivates employees to exert more task effort, if they think the prize is attainable. Due to a higher probability of winning in multiple-winner schemes than in winner-takes-all schemes, feedback in the former will likely indicate that the prize is more attainable than it will in the latter. Therefore, I argue that relative performance feedback motivates employees to exert more task effort in multiple-winner schemes than in winner-takes-all schemes, and also to exert more task effort in multiple-winner and winner-takes-all schemes than in piece-rate schemes.

Next, I investigate the effect of tournament schemes on learning effort. Tournament theory suggests that employees will choose their level of learning effort for relevant skill acquisition based on the probability of winning, and multiple-winner schemes have a higher probability of winning than winner-takes-all schemes. Therefore, I argue that learning effort will be higher in multiple-winner schemes than in winner-takes-all schemes, and higher in multiple-winner and winner-takes-all schemes than in piece-rate schemes. I also hypothesize a mediating effect of learning transfer in the relationship between learning effort and performance.

In addition, I examine the moderating effect of providing relative performance feedback on learning effort in the tournament setting. Social comparison theory (Festinger 1954) suggests that relative performance feedback motivates employees to exert more learning effort because they anticipate that comparable others will do the same, and thus they also anticipate that they will need to exert at least as much learning effort as their comparable others to maintain or increase their current performance ranking. Due to a higher probability of winning in multiple-winner schemes than in winner-takes-all schemes, performance feedback in the former will be more likely to indicate that individuals can meet a performance ranking threshold than it will in the latter. Therefore, I argue that relative performance feedback increases learning effort more in multiple-winner schemes than in winner-takes-all schemes, and also that it increases learning effort more in multiple-winner and winner-takes-all schemes than in piece-rate schemes.

Chapter 3.

Methodology: Two-Stage Experiment

3.1. Research Design

My research design uses a two-stage 3 x 2 experiment, with three levels of incentives and two levels of relative performance feedback; participants are randomly assigned to one of six groups.

[Insert Figure 2]

The three levels of incentives are: *piece-rate scheme*, *winner-takes-all scheme* and *multiple-winner scheme*. The former serve as a control group for the two levels of tournament incentives: winner-takes-all schemes, with only one winner, and multiple-winner schemes, with more than one.

In the winner-takes-all scheme, the (sole) winner of the first work session (out of 15 participants) is awarded a tournament prize of $10, as is the winner of the second work session. In other words, a participant can win up to a total of $20 (if s/he is the winner of both sessions). In the multiple-winner schemes, winners of the first work session (who constitute around 7 of the 15 participants) are awarded a prize of $10, as are winners of the second work session. In other words, the total maximum prize per participant is $20, but multiple participants may potentially win it. In addition, each participant in each group gets a basic participation payment of $20, regardless of which incentive plan s/he is assigned to and regardless of performance. In piece-rate schemes,

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participants earn five cents per correct translation in addition to this basic participation pay of $20.

The two levels of relative performance feedback are *presence* and *absence.* Relative performance feedback in the experiment, if present, communicates participants' performance percentile relative to their peers by ranking participants and also notifies a participant of his or her absolute performance as measured by number of correct translations in total at a given time for that participant and benchmark participants—the top performer and the median performer. Specifically, the feedback information displays as follows: Your rank is X (the Xth percentile) and your performance is Y; the top winner's performance is Y1; the median contestant's performance is Y2.

Participants in all six groups first perform a symbol-matching task in three uncompensated practice sessions. The task involves translating symbols into alphabetic letters using a translation key on a computer screen. After three rounds of practice, participants perform the same task in two compensated work sessions. The first work session comes before a learning session, and the second, after. Every participant gets a learning session. In the learning session, participants learn and acquire a job-related skill prior to performing the task in the second work session. The purpose of including the learning session is for participants to acquire a job-related skill (Bonner et al. 2000). Bonner et al. (2000) point out that a large number of experimental studies on financial incentives are short in duration[32] and that therefore, participants may not have a chance or sufficient time to learn, but may still simply be trying to understand the task requirements, even after a practice session.

Similarly, tournament theory (Lazear and Rosen 1981) suggests that employees should acquire a job-related skill prior to performing a job. Based on this, a good approach should be to measure employees' learning effort in a training program before they perform a job task, rather than inferring learning (effort) from performance change.

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[32] "The vast majority of studies examining the effects of financial incentives are quite short in duration (e.g., many studies are "one-shot" in nature). Thus, unless subjects possess appropriate skills and strategies at the beginning of the experiment, they likely do not have time to acquire them during the experiment. Although many studies provide a brief practice period, this may not be adequate for skill acquisition" (p. 23).

However, studies often still take the latter approach (Hannan et al. 2008; Bailey and Fessler 2011; Bailey et al. 1998).

In light of this, my experiment provides participants a learning opportunity to acquire a job-related skill: They learn a specific way to unscramble the letter order in a pattern to form an English word. After learning, I measure subjects' performance by the number of patterns they successfully recognize in the job task. If they can manage to transfer their learned skills to the job task correctly, their performance should improve.

3.1.1.   Sample

I recruited 90 participants. They include:

1) MBA students from an Association to Advance Collegiate Schools of Business (AACSB)–accredited business school,

2) Non-business graduate students with at least one year working experience, and

3) Working accounting and financial professionals.

In all, 55 (61%) out of the 90 participants were MBA students. 19 (21%) were working accounting and financial professionals, and 16 (18%) were non-business grad students. Females accounted for 43 of the participants (47%). On average, participants had 4.75 years of full-time working experience. Their average age was 27.86 years old.

3.1.2.   The Eye-Tracking Device

I used an eye-tracker to directly measure task effort and learning effort for relevant skill acquisition. I measured task effort when participants matched symbols in a specific area on a computer screen, and measured learning effort when participants

learned patterns in the learning session. The eye-tracking data provides an account of participants' behaviour and cognitive processing that makes it possible to interpret their actions (Rayner 1998).

3.1.3.   Study Site

Participants sat on the right-hand side of a large desk with a computer monitor placed on it and used a mouse to perform a symbol-matching task on the computer. The eye-tracking device was situated just below the computer monitor to record their eye movements.

The experimenter sat on the left-hand side of the desk to conduct the experiment and ensured that the data was saved onto a laptop (also placed on the desk).
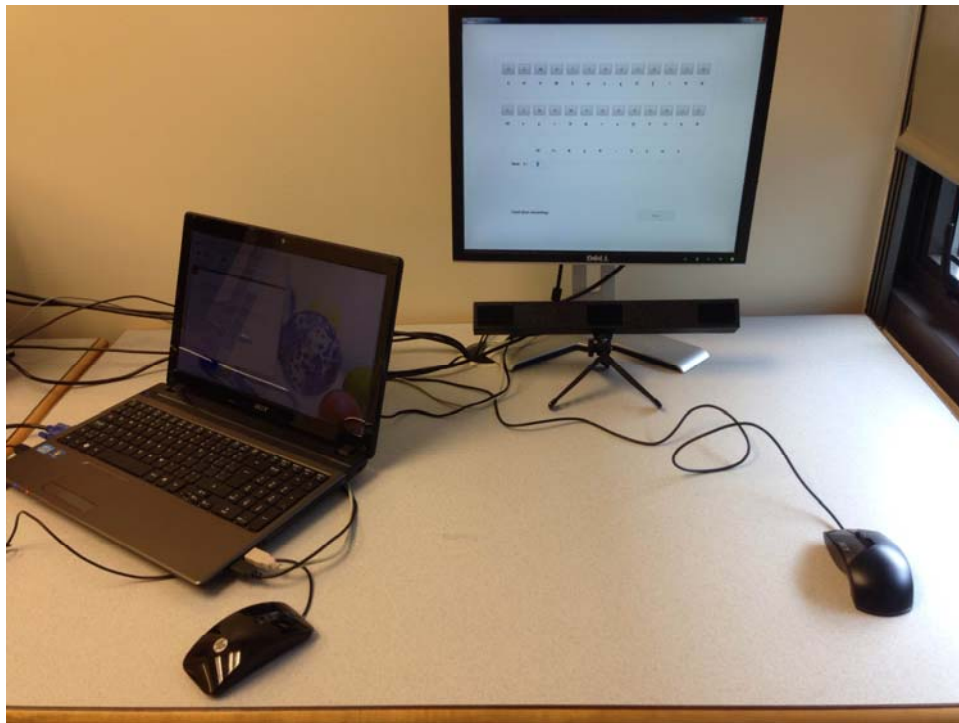
Study site of the experiment

3.1.4. Experimental Structure

I extend Church et al.'s (2008) research design to investigate the effect of learning on performance. They used three practice sessions (Period 1, Period 2, and Period 3) and one experimental session (Period 4) to investigate the effect of incentives on performance. I use Period 4 as the first experimental session (the first compensated work session) to investigate the effect of incentives on performance, and add Period 5 to investigate learning effort for relevant skill acquisition in the learning session; Period 6 to investigate how participants apply their learned skills in a new context in a post-learning session; and Period 7 as the second compensated work session, to investigate how participants apply their learned skills to the job task. The difference between Period 6 and Period 7 is that Period 7 has a job task, whereas Period 6 does not.

[Insert Figure 3]

The overall purpose of using Period 4 and adding Periods 5 and 7 is to investigate the effect of learning on performance. I use Period 4 to investigate the effect of incentives on performance, Period 5 to investigate the effect of incentives on learning effort for relevant skill acquisition, and Period 7 to investigate the effect of learning transfer on performance. I use a button in Period 7 to measure learning transfer to the job task. The difference in the level of performance between Period 4 and Period 7 represents the effect of learning.

Practice sessions (Periods 1-3)

Participants practice the same symbol-matching task three times, once each in Period 1, Period 2 and Period 3. No incentive or feedback is used. Three rounds of practice give participants an opportunity to become familiar with the job task and reach their *performance capacity* (Church et al. 2008). Similarly to Church et al. (2008), Period 1 lasts for 2.5 minutes, Period 2 lasts for 5 minutes, and Period 3 lasts for 5 minutes.

Instrument used for practice sessions and the first work session

For the job task, I adapted and computerized the experimental instrument used for a translation task by Church et al. (2008). Participants act as employees working for a translation shop, and the job task requires them to translate symbols into alphabetic letters. Church et al. (2008) provided participants with a worksheet showing the symbols with a translation key on the upper part, and symbols submitted as part of "customer orders" on the lower part. When participants see a symbol on the customer order, they can find the same symbol in the translation key, and memorize the letter above the matched symbol. Then they go down to the worksheet to fill in an empty space below the given symbol. Doing so completes one correct translation.

[Insert Figure 4]

The instrument used by the present study at this stage differs from Church et al. (2008) only in the use of a computer as a tool. I provide participants with symbols on a translation key on the upper part of a computer screen, and symbols from customer orders on the lower part of the screen. When the participant finds a give symbol on the translation key, he or she clicks on the button above the matched symbol, and the empty space below the given symbol is filled automatically. This completes one correct translation.

This purpose of this activity is to record the participant's symbol-matching performance level prior to skill acquisition and to measure their effort expended on the job task using the eye-tracker.

[Insert Figure 5]

[Insert Figure 6]

[Insert Figure 7]

[Insert Figure 8]

First experimental work session (pre-learning session) (Period 4 or Work Session 1)

Incentives and (in some conditions) feedback are used in Period 4 to motivate participants to exert additional effort to perform the job task. Church et al. (2008) find that the difference in performance and effort between Period 3 and Period 4 is taken in the present study to represent the additional effort that participants expend on the task. Period 4 lasts for 5 minutes.

[Insert Figure 9]

[Insert Figure 10]

[Insert Figure 11]

Learning session (Period 5)

In this session, participants acquire the skill of knowing how to unscramble patterns by following a specific letter order. If participants apply this learned skill to the job task correctly and quickly, their performance will improve.

There are nine patterns in the learning session, which lasts for 3 minutes. Participants follow the instructions to learn to unscramble patterns to form English words. The unscrambling rule is explained to the participants: It is that participants need to move every second letter in a pattern to the left to form an English word. For a pattern, such as UBPM, for instance, participants move the second and fourth letters one space to the left to form the English word BUMP. For a longer pattern, such as

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UQSEITNO, participants move the second, fourth, sixth and eighth letters one space to the left to form the English word QUESTION. In this session, participants practice this unscrambling; this repeated practice represents learning effort (Bonner 2008). Following Bonner (2008), more encounters with the learning material are taken to facilitate learning.

Instrument used for learning session

As an instrument for the learning task, I adapted anagrams with English word solutions from Hannan et al. (2012), who used four- and six-letter anagrams for the verbal task. Each anagram is scrambled from a common English word. I use their four-letter and six-letter words, and obtained eight-letter words directly from the same word puzzle book they used: *Merriam-Webster's Crossword Puzzle Dictionary*, third edition. In total, I used nine words: three four-letter words, three six-letter words, and three eight-letter words. To make anagrams or patterns from these English words, I developed a scrambling rule: to move every second letter in the word to the right—the first letter becomes the second, the third letter becomes the fourth, etc. For instance, the word DUCK would become the pattern, UDKC, and the word CART would become the pattern, ACTR. The written instructions provide participants with the unscrambling rule, which requires participants to find each letter by sight and re-arrange letters in a pattern. The purpose of this computerized instrument is for participants to learn to follow a specific letter order to unscramble patterns. An eye-tracker can measure their learning effort on this instrument.

Post-learning session (Period 6)

In this session, participants have a chance to apply their learned skills in a new context. Period 6 lasts for 2 minutes. In the task for Period 6, participants are informed that when they recognize the first half of a pattern, they should indicate their recognition by clicking the FOUND button, which will complete the remaining letters in the pattern automatically. If participants correctly click the button when the first half of the pattern appears, this is taken to successful learning transfer; when there is only a short delay in the button click, this indicates fast learning transfer. The computer program records the number of times the button is clicked correctly and also the time elapsed before the button click. The button click represents two dimensions of learning transfer: the probability of retrieval and the time taken to retrieve. If participants always click the button correctly, the probability of retrieval is one, and if participants never click the button correctly, the probability of retrieval is zero. Moreover, if participants always recognize the first half of the pattern quickly and click the button, then the time taken to retrieve will be closer to zero, and if participants recognize the first half of the pattern and click the button only after a noticeable delay, the time taken to retrieve will be a noticeably large number.

Instrument used for post-learning session

The third instrument, used in the symbol-recognition task, is participants' clicks of the FOUND button to indicate their recognition of a pattern that reappears in the symbol-recognition task. For instance, for the pattern UDKC, once UD appears, participants can click the button; the instrument will indicate that the button click is correct, and the

remaining letters, KC, will be filled in automatically. If only U appears and participants click the button, then the instrument will indicate that the button click is incorrect, and no remaining letters will be filled in automatically. However, if UDK appears and participants click the button, then the instrument will indicate that the button click is correct, and the remaining letter, C, will be filled in automatically.

[Insert Figure 17]

[Insert Figure 18]

Second experimental work session (Period 7 or Work Session 2)

The difference between performance in Period 7 and in Period 4 represents the effect of learning. When (or the more) a participant applies his or her learned skill to the job task, then (the more) his or her performance should improve; this should be reflected in faster and more frequently correct button clicks. Period 7 lasts for 5 minutes.

Instrument used for the second work session

The fourth instrument is a symbol-recognition task, requiring participants to press a button at a correct time; the more they do so, the more correct translations they will complete. This can speed up their translations; in contrast, if participants do not use the button, they will need to complete translations one by one.

In this session, participants are informed that as soon as the first half of a pattern reappears, they can click on a USE PATTERN button to indicate their recognition of it. As before, this should only be done once enough of the pattern appears (i.e., the first half) that the participant is able to identify it and differentiate it from others with 100 percent certainty. For instance, for the pattern UDKC, once UD appears, participants should click the button. The instrument will automatically fill in the remaining letters, KC. If only the letter U appears and participants click the button, then the instrument will not fill in any letters; there is no penalty in terms of performance and therefore also no penalty in terms of rewards when participants do this. If UDK appears and participants

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click the button, then the instrument will automatically fill in the remaining letter, C, and the participant will get a lower score (for a higher time elapsed) on the measure of time taken to retrieve.

[Insert Figure 19]

[Insert Figure 20]

[Insert Figure 21]

[Insert Figure 22]

[Insert Figure 23]

3.2. Variables and Measurement

3.2.1. Stage One

Independent variable: Incentive contracts and relative performance feedback

Incentive contracts in this study have three levels of incentives: winner-takes-all scheme schemes (which have a low win probability), multiple-winner schemes (which have a moderate win probability), and piece-rate schemes (for benchmarking purposes). The relative performance feedback condition has two levels: presence and absence.

Mediating variables: Effort duration and effort intensity

A gaze point is the fundamental unit of eye-tracker measurement; the eye-tracking device used here measures coordination of gaze points as well as the time stamp of each gaze point. The eye-tracker device recognizes a gaze point in 16 milliseconds. The device manual explains that when three gaze-points fall within 50 pixels of each other, the eye-tracker automatically labels the third gaze point and the following gaze points as a *fixation point*. Therefore, a fixation point reflects that the

participant is staring at a point on the screen for at least 48 milliseconds. The eye-tracker stores each piece of gaze and fixation point information in its database; it also records the subject's pupil size at each gaze point.

Effort intensity

The eye-tracker measures pupil size at each gaze point on the translation key, which is the symbol-matching area. I calculate the average of pupil size across all fixation points in the last one-third of the time in the first work session, as well as average of pupil size across all fixation points in the first one-third of the time allocated for the session. Then I calculate the percentage change between these two numbers. This number represents change in pupil size from baseline, that is, from the beginning one-third of the experimental time in the first work session. This is based on the theory that tournament schemes motivate participants to sustain their effort (intensity) until the conclusion of the competition (Lazear and Rosen 1981; Berger et al. 2013); recording a positive percentage change in average pupil size would support this assertion, since (larger) average pupil size change reflects (more) intensity of effort.

I use average percentage change in pupil size, rather than an absolute measure to reflect individual pupil size difference. Specifically, I use this formula:

([average pupil size during the last one-third of the time in the first work session] / [average pupil size during the first one-third of the first work session]) – ([average pupil size during the last one-third of the last practice session] / [average pupil size during the first one-third of the last practice session]).

Assume average pupil size during the last one-third of the time in the first work session is 7 millimetres, and average pupil size during the first one-third of the time in the same session is 5 millimetres. The percentage change is 40 percent, for (7/5) - 1. Next, assume average pupil size during the last one-third of the time in the last practice session is 6 millimetres, and average pupil size during the first one-third of the time in the last practice session is 5 millimetres. The percentage change is 20 percent, that is,

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for (6/5) - 1. The difference in these two number is 20 percent, because 40 percent minus 20 percent is 20 percent.

Effort duration

The eye-tracker measures the fixation time participants spend on the symbol-matching area. I calculate the total fixation time on the translation key in the first work session as compared to that in the last practice session to account for individual variations in their performance capacity.

Dependent variable: Job performance

A correct symbol match is a unit of performance; that is, I use the total number of correct symbol matches to measure performance. This 5-minute session has a maximum of 200 symbols to be translated; no participant reached the maximum.

3.2.2.   Stage Two

First independent variable: Incentive contracts and relative performance feedback

Incentive contracts have three levels of incentives: winner-takes-all schemes (low win probability), a multiple-winner schemes (moderate win probability), and piece-rate schemes (for benchmarking purposes). The relative performance feedback condition has two levels: presence and absence.

Second independent variable: Learning effort measured by effort direction (fixation time on patterns)

The eye-tracking device records the length of fixation time on patterns when participants are unscrambling patterns by following a specific letter order. The eye-tracking device records data on fixation time and the location of gaze points. I calculate

the total time from all fixation points on patterns while participants are exhibiting small leftward eye movements.

Second independent variable: Learning effort measured by effort toward problem-solving (number of leftward saccades on patterns)

The eye-tracking device records coordinates of gaze points and fixation points. This helps detect the direction of eye movements, representing individual learning patterns. Specifically, the eye-tracker detects whether participants unscramble patterns by following a specific letter order, by providing data on leftward eye movements falling within the space of 60 pixels[33] between two fixation points (i.e., saccades). I calculate the number of leftward saccades on patterns.

Mediating variables: Learning transfer

Bonner (2008) suggests that learning transfer has two dimensions: the probability of retrieval and the time taken to retrieve.

I measure the probability of retrieval by the number of patterns correctly identified with a button click, divided by the number of patterns available. A higher value indicates greater learning transfer. The program's self-generated database records the number of patterns correctly indicated, and also the number of patterns available.

I measure time taken to retrieve by the amount of time that elapses (in seconds) between when the first half of a pattern reappears and when participants click the button correctly, divided by the total number of patterns correctly indicated. A higher value indicates less efficient learning transfer (i.e., more time taken for pattern recognition). The computer database provides a time stamp on button click, and also a time stamp on each symbol. I use the time stamp on the last letter in the first half of a pattern, and

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[33] The distance between two alphabetic letters in a pattern is about 60 pixels on the instrument used for the learning session.

compare it with the time stamp on the button click. The difference is the time elapsed for the button click.

Dependent variable: Performance change

Performance change is measured by the difference between the total number of correct symbol matches in the second stage and in the first stage. Each of the 5-minute sessions has a maximum of 200 symbols to be translated, and no participant reached the maximum.

3.3. Experimental Procedure

General instructions

Only one participant is tested at a time in the experiment. Participants arrive at the experimental site, and read the written instructions on a computer screen. Participants assume the role of translators working for a translation shop. Their job is to translate symbols into alphabetic letters. In the task, "customers" place their order via a computerized ordering system. Each customer order row has a request for 10 symbol translations. Participants need to begin with a symbol and find its match on the translation key on the computer screen, which contains 26 alphabetic letters and 26 symbols. Once participants find the right symbol on the translation key, they click on the button above the matched symbol to complete one translation. One correct symbol match is one unit of performance.

Participants have a total of 12.5 minutes over three practice sessions to familiarize themselves with the translation task. The symbols are expected not to confuse them after three rounds of practice on the same task. At the end of the 12.5 minutes, they should reach their performance capacity under a state of familiarity with the symbols.

At the end of each practice session, participants are shown their performance summary report, which shows the correctness of each translation the participant has made. This gives them a chance to review their work and improve their performance in

the next round of practice. It also shows the number of correct translations and incorrect translations, giving them a sense of their overall performance.

The eye-tracking device is turned on after the first practice session to record participants' visual attention and actions. There is a nine-point calibration process for the eye-tracker to synchronize with participants' eye movements, in which they need to gaze at a white dot that appears sequentially in nine locations on the computer screen.

Participants know that they need to sit in a way in which they feel comfortable and can see the symbols fairly clearly. They can adjust their sitting position during the first practice session (as stated before, the eye-tracking device is turned on after this session). After this session, participants are expected to maintain the same sitting position throughout the experiment.

The instructions explain the overall structure of the experiment to participants. Participants will do three rounds of practice before they perform the first work session, which is compensated. Afterwards, they will do a learning session, followed by a trial session for learning transfer, and then the second work session. Participants are informed that the task is the same throughout the experiment. The translation key remains in the same position on the computer screen throughout the experiment. As stated before, the compensation for their participation is $20, in addition to the potential to earn tournament prizes for winning the first and second work sessions. Participants collect their cash payment at the end of the experiment.

Practice sessions (Periods 1-3)

Participants have three uncompensated practice sessions to gain proficiency with the translation task. For a given symbol, they find the same symbol on the translation key; then they click the button above the symbol to complete one translation. It may take some time for participants to improve their translation speed. At the end of each practice session, the performance summary page will show the result for each symbol they translated, and also the number of correct and incorrect translations.

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First work session (Period 4 / Work Session 1)

Incentives and (in some cases) feedback are used in the first work session. Participants read an explanation of the payment scheme prior to performing the translation task. The experimenter randomly assigns participants into one of six groups, one for each of three levels of incentives by two levels of feedback.

The written instructions inform participants that they are the last person to enrol in the group. This setting simulates an intragroup tournament, in which each group member competes with other group members for the prize (Chen et al. 2012). Four of the groups are compensated based on relative performance: In multiple-winner schemes, participants get a tournament prize only if they are above the 50th percentile of performers; and in winner-takes-all schemes, participants get a tournament prize only if they are the top performer. Piece-rate groups are compensated based on absolute performance, at a rate of five cents per correct translation.

The written instructions also inform participants about the feedback conditions, that is, whether they will get performance feedback in the translation process. Relative performance feedback information, if present, includes the participant's relative ranking in percentiles and the number of correct translations achieved by the top performer and the median performer. Ranking information is provided after every three rows of symbols completed; that is, if participants complete 20 rows of translations, they will receive performance feedback six times. Providing performance feedback after every third row allows participants to get an average assessment of their performance.

Learning session (Period 5)

The written instructions inform participants that the purpose of the learning session is for them to exert learning effort for relevant skill acquisition. Every participant will undergo a three-minute learning session. The patterns learned in the learning session will reappear in the job task. If participants exert learning effort for skill

acquisition in the learning session, they will be expected to learn the new skill well and to be able to apply it to the job task to improve performance.

The specific job-related skill participants learn is how to unscramble anagrammatic patterns in a specific way to yield English words. The unscrambling rule is explained to the participants, and then they spend 3 minutes practicing unscrambling patterns using this rule. They are informed that more practice on unscrambling patterns will enable them to better recognize the same patterns after learning. The written instructions provide two illustrative examples.

For a shorter pattern such as UBPM, you can move the second and fourth letters one space to the LEFT to form the English word BUMP.

UB PM

BU MP

UB ➔ BU

PM ➔ MP

For a longer pattern such as UQSEITNO, you can move the second, fourth, sixth and eighth letters one space to the LEFT to form the English word QUESTION.

UQ SE IT NO

QU ES TI ON

UQ ➔ QU

SE ➔ ES

IT ➔ TI

NO ➔ ON

Participants will see three window views: One view has three four-letter patterns, another view has three six-letter patterns, and the third has three eight-letter patterns. All the patterns in a given window are the same length. Participants can start with any view or any pattern. Participants apply the every-second-letter movement rule mentally; once they have an English word in mind, they can click on an empty slot next to the pattern to reveal the correct solution and verify their response.

Post-learning session (Period 6)

In this 2-minute session to practice learning transfer, participants can apply their learned skills in a new context for the first time, and gain experience in recognizing nine patterns that reappear among random letters[34]. Participants are informed that they should practice recognizing patterns among random letters quickly and correctly.

Participants are informed that a *half-pattern* rule applies. That is, they have to recognize at least the first half of a pattern before they can click the FOUND button to indicate their recognition. For instance, if they see UB and click the button, that is correct. As a result, the letters PM will be filled in automatically. But if they see U and click the button, that is incorrect, and no letter will be filled in. In this case, the pattern UBPM is derived from an English word BUMP. For a longer pattern such as UQSEITNO, if they see UQSE and click the button, that is correct, and the letters ITNO will be filled in automatically. But if they see UQS and click the button, that is incorrect, and no letter will be filled in automatically. In this case, the pattern UQSEITNO is derived from an English word QUESTION.

This half-pattern rule demonstrates the application of procedural knowledge in learning transfer. The recognition of the first half of a pattern satisfies the "if" condition and the action (i.e., the button click) satisfies the "then" action.

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[34] Bonner (2008) argues that "if the rules are successful for solving problems, they gain strength in memory; if they are unsuccessful, they are discarded" (p. 312).

Participants are instructed to click empty boxes on the computer screen. Each click on a box will reveal a letter. Participants keep revealing more letters, until they see the first half of a pattern; then, they indicate their recognition by clicking the FOUND button (under the half-pattern rule). All participants watch a video that shows exactly what they are expected to do in this post-learning session.

Second work session (Period 7 / Work Session 2)

In this session, participants can apply their learned skills to their job task. The only difference between the first work session (P4) and the second work session (P7) is one additional feature in P7: the USE PATTERN button. The purpose of adding this button is to help participants improve their performance. For instance, if they recognize the first half of a pattern correctly and use the button, the button will complete the remaining letters in the pattern automatically. Participants know that their main focus is to translate symbols one by one (the manual approach) in the job task; the USE PATTERN button provides an enhancement to this manual approach, in that using the button, participants can complete multiple translations automatically. For instance, when they recognize UB (i.e., the first half of the pattern UBPM) in the customer order row and click the button, the button completes PM automatically wherever UB appears. The button fills in the remaining letters wherever UB appears. This saves them the time it would take to complete multiple translations manually, and as a result, they can make more translations. Participants who are motivated to improve their performance are likely to click the button. Prior research shows that learning transfer is evidenced by faster and more accurate performance, and allows one to carry out other tasks simultaneously (Bonner and Sprinkle 2002; Straus et al. 2011). All participants watch a video that shows exactly what they are expected to do in the second work session.

Participants can only click the button once per customer row. Once clicked, the button is disabled until the next row rolls in. Each customer order row contains a pattern, which can appear anywhere in the row.

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Post-experiment questionnaire

The experimenter asked participants to complete a questionnaire online, collecting their demographic information, such as years of working experience, age, gender, industry, educational background, etc.

Chapter 4.

Data Analysis and Results

4.1. Descriptive Statistics and Correlations

Table 1, panel A, presents two measures of effort expended on the task and two measures of learning effort for relevant skill acquisition in Stages 1 and 2. It also shows how the eye-tracker will measure task effort and learning effort at each stage. Table 1, panel B, presents two dimensions of learning transfer: probability of retrieval and time taken to retrieve, along with how they are measured. Table 1, panel C, provides the 3 by 2 matrix, for a total of six treatment groups, used by this research design. For each of these six groups, I record measurements of task effort and learning effort as well as dimensions of learning transfer. Tables 2 presents the descriptive statistics for all the variables used in this study.

Tables 3 presents the Analysis of Variance (ANOVA) test results for multiple comparisons among the six treatment groups (three incentive groups and two feedback groups). The purpose of the ANOVA is to provide a preliminary indication of whether the incentive effect is different across three levels of incentive plans (i.e., multiple-winner, winner-takes-all, and piece-rate schemes). Each level of the incentive plans contains an incentive group with relative performance feedback and a group without such performance feedback. The ANOVA test results thus provide a preliminary indication of whether the feedback effect is different across these three levels of incentive plans.

Table 4 presents the t-test results, which constitute simple comparisons between any two levels of incentive plans for the main effect of incentives on task effort. The purpose of the t-test is to show whether the incentive effect on task effort is different between any two levels of incentive plans. Table 5 presents the results of the Pearson

product-moment correlation coefficient (Pearson's r) for all variables used in Stage 1. Table 6 presents the ANOVA results for multiple comparisons between any two incentive groups and two feedback groups. These ANOVA results show whether providing relative performance feedback in any two levels of incentive plans has a moderating effect on task effort.

Table 7 presents the t-tests, which provide a simple comparison between any two levels of incentive plans for the main effect of incentives on learning effort. The purpose of the t-test is to determine whether the incentive effect on learning effort is different between any two levels of incentive plans. Table 8 presents Pearson's correlations for all variables in Stage 2. Table 9 presents the result of multivariate regressions testing the mediating effect of learning transfer in the relationship between learning effort and performance for all six treatment groups. Table 10 presents the result of multivariate regressions testing the mediating effect of learning transfer in the relationship between learning effort and performance for the four tournament groups (G1, G2, G3, and G4). Table 11 presents the corresponding results for the two non-tournament groups (G5 and G6). Table 12 presents the ANOVA results for multiple comparisons between any two incentive groups and two feedback groups, showing whether providing relative performance feedback in any two levels of incentive plans has a moderating effect on learning effort.

Table 13 presents the t-tests, which provide a simple comparison between any two levels of incentive plan for the main effect of incentives on non–eye-tracking variables. It shows whether the incentive effect on non–eye-tracking variables is different between any two levels of incentive plans.

4.2. Hypothesis Testing and Results

In Stage 1, two relationships are investigated: one in which task effort serves as the dependent variable and tournament schemes as the independent variable, and another in which job performance serves as the dependent variable and task effort as the independent variable. The role of feedback is also examined in the relationship between tournament schemes and task effort.

In Stage 2, two relationships are investigated: one in which learning effort serves as the dependent variable and tournament schemes as the independent variable, and another in which job performance serves as the dependent variable, and learning effort as the independent variable. The role of feedback is also examined in the relationship between tournament schemes and learning effort, and the role of learning transfer is also examined in the relationship between learning effort and performance. I use the Student's t-test and ANOVA to do the data analysis. The Student's t-test is a hypothesis test used to examine if two sets of data are significantly different from one another.

Task effort measures include effort intensity (as measured by pupil dilation change from a baseline) and effort duration (as measured by fixation time on a symbol-matching area). I contrast the mean difference of effort intensity and effort duration for H1a and H2b for multiple-winner schemes and winner-takes-all schemes, respectively. I also contrast the mean difference of effort intensity and effort duration for H1c and H2d for multiple-winner schemes and piece-rate schemes, respectively. Finally, I contrast the mean difference of effort intensity and effort duration for H1e and H2f for winner-takes-all schemes and piece-rate schemes, respectively.

The results for each sub-hypothesis for hypothesis 1 were as follows:

H1a predicts that effort intensity is higher in multiple-winner schemes than in winner-takes-all schemes. Table 4, panel A, shows that the result is consistent with the prediction, with a significant coefficient at the 5 percent level. The t-test for effort intensity shows t = 2.64 and p = 0.011. This result supports H1a.

H1b predicts that effort duration is higher in multiple-winner schemes than in winner-takes-all schemes. Table 4, panel B, shows that the result is non-significant at the 10 percent level. The t-test for effort intensity shows t = 0.05 and p = 0.963. This result does not support H1b.

H1c predicts that effort intensity is higher in multiple-winner schemes than in piece-rate schemes. Table 4, panel A, shows that the result is consistent with the prediction, with a significant coefficient at the 1 percent level. The t-test for effort intensity shows t = 3.53 and p = 0.001. This result supports H1c.

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H1d predicts that effort duration is higher in multiple-winner schemes than in piece-rate schemes. Table 4, panel B, shows that the result is consistent with the prediction, with a significant coefficient at the 5 percent level. The t-test for effort duration shows t = 2.47 and p = 0.016. This result supports H1d.

H1e predicts that effort intensity is higher in winner-takes-all schemes than in piece-rate schemes. Table 4, panel A, shows that the result is non-significant at the 10 percent level. The t-test for effort intensity shows t = 0.35 and p = 0.725. This result does not support H1e.

H1f predicts that effort duration is higher in winner-takes-all schemes than in piece-rate schemes. Table 4, panel B, shows that the result is consistent with the prediction, with a significant coefficient at the 1 percent level. The t-test for effort duration shows t = 2.94 and p = 0.005. This result supports H1f.

The results for each sub-hypothesis for hypothesis 2 were as follows:

H2a predicts that effort intensity has a positive effect on job performance. Table 5 shows that the result is consistent with the prediction, with a significant correlation coefficient at the 5 percent level (r = 0.266; p = 0.011). This result supports H2a.

H2b predicts that effort duration has a positive effect job performance. Table 5 shows that the result is non-significant at the 10 percent level (r = 0.08; p = 0.453). This result does not support H2b.

The general results for hypothesis 3 were as follows. H3 predicts that relative performance feedback has a stronger effect on task effort in multiple-winner schemes than in winner-takes-all or piece-rate schemes. I include in the model an interaction term that captures the combined effect of incentives and relative performance feedback on task effort, following Chenhall et al. (2011). (An *interaction term* is a multiplication of two independent variables.) Table 6 shows that the coefficient of the interaction term is not significant at the 10 percent level for any of the H3 sub-hypotheses. Therefore H3a, H3b, H3c, H3d, H3e, and H3f are not supported.

The results for each sub-hypothesis for hypothesis 4 were as follows:

H4a predicts that effort direction is higher in multiple-winner schemes than in winner-takes-all schemes. Table 7, panel A, shows that the result is consistent with the prediction, with a significant coefficient at the 5 percent level (t = 2.18, p = 0.034). This result supports H4a.

H4b predicts that effort toward problem-solving is higher in multiple-winner schemes than in winner-takes-all schemes. Table 7, panel B, shows that the result is consistent with the prediction, with a significant coefficient at the 5 percent level (t = 2.03, p = 0.047). This result supports H4b.

H4c predicts that effort direction is higher in multiple-winner schemes than in piece-rate schemes. Table 7, panel A, shows that the result is consistent with the prediction, with a significant coefficient at the 5 percent level (t = 2.13, p = 0.037). This result supports H4c.

H4d predicts that effort toward problem-solving is higher in multiple-winner schemes than in piece-rate schemes. Table 7, panel B, shows that the result is consistent with the prediction, with a significant coefficient at the 10 percent level (t = 1.92, p = 0.059). This result supports H4d.

H4e predicts that effort direction is higher in winner-takes-all schemes than in piece-rate schemes. Table 7, panel A, shows that the result is not significant at the 10 percent level (t = 0.21, p = 0.837). This result does not support H4e.

H4f predicts that effort toward problem-solving is higher in winner-takes-all schemes than in piece-rate schemes. Table 7, panel B, shows that the result is not significant at the 10 percent level (t = 0.18, p = 0.861). This result does not support H4f.

Moving on to H5, we recall that it predicts that learning transfer mediates the relationship between learning effort and performance. That is, assuming there is a relationship between learning effort and performance, H5 predicts that the inclusion of the mediator (i.e., dimensions of learning transfer) will weaken or remove the direct

relationship between the IV and DV. I conduct a mediation analysis using the three-step method proposed by Baron and Kenny (1986), who suggest to do so, first, a relationship between an independent variable and a mediator needs to be established; then a relationship between an independent variable and the dependent variable needs to be established; and finally when a mediator is included in the relationship between an independent variable and the dependent variable, the bivariate relationship is shown to be less significant than it appeared before the inclusion of a mediator (since some or all of the full effect is due to the mediator). If an independent variable is still significant when a mediator is controlled (i.e., both an independent variable and a mediator significantly predict the dependent variable), the finding supports partial mediation. If an independent variable becomes insignificant when a mediator is controlled, the finding supports full mediation.

I test two dimensions of learning transfer, probability of retrieval and time taken to retrieve, as potential mediators between two measures of learning effort as independent variables—effort direction and effort toward problem-solving—and performance as a dependent variable.

I test H5's sub-hypotheses across incentive groups. The results for each sub-hypothesis for hypothesis 5 were as follows:

H5a predicts that the probability of retrieval mediates the link between effort direction and performance. I first show that the independent variable (effort direction) has a significant effect on the mediating variable (probability of retrieval). This is accomplished using the Pearson's r result reported in Panel A of Table 8, which finds a significant correlation between effort direction and probability of retrieval (r = 0.205, p = 0.057). Second, I regress the dependent variable (performance) on the independent variable (effort direction). The regression finds that effort direction has a significant positive effect on performance (t = 3.51 and p = 0.001, as in Panel A of Table 9). Third, I regress the dependent variable (performance) on *both* the independent variable (effort direction) and the mediator (probability of retrieval). The multivariate regression (as in Panel B of Table 9) finds a significant coefficient of the mediator (t = 4.53 and p < 0.001)

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and a significant coefficient of the independent variable (t = 2.93 and p = 0.004). This indicates a partial mediation. This result supports H5a.

H5b predicts that the time taken to retrieve mediates the link between effort direction and performance. I first show that the independent variable (effort direction) has a significant effect on the mediating variable (time taken to retrieve). This is accomplished using the Pearson's r result reported in Panel A of Table 8, which finds a significant correlation between effort direction and the time taken to retrieve (r = -0.192, p = 0.074). Second, I regress the dependent variable (performance) on the independent variable (effort direction). The regression finds that effort direction has a significant positive effect on performance (t = 3.51 and p = 0.001, as in Panel A of Table 9). Third, I regress the dependent variable (performance) on *both* the independent variable (effort direction) and the mediator (time taken to retrieve). The multivariate regression (as in Panel C of Table 9) finds a significant coefficient of the mediator (t = -3.79 and p < 0.001) and a significant coefficient of the independent variable (t = 3.02 and p = 0.003). This indicates a partial mediation. This result supports H5b.

H5c predicts that the probability of retrieval mediates the link between effort toward problem-solving and performance. I do not find that the independent variable (effort toward problem-solving) has a significant effect on the mediating variable (probability of retrieval). This is accomplished using the Pearson's r result reported in Panel A of Table 8, which finds a non-significant correlation between effort toward problem-solving and probability of retrieval (r = -0.072, p = 0.505). This indicates no mediating effect. This result does not support H5c.

H5d predicts that the time taken to retrieve mediates the link between effort toward problem-solving and performance. I do not find that the independent variable (effort toward problem-solving) has a significant effect on the mediating variable (time taken to retrieve). This is accomplished using the Pearson's r result reported in Panel B of Table 8, which finds a non-significant correlation between effort toward problem-solving and the time taken to retrieve (r = -0.097, p = 0.37). This indicates no mediating effect. This result does not support H5d.

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Moving on now to hypothesis 6, it predicts that relative performance feedback has a stronger effect on learning effort in multiple-winner schemes than in winner-takes-all or piece-rate schemes. I include in the model an interaction term that captures the combined effect of incentives and relative performance feedback on task effort. Table 12 shows that the coefficient of the interaction term is not significant at the 10 percent level for any of the H6 sub-hypotheses. Therefore H6a, H6b, H6c, H6d, H6e, and H6f are not supported.

Summary table: Statistical results for the main hypotheses. I only list one measure of task effort—is effort intensity, using pupil size—and one measure of learning effort—effort direction. These two measures are found to be correlated with performance.

Item	Sub-hypothesis statement	Statistical result
	Stage 1	
H1a	Employees' effort intensity in multiple-winner schemes is higher than that in winner-takes-all schemes.	Supported (p = 0.0105)
H1c	Employees' effort intensity in multiple-winner schemes is higher than that in piece-rate schemes.	Supported (p = 0.001)
H1e	Employees' effort intensity in winner-takes-all schemes is higher than that in piece-rate schemes.	Not supported (p = 0.725)
H2	More effort intensity leads to higher performance.	Supported (p = 0.011)
H3a	Relative performance feedback increases employees' effort intensity more in multiple-winner schemes than in winner-takes-	Not supported

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	all schemes.	(p = 0.148)
H3c	Relative performance feedback increases employees' effort intensity more in multiple-winner schemes than in piece-rate schemes.	Not supported (p = 0.292)
H3e	Relative performance feedback increases employees' effort intensity more in winner-takes-all schemes than in piece-rate schemes.	Not supported (p = 0.543)
	Stage 2	
H4a	Employees' effort direction in multiple-winner schemes is higher than that in winner-takes-all schemes.	Supported (p = 0.034)
H4c	Employees' effort direction in multiple-winner schemes is higher than that in piece-rate schemes.	Supported (p = 0.037)
H4e	Employees' effort direction in winner-takes-all schemes is higher than that in piece-rate schemes.	Not supported (p = 0.837)
H5a	The probability of retrieval mediates the relationship between effort direction and performance.	Supported (p < 0.001)
H5b	The time taken to retrieve learned skills mediates the relationship between effort direction and performance.	Supported (p < 0.001)
H6a	Relative performance feedback increases employees' effort direction more in multiple-winner schemes than in winner-takes-all schemes.	Not supported (p = 0.338)
H6c	Relative performance feedback increases employees' effort direction more in multiple-winner schemes than in piece-rate schemes.	Not supported (p = 0.671

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H6e	Relative performance feedback increases employees' effort direction more in winner-takes-all schemes than in piece-rate schemes.	Not supported (p = 0.162)

Chapter 5.

Discussion of Statistical Results

5.1. Statistical Results

H1 mainly concerned the relationship between incentives and task effort. For task effort, I used effort intensity (as measured by average pupil dilation change from a baseline) and effort duration (as measured by fixation time on a symbol-matching area).

H1a predicted that effort intensity is higher in multiple-winner schemes than in winner-takes-all schemes. As seen in Table 4, panel A, this sub-hypothesis was supported (t = 2.64, p = 0.011). This finding shows that subjects apply more focus to the symbol-matching area in multiple-winner schemes than in winner-takes-all schemes. This result is consistent with tournament theory, which suggests that employees choose their level of effort based on their probability of winning, which is higher in multiple-winner schemes than in winner-takes-all schemes.

H1b predicted that effort duration is higher in multiple-winner schemes than in winner-takes-all schemes. As seen in Table 4, panel B, this sub-hypothesis was not supported (t = 0.05, p = 0.963): Subjects in winner-takes-all schemes are spending a similar amount of fixation time on the symbol-matching area to those in multiple-winner schemes. That is, multiple-winner schemes do not motivate employees to exert effort for a longer duration than winner-takes-all schemes.

Taken together, these results may be interpreted to show that subjects may have spent insufficient time focusing on the symbol-matching area. As seen in Table 5, panel B, effort duration is significantly correlated with *search distance* per translation at the 1 percent level (r = 0.506, p < 0.001), which in turn is negatively correlated with

performance, also at the 1 percent level (r = -0.342, p = 0.001). Search distance per translation is calculated as total search distance on the symbol-matching area divided by the total number of translations, regardless of whether the answer is correct or not. This indicates that the subject's eye (or visual attention) has travelled more distance to complete the translation. The assumption is that when subjects want to be more careful and to scrutinize the translation they have just completed, they will come back to double-check. This behaviour can result in more distance per translation and more fixation time on the symbol-matching area. However, more double-checks on the completed work may not lead to improved performance for two reasons. First, the symbol-matching task is a routine, simple task, and subjects get three rounds of practice beforehand. Double-checking work in addition to this may not add significantly to the total number of translations and perhaps also accuracy, merely slowing down the translation process. This is a concern because, second, time is a constraint (each experimental session lasts only for 5 minutes). Within a limited time framework, double-checking may result in a lower total number of translations. In light of this, subjects in winner-takes-all schemes may be over-searching symbols during the additional fixation time they spend on the symbol-matching area. This may explain why effort duration does not have a significant impact on performance.

H1c predicted that effort intensity is higher in multiple-winner schemes than in piece-rate schemes. As shown in Table 4, panel A, this sub-hypothesis was supported (t = 3.53, p = 0.001). This is interpreted to indicate that subjects are more focused on the symbol-matching area in multiple-winner schemes than piece-rate schemes. This result means that multiple-winner schemes motivate employees to exert more effort intensity than piece-rate schemes. This result is consistent with tournament theory, which suggests tournament schemes motivate more effort intensity than piece-rate schemes, all other things being equal.

H1d predicted that effort duration is higher in multiple-winner schemes than in piece-rate schemes. As seen in Table 4, panel B, this sub-hypothesis was supported (t = 2.47, p = 0.016). The interpretation is that subjects spend more fixation time on the symbol-matching area in multiple-winner schemes than in piece-rate schemes. This result indicates that multiple-winner schemes motivate employees to exert more effort

duration than piece-rate schemes. This result is consistent with tournament theory, which suggests that a tournament scheme motivates more effort than piece-rate schemes, all other things being equal.

H1e predicted that effort intensity is higher in winner-takes-all schemes than in piece-rate schemes. As seen in Table 4, panel A, this sub-hypothesis was not supported (t = 0.35, p = 0.725). The interpretation is that subjects are not more focused on the symbol-matching area when they are in winner-takes-all schemes than when they are in piece-rate schemes. This result indicates that winner-takes-all schemes do not motivate employees to exert more effort intensity than piece-rate schemes, perhaps due to the low probability of winning.

H1f predicted that effort duration is higher in winner-takes-all schemes than in piece-rate schemes. As seen in Table 4, panel B, this sub-hypothesis was supported (t = 2.94, p = 0.005). The interpretation is that subjects spend more fixation time on the symbol-matching area in winner-takes-all schemes than in piece-rate schemes. This result indicates that winner-takes-all schemes motivate employees to exert more effort duration than piece-rate schemes.

H2 mainly concerned the relationship between task effort and performance. For task effort, I used effort intensity (measured by average pupil dilation change from a baseline) and effort duration (measured by fixation time on a symbol-matching area), and for performance, I used the number of correct translations.

H2a predicted that effort intensity is associated with performance. As seen in Table 5, panel A, this sub-hypothesis was supported (r = 0.266; p = 0.011). This result indicates that effort intensity is positively associated with performance. This result is consistent with tournament theory, which suggests that more effort expended on a task leads to improved performance.

H2b predicted that effort duration is associated with performance. As seen in Table 5, panel A, this sub-hypothesis was not supported (r = 0.080; p = 0.453). This might be because subjects under longer duration are too careful in performing the task and in double-checking their completed work, in the present case, spending more

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fixation time on the symbol-matching area while traveling more distance on it. As noted above, Table 5, panel B, shows that effort duration is significantly associated with search distance per translation. This might explain why more effort duration may not lead to improved performance.

H3 mainly concerned the moderating effect of providing relative performance feedback on the relationship between incentives and task effort. I used relative performance feedback (subjects' performance ranking percentile), effort intensity (average pupil dilation change from a baseline) and effort duration (fixation time on a symbol-matching area) to test H3.

H3a predicted that providing relative performance feedback increases effort intensity more in multiple-winner schemes than in winner-takes-all schemes. As seen in Table 6, panel A, this sub-hypothesis was not supported ($t = 2.15$, $p = 0.148$). Tournament theory suggests that tournament schemes motivate subjects to exert their best effort; therefore, it might be that subjects are already exerting their best effort, and so might not be possible for relative performance feedback to motivate them to exert more effort intensity. Or, winner-takes-all schemes can induce subjects to give up, and it might be that these subjects had already done so, making it almost impossible for relative performance feedback to motivate them to exert more effort intensity.

H3b predicted that providing relative performance feedback increases effort duration more in multiple-winner schemes than in winner-takes-all schemes. As seen in Table 6, panel B, this sub-hypothesis was not supported ($t = 0.05$, $p = 0.82$). This might be because, by the same logic as in H3a, it might not be possible for relative performance feedback to motivate participants to exert more effort duration.

H3c predicted that providing relative performance feedback increases effort intensity more in multiple-winner schemes than in piece-rate schemes. As seen in Table 6, panel C, this sub-hypothesis was not supported ($t = 1.13$, $p = 0.29$). This might be because similar to the suggestion above under 3a, subjects in multiple-winner schemes are already exerting their best effort, and it might not be possible for relative performance feedback to motivate them to exert more effort intensity. Also, subjects in piece-rate schemes are compensated on the basis of their absolute performance; even

in extreme cases in which they rank very low relative to their peers, they can still get paid for their translations. Therefore, they might not be motivated by relative performance feedback that shows their performance ranking to exert more effort intensity.

H3d predicted that providing relative performance feedback increases effort duration more in multiple-winner schemes than in piece-rate schemes. As seen in Table 6, panel D, this sub-hypothesis was not supported (t = 0.00, p = 0.962). By the same logic as in H3c, it might not be possible for relative performance feedback to motivate participants to exert more effort duration.

H3e predicted that providing relative performance feedback increases effort intensity more in winner-takes-all schemes than in piece-rate schemes. As seen in Table 6, panel E, this sub-hypothesis was not supported (t = 0.37, p = 0.543). As noted above under H3a, winner-takes-all schemes can induce subjects to give up, and it might be that these subjects had already given up, making it almost impossible for relative performance to motivate them to exert more effort intensity. Also as noted above, subject in piece-rate are compensated on the basis of their absolute performance and might not be motivated to exert more effort intensity by feedback on their relative performance.

H3f predicted that providing relative performance feedback increases effort duration more in winner-takes-all schemes than in piece-rate schemes. As seen in Table 6, panel F, support this sub-hypothesis was not supported (t = 0.07, p = 0.788). By the same logic as in H3e, it might not be possible for relative performance feedback to motivate subjects to exert more effort duration.

H4 mainly concerned the relationship between incentives and learning effort. For learning effort, I used effort direction (fixation time on patterns) and effort toward problem-solving (the number of leftward saccades on patterns).

H4a predicted that effort direction is higher in multiple-winner schemes than in winner-takes-all schemes. As seen in Table 7, panel A, this sub-hypothesis was supported (t = 2.18, p = 0.034). The interpretation is that subjects spend more fixation

time on patterns in multiple-winners schemes than in winner-takes-all schemes. Since the probability of winning is higher in multiple-winner schemes than in winner-takes-all schemes, this result is consistent with tournament theory, which suggests that employees choose their level of learning effort based on their probability of winning.

H4b predicted that effort toward problem-solving is higher in multiple-winner schemes than in winner-takes-all schemes. As seen in Table 7, this sub-hypothesis was supported ($t = 2.03$, $p = 0.047$). The interpretation is that subjects will more closely follow the instructions to learn a specific way to unscramble the letter order in a pattern to form a word in multiple-winner schemes than in winner-takes-all schemes.

H4c predicted that effort direction is higher in multiple-winner schemes than in piece-rate schemes. As seen in Table 7, panel A, this sub-hypothesis was supported ($t = 2.13$, $p = 0.037$). The interpretation is that subjects spend more fixation time on patterns in multiple-winner schemes than in piece-rate schemes. This result is consistent with tournament theory, which suggests that tournament schemes motivate learning effort to improve performance.

H4d predicted that effort toward problem-solving is higher in multiple-winner schemes than in piece-rate schemes. As seen in Table 7, this sub-hypothesis was supported ($t = 1.92$, $p = 0.059$). The interpretation is that subjects will more closely follow the instructions to learn a specific way to unscramble the letter order in a pattern to form an English word in multiple-winner schemes than in piece-rate schemes. This result is consistent with tournament theory, which suggests that tournament schemes motivate learning effort to improve performance.

H4e predicted that effort direction is higher in winner-takes-all schemes than in piece-rate schemes. As seen in Table 7, panel A, this sub-hypothesis was not supported ($t = 0.21$, $p = 0.837$). The interpretation is that subjects will not spend more fixation time on patterns in winner-takes-all schemes than in piece-rate schemes. It might be that due to the low probability of winning, winner-takes-all schemes fail to motivate employees to spend fixation time on patterns.

H4f predicted that effort toward problem-solving is higher in winner-takes-all schemes than in piece-rate schemes. As seen in Table 7, panel B, this sub-hypothesis was not supported (t = 0.18, p = 0.861). The interpretation is that subjects will not more closely follow the instructions to learn a specific way to unscramble the letter order in winner-takes-all schemes than in piece-rate schemes. It might be that due to the low probability of winning, winner-takes-all schemes fail to motivate employees to exert effort toward problem-solving.

H5 mainly concerned the mediating effect of learning transfer in the relationship between learning effort and performance. For dimensions of learning transfer, I used probability of retrieval (the number of correct button clicks) and time taken to retrieve (the time that elapses between when the first half of a pattern reappears and when participants correctly click the button), and for performance, the number of correct translations in Stage 2 as compared to that in Stage 1.

H5a predicted that the link between effort direction and job performance is mediated by the probability of retrieval. As seen in Table 8, panel A, and Table 9, Panel B, this sub-hypothesis was partially supported; the probability of retrieval and effort direction are correlated (r = 0.205; p = 0.057). Table 9, panel B, reports the result of the multi-variate regression, showing a significant coefficient of effort direction (t = 2.93, p = 0.004), and a significant coefficient of the probability of retrieval (t = 4.53, p < 0.001) in the full model using performance as the dependent variable. That is, the probability of retrieval partially mediates the relationship between effort direction and performance. The interpretation is that when subjects spend more fixation time on patterns, they can recognize more of these patterns in the job task, and also that when subjects apply more of their learned skill to the job task, they can improve their performance.

H5b predicted that the link between effort direction and job performance is mediated by the time taken to retrieve learned skills. As seen in Table 8, panel A, and Table 9, Panel C, this sub-hypothesis was partially supported; the time taken to retrieve and effort direction are correlated (r = -0.192; p = 0.074). Table 9, panel C, reports the result of the multi-variate regression, showing a significant coefficient of effort direction (t = 3.02, p = 0.003), and a significant coefficient of the time taken to retrieve (t = 3.79, p <

0.001) in the full model using performance as the dependent variable. That is, the time taken to retrieve partially mediates the relationship between effort direction and performance. The interpretation is that when subjects spend more fixation time on patterns, they can recognize these patterns more quickly in the job task, and also that when subjects apply their learned skill to their job task quickly, they can improve their performance.

H5c predicted that the link between effort toward problem-solving and job performance is mediated by the probability of retrieval. As seen in Table 8, panel A, this sub-hypothesis was not supported, because the Pearson correlation between the probability of retrieval and effort toward problem-solving is non-significant ($r = 0.072$; $p = 0.505$). It might be that subjects follow the instructions to learn a specific way to unscramble letter order in a pattern to form an English word, but do not spend enough fixation time on patterns, meaning that their memory of those patterns is not adequate to recognize many patterns in the job task. Thus, they do not apply their learned skills properly to the job task, and cannot improve performance.

H5d predicted that the link between effort toward problem-solving and job performance is mediated by the time taken to retrieve learned skills. As seen in Table 8, panel A, this sub-hypothesis was not supported, because the Pearson correlation between the time to retrieve and effort toward problem-solving is non-significant ($r = -0.097$; $p = 0.37$). It might be that subjects follow the instructions to learn a specific way to unscramble letter order, but do not spend sufficient fixation time to enhance their memory of these patterns, as outlined above. Therefore , they do not recognize patterns quickly in the job task, cannot apply their learned skills, and do not improve performance.

H6 mainly concerned the moderating effect of providing relative performance feedback on the relationship between incentives and learning effort. I used relative performance feedback (performance ranking percentile), effort direction (fixation time on patterns), and effort toward problem-solving (number of leftward saccades on patterns).

H6a predicted that providing relative performance feedback increases effort direction more in multiple-winner schemes than in winner-takes-all schemes. As seen in

Table 12, panel A, this sub-hypothesis was not supported (t = 0.94, p = 0.338). This may be because subjects anticipated the content (favourable or unfavourable) of the feedback, and therefore, it might not be possible for relative performance feedback to motivate more effort direction in multiple-winner schemes than in winner-takes-all schemes.

H6b predicted that providing relative performance feedback increases effort toward problem-solving more in multiple-winner schemes than in winner-takes-all schemes. As seen in Table 12, panel B, this sub-hypothesis was not supported (t = 0.96, p = 0.332) perhaps by the same logic as in H6a, where we saw that subjects anticipating the content of the feedback might prevent relative performance feedback from motivating more effort toward problem-solving in multiple-winner schemes than in winner-takes-all schemes.

H6c predicted that providing relative performance feedback increases effort direction more in multiple-winner schemes than in piece-rate schemes. As seen in Table 12, panel C, this sub-hypothesis was not supported (t = 0.18, p = 0.671) again perhaps because subjects may have anticipated the content (i.e., favourable or unfavourable) of relative performance feedback.

H6d predicted that providing relative performance feedback increases effort toward problem-solving more in multiple-winner schemes than in piece-rate schemes. As seen in Table 12, panel D, this sub-hypothesis was not supported (t = 0.06, p = 0.801). By the same logic as in H6c, it might not be possible for relative performance feedback to motivate more effort toward problem-solving in multiple-winner schemes than in piece-rate schemes.

H6e predicted that providing relative performance feedback increases effort direction more in winner-takes-all schemes than in piece-rate schemes. As seen in Table 12, panel E, this sub-hypothesis was not supported (t = 2.01, p = 0.162). this may again be because subjects anticipated the content of relative performance feedback.

H6f predicted that providing relative performance feedback increases effort toward problem-solving more in winner-takes-all schemes than in piece-rate schemes.

As seen in Table 12, panel F, this sub-hypothesis was not supported (t = 1.5, p = 0.226). By the same logic as in H6e, relative performance feedback might not more effort toward problem-solving in winner-takes-all schemes than in piece-rate schemes.

Overall, for the first stage, H1 mainly concerned the relationship between incentives and task effort. I found support for 4 out of 6 sub-hypotheses at the 5 percent level (as in Table 4). H2 mainly concerned the relationship between effort and performance. I found support for 1 out of 2 sub-hypotheses at the 5 percent level (as in Table 5). H3 mainly concerned the moderating effect of providing relative performance feedback on the relationship between incentives and effort. I found no support for any of 6 sub-hypotheses at the 10 percent level (as in Table 6).

For the second stage, H4 mainly concerned the relationship between incentives and learning effort. I found support for 4 out of 6 sub-hypotheses at the 10 percent level (as in Table 7). H5 mainly concerned the mediating effect of learning transfer in the relationship between learning effort and performance. I found support for 2 out of 4 sub-hypotheses at the 1 percent level (as in Table 9). H6 mainly concerned the moderating effect of providing relative performance feedback on the relationship between incentives and learning effort. I found no support for any of 6 sub-hypotheses at the 10 percent level (as in Table 12).

Chapter 6.

Conclusions

6.1. Summary

Corporations provide learning opportunities to employees in order to enhance their productivity and to increase the firm's value. Sprinkle (2003) suggests that when workers apply their skills to their job tasks, firm value increases. Corporations and other organizations spend billions of dollars on instructional programs in the hope that employees will apply their learned skills to their job tasks to improve their performance. The more and the faster employees apply their learned skills to their job tasks, the more the firm will benefit; however, studies show that in practice only 5 percent of learning is actually transferred to the job for the organization's benefit (Georgenson 1982; Salas and Stagl, 2009; Swanson 2001). In light of this, any percentage change in learning transfer has billion-dollar implications for business. How can organizations motivate employees to exert learning effort for relevant skill acquisition and to apply their learned skills to their job tasks? I used a 3 by 2 matrix model to address this question by providing evidence regarding the effect of tournament schemes on learning, and also the effect of learning on performance.

To assess the effect of learning on performance, I used a two-stage experiment. I used the first stage to investigate the effect of tournament incentives on task effort and performance, and also the moderating role of relative performance feedback on the relationship between incentives and effort. I use the second stage to investigate the effect of incentives on learning effort, and also the mediating effect of learning transfer in the relationship between learning effort and performance. In addition, I investigate the moderating role of relative performance feedback on the relationship between incentives and learning effort.

The first stage of the experiment showed that the probability of winning in a tournament scheme influences employees' task effort. That is, effort intensity is higher in multiple-winner schemes than in winner-takes-all schemes. I also found that greater effort intensity leads to improved performance, based on the finding that when subjects are more focused on a symbol-matching task, they can achieve more correct translations. Moreover, I did not find that relative performance feedback had a moderating effect on the relationship between incentives and effort, nor did I find a significant difference in effort intensity between winner-takes-all schemes and piece-rate schemes.

The second stage of the experiment showed that the probability of winning in a tournament scheme influences employees' learning effort (as well as task effort). Effort direction, as measured by fixation time on patterns, is higher in multiple-winner schemes than in winner-takes-all schemes. I also found that two dimensions of learning transfer partially mediate the relationship between effort direction and performance. The interpretation is that if subjects spend more fixation time on patterns, they can improve their memory of those patterns, which enables them to apply their learned skills to their job task more frequently and quickly and thus to achieve higher performance. Finally, I do not find that relative performance feedback has a moderating effect on the relationship between incentives and learning effort, and did not find any significant difference in effort direction between winner-takes-all schemes and piece-rate schemes.

Overall, this thesis makes two contributions to the accounting literature.

First, tournament theory proposes that the ideal compensation should be based on effort. In this sense, direct measurement of effort is important in the tournament model (Lazear and Rosen 1981). Performance is an imperfect measure of effort (Irlenbusch 2006; Douthit et al. 2012), and to design better compensation schemes, it is important to understand the relationship between effort and performance. Effort has several measures, and each measure can have a different impact on performance.

This thesis provides evidence for the relationship between effort and performance. This relationship has been assumed in the literature, but had not yet been verified empirically. Prior research suggests that it is difficult to observe effort, and that

there are costs associated with measurement of it (Church et al. 2008; Newman and Tafkov 2011; Bonner 2008). This study's novel methodology using an eye-tracker measures pupil dilation, which reflects the intensity of effort. This addresses suggestions and concerns in previous studies, such as Mauldin (2003), who points out the need for direct measurement of effort intensity using pupil dilation, and Towry (2003), who suggests that effort intensity is less easily observable and that this offers an opportunity for future research. The conventional measure of effort in prior research is effort duration (Mauldin 2003). This thesis also employs effort intensity, and, by benchmarking with effort duration, shows that the usefulness of effort intensity in verifying the relationship between task effort and performance (Mauldin 2003; Church et al. 2008; Newman and Tafkov 2011; Bonner 2008). This thesis shows that effort intensity has a stronger impact on performance than effort duration, which constitutes a methodological contribution to the literature on the direct measurement of effort.

Second, Bonner and Sprinkle (2002) suggest that prior studies had failed discern the effect of learning on performance because they had not used the right (training) task for subjects to acquire (i.e., learn) skills, or provided evidence that training actually enhanced skill. If the right training task were employed argue, learning should improve performance (Bonner and Sprinkle 2002). This lack of empirical research meant that we could not be sure whether learning improves performance. In light of this, I designed a learning task that involves learning problem-solving skills. This learning task is an anagram-solving task. I then measured whether subjects can apply learned skills to a job task to improve performance, by measuring the number of times subjects applied a learned skill to the job task and how fast they applied it. I measured two dimensions of learning transfer to a job task: probability of retrieval and time taken to retrieve learned skills. I found that both are significantly correlated with performance. This shows that individuals can apply learned skills to their job tasks to improve performance. Moreover, I tested a 2 x 2 relationship matrix between two dimensions of learning transfer and two dimensions of learning effort, and showed relationships between each dimension of learning effort and learning transfer. This provides insights into how learned skills can be better transferred to a job task, and contributes to the literature regarding the effect of learning on performance.

Bonner and Sprinkle (2002) suggest that further studies should investigate how incentives and learning can combine to affect performance. In particular, the existing literature provides a limited understanding of the relationship between tournament schemes and learning effort. In light of this, I investigated the relationship between tournament schemes and learning (in the tournament framework). Tournament theory suggests that proper tournament schemes can motivate subjects to exert more learning effort to improve performance. I used two tournament schemes: multiple-winner and winner-takes-all. I showed that multiple-winner schemes can motivate subjects to exert more learning effort than winner-takes-all schemes, and that increased learning effort, measured by effort direction, leads to performance improvement. This means incentives and learning can combine to improve performance. Bailey and Fessler (2011) and Bailey et al. (1998) suggest that further studies should provide a learning opportunity for subjects to acquire skills and be able to use such skills to improve on their initial performance. This thesis thus addresses concerns in Bonner and Sprinkle (2002), Bailey and Fessler (2011), and Bailey et al. (1998) and contributes to the literature.

This thesis has practical implications for corporate management. Studies show that firms are constantly re-evaluating tournament schemes in order to find ways to better motivate employees to improve performance. This thesis provides insights on the effect of tournament schemes on performance inputs (task effort and learning effort), which will benefit these organizations. Management accounting studies on incentive compensation and reporting systems would also benefit from this thesis. For instance, Hannan et al. (2008) suggest that constant re-evaluation of the effectiveness of incentive and feedback systems is desirable. In short, this thesis finds that multiple-winner schemes motivate employees to exert more effort on job tasks and more learning effort for relevant skill acquisition than winner-takes-all schemes do, and that increased learning effort enables employees to apply their learned skills to their job tasks more frequently and quickly. This results in improved performance.

A limitation of this research is that I only use two levels of probability of winning in the design of tournament schemes: 10 percent and 50 percent. One might suggest that a probability of winning other than 10 percent or 50 percent could be investigated to see whether the same results would hold. Or, further studies may use a different task, such

as puzzle-solving task, that is not a routine production task. Bailey and Fessler (2011) note that puzzle-solving tasks are more complex than routine production tasks. It may be worth researching and contrasting the effect of learning on performance with different kinds of tasks.

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Appendix A.

Figures

Figure 1: Framework
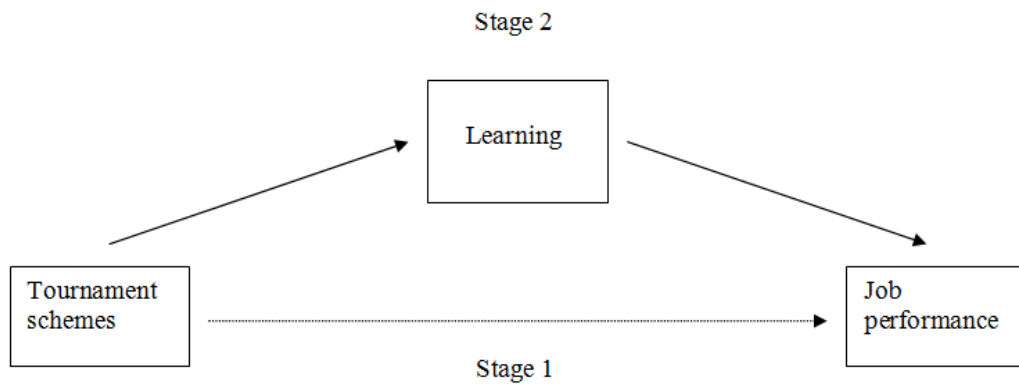
Stage one:
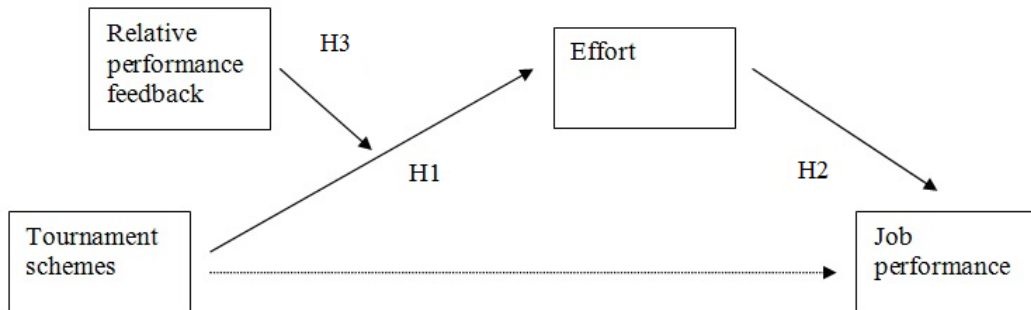
Stage two:
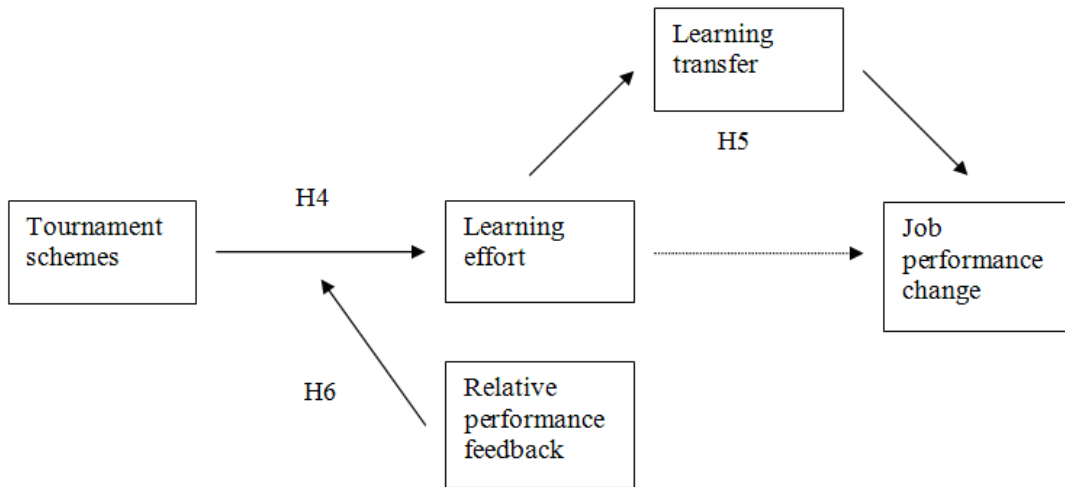
Figure 2: 3 by 2 matrix

Incentive schemes without relative performance feedback	Incentive schemes with relative performance feedback (RPF)
Piece-rate scheme	Piece-rate scheme with RPF
Multiple-winner tournament scheme	Multiple-winner tournament scheme with RPF
Winner-takes-all tournament scheme	Winner-takes-all tournament scheme with RPF

Figure 3: The experimental structure

Figure 4: Paper-based translation task used in Church et al. (2008)

Figure 5: Instrument I: practice session

Figure 6: Instrument I: practice session summary page

Figure 7: Instrument I: last practice session summary page

Figure 8: Instrument I: the symbol-matching area for measuring task effort with an eye-tracker

Figure 9: Instrument I: the first work session (and also the pre-learning session)

Figure 10: Instrument I: the first work session (and also the pre-learning session) with relative performance feedback

Figure 11: Instrument I: the first work session (and also the pre-learning session) summary page
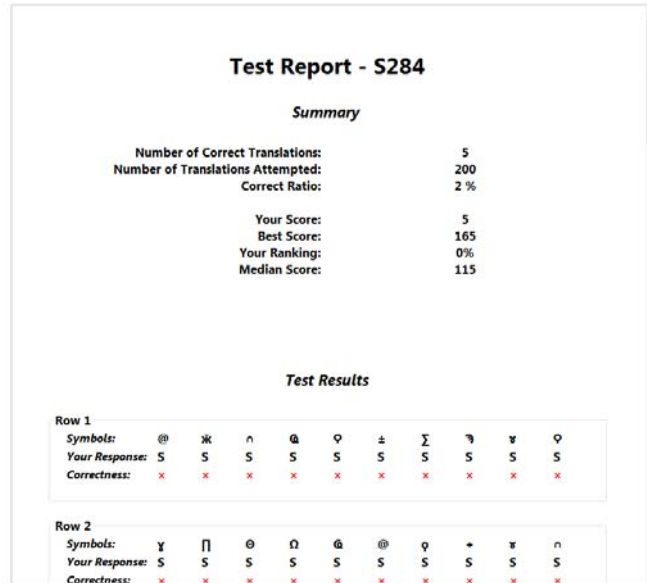
Figure 12: Patterns and English word solutions used in Hannan et al. (2012)

4 LETTERS		6 LETTERS		8 LETTERS	
DUCK	UDKC	ADVICE	DAIVEC	TRAVELER	RTVALERE
CART	ACRT	COUPLE	OCPUEL	QUESTION	UQSEITNO
BUMP	UBPM	PENCIL	EPCNLI	PAINTING	APNIITGN

Figure 13: Instrument II: learning session (4-letter)

Figure 14: Instrument II: learning session (6-letter)

4 Letters	6 Letters	8 Letters
View	View	View

DAIVEC	
OCPUEL	
EPCNLI	

04:24

143

Figure 15: Instrument II: learning session (8-letter)

4 Letters	6 Letters	8 Letters
View	View	View

RTVALERE

UQSEITNO

APNIITGN

03:36

Figure 16: Instrument II: an area for measuring learning effort with an eye-tracker

4 Letters	6 Letters	8 Letters
View	View	View

DAIVEC   ADVICE

OCPUEL   COUPLE

EPCNLI   PENCIL
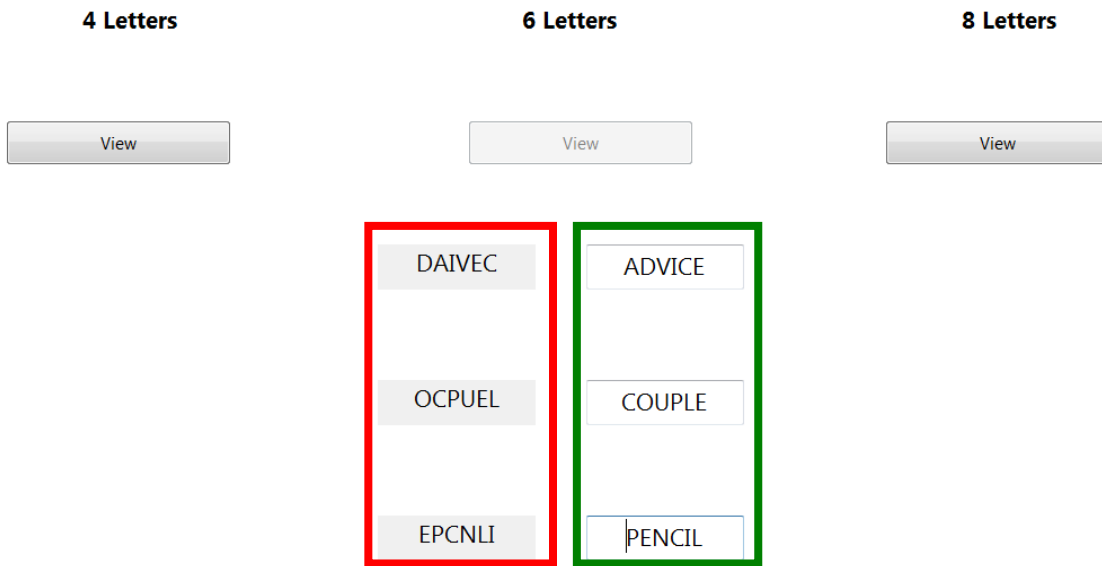
Figure 17: Instrument III: practice learning transfer session (and also the post-learning session)

Row 1 :   [|] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

Total time remaining: **04:44**   [FOUND]   [Next]

Figure 18: Instrument III: an area for measuring learning transfer with a computer-based program

Row 1: C U B [ ] [ ] [ ] [ ] [ ] [ ]

Total time remaining: FOUND   Next

Row 1: C U B P M [ ] [ ] [ ] [ ] [ ]

Total time remaining: FOUND   Next

Figure 19: Instrument IV: the second work session (and also the post-learning session)

Figure 20: Instrument IV: the second work session (and also the post-learning session) with relative performance feedback

Figure 21: Instrument IV: the second work session (and also the post-learning session) summary page

Test Report - S287

Summary

Number of Correct Translations:	34
Number of Translations Attempted:	200
Correct Ratio:	17 %
Your Score:	34
Best Score:	185
Your Ranking:	0%
Median Score:	135

Test Results

Row 1

Symbols:	@	ж	∩	Ⓐ	♀	±	Σ	Ϡ	୪	♀
Your Response:	S	S	S	S	S	S	S	S	S	S
Correctness:	×	×	×	×	×	×	×	×	×	×

Row 2

Symbols:	ɣ	Π	Θ	Ω	Ⓐ	@	ọ	+	୪	∩
Your Response:	K	R	F	E	P	C	N	L	I	B
Correctness:	√	√	√	√	√	√	√	√	√	√
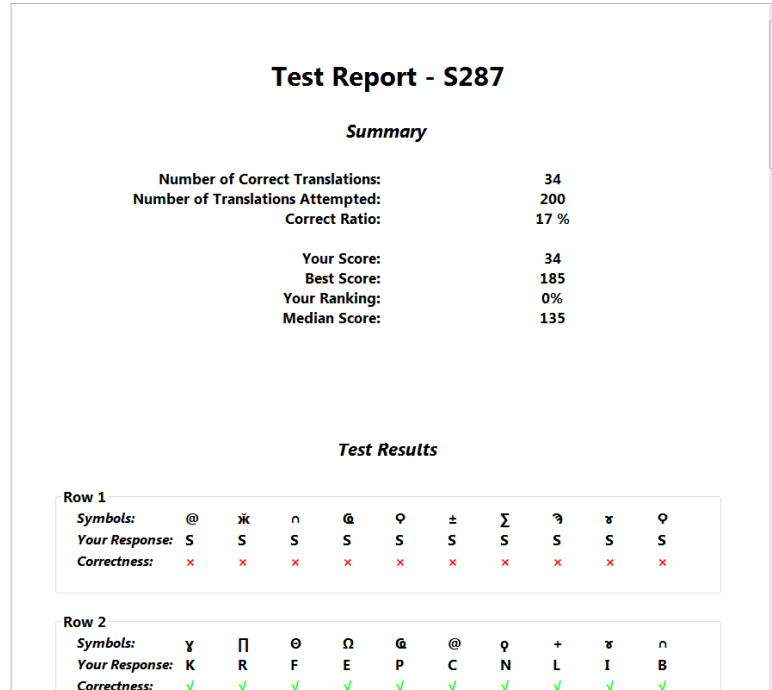
Figure 22: Instrument IV: an area for measuring learning transfer with a computer-based program

Figure 23: Instrument IV: a distribution of nine patterns in each of twenty customer order rows (the patterns are highlighted in yellow)

Row number	1	2	3	4	5	6	7	8	9	10
1	C	U	B	P	M	A	D	G	I	M
2	K	R	F	E	P	C	N	L	I	B
3	K	A	P	N	I	I	T	G	N	I
4	Z	U	A	C	R	T	P	K	B	L
5	X	T	O	C	P	U	E	L	S	O
6	N	Q	U	Q	S	E	I	T	N	O
7	U	D	K	C	E	J	H	L	V	Y
8	E	S	U	R	D	A	I	V	E	C
9	R	T	V	A	L	E	R	E	N	Q
10	O	F	U	B	P	M	W	Y	M	D
11	T	X	E	P	C	N	L	I	Z	P
12	G	J	A	P	N	I	I	T	G	N
13	A	C	R	T	V	C	A	H	A	M
14	O	D	L	F	O	C	P	U	E	L
15	U	Q	S	E	I	T	N	O	S	Q
16	P	W	U	D	K	C	U	X	Y	H
17	C	K	D	A	I	V	E	C	R	T
18	B	N	R	T	V	A	L	E	R	E
19	U	B	P	M	G	V	I	Z	J	E
20	L	V	E	P	C	N	L	I	E	J

Figure 24: Effort intensity over three levels of incentives in Stage 1
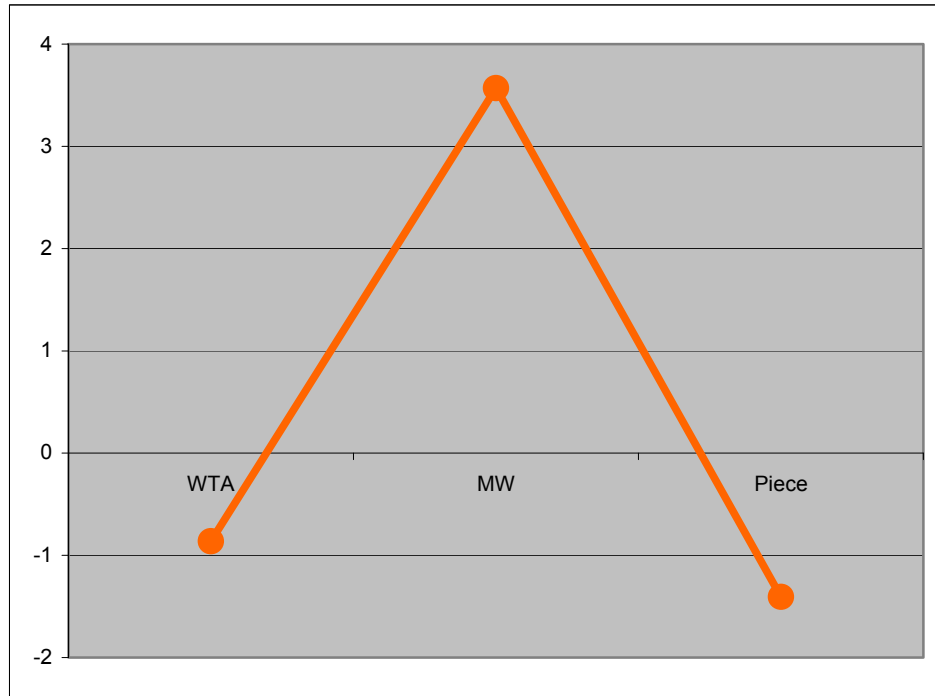
Figure 25: Effort duration over three levels of incentives in Stage 1

153
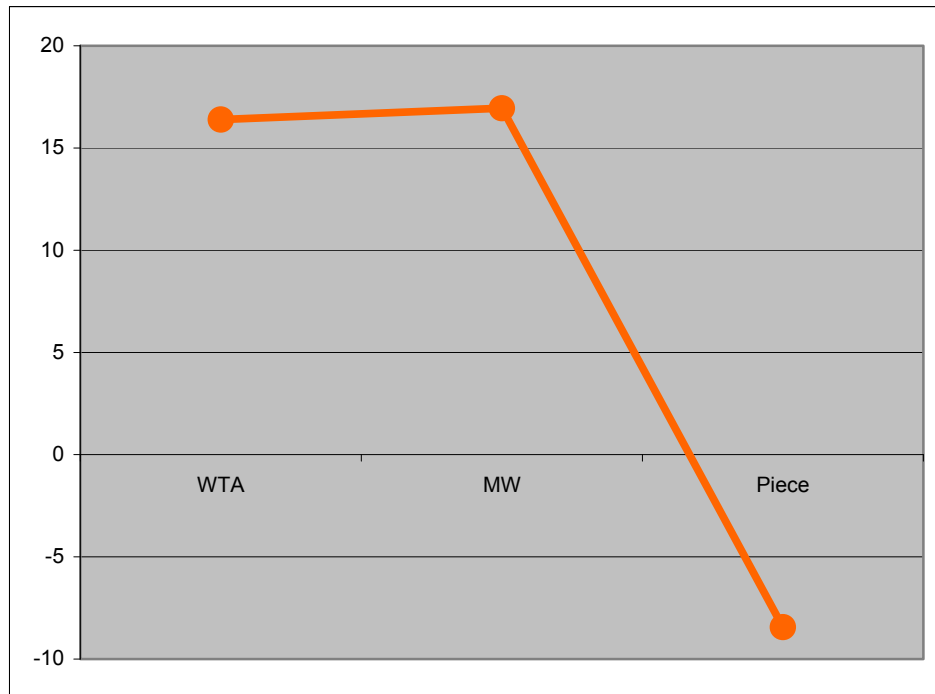
Figure 26: Effort direction over three levels of incentives in Stage 2
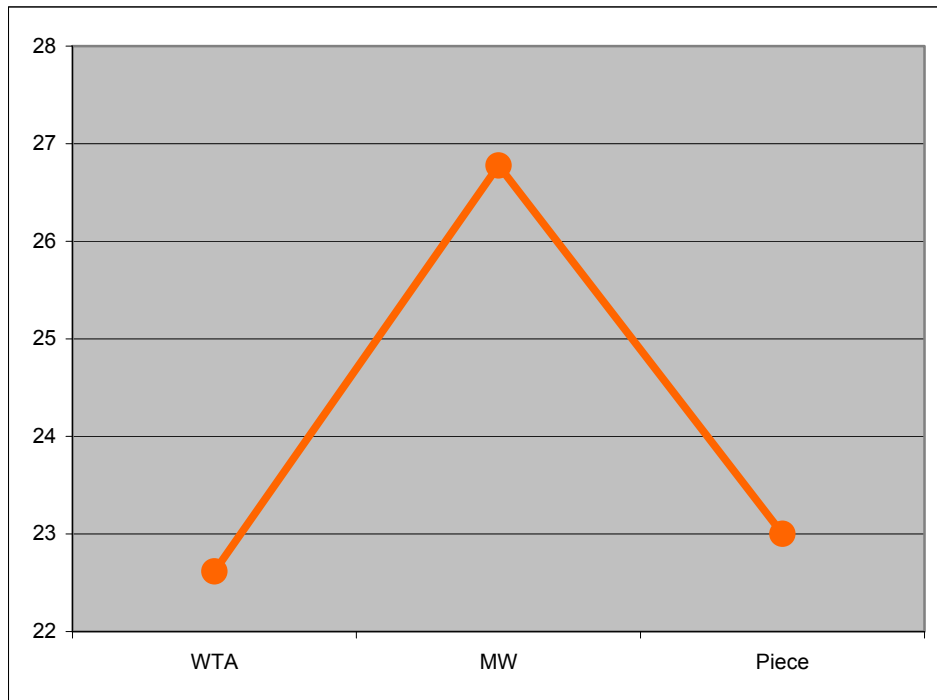
Figure 27: Effort toward problem-solving over three levels of incentives in Stage 2
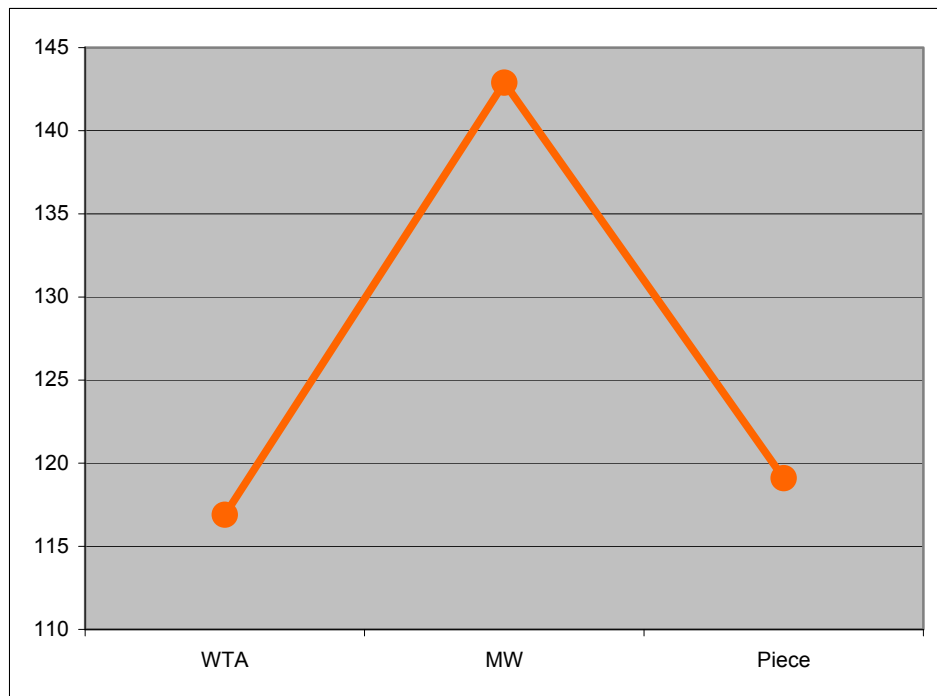
Figure 28: The probability of retrieval over three levels of incentives in Stage 2
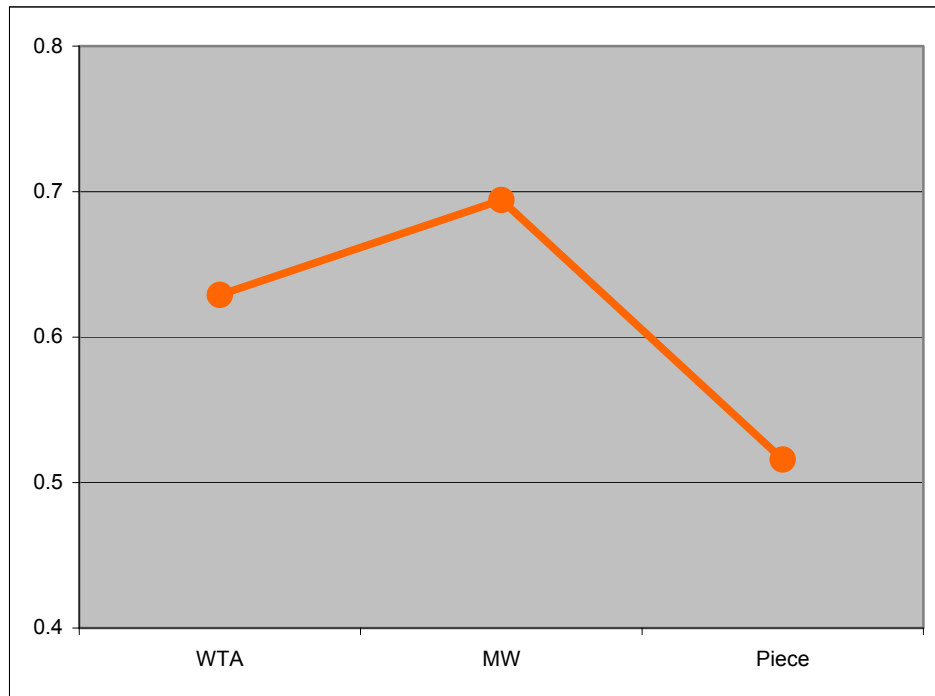
Figure 29: The time taken to retrieve over three levels of incentives in Stage 2
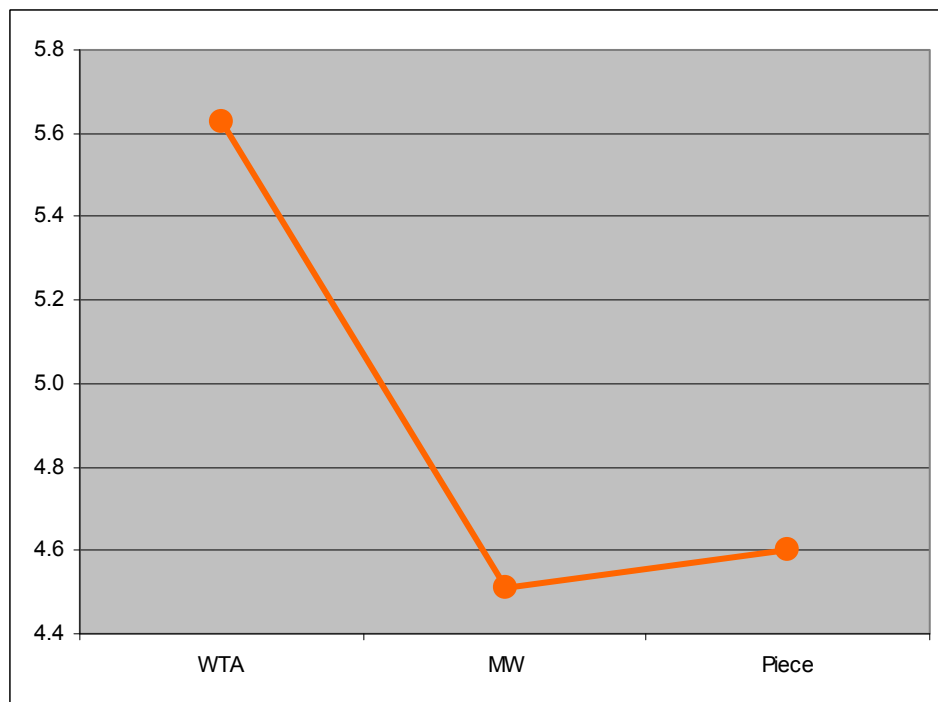
Figure 30: Contribution of learning transfer to performance over three levels of incentives in Stage 2
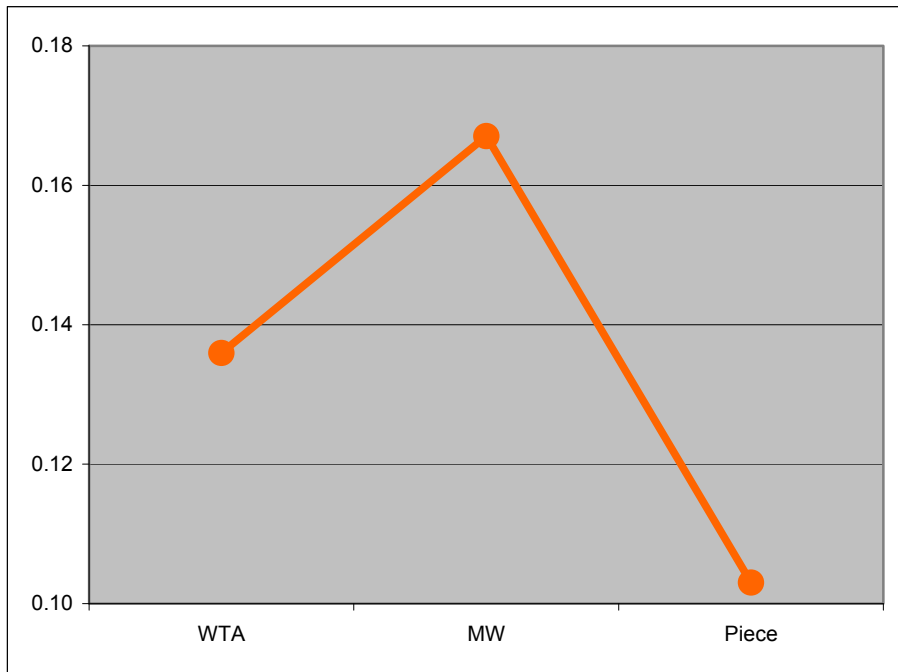
Figure 31: Performance over three levels of incentives in Stage 1
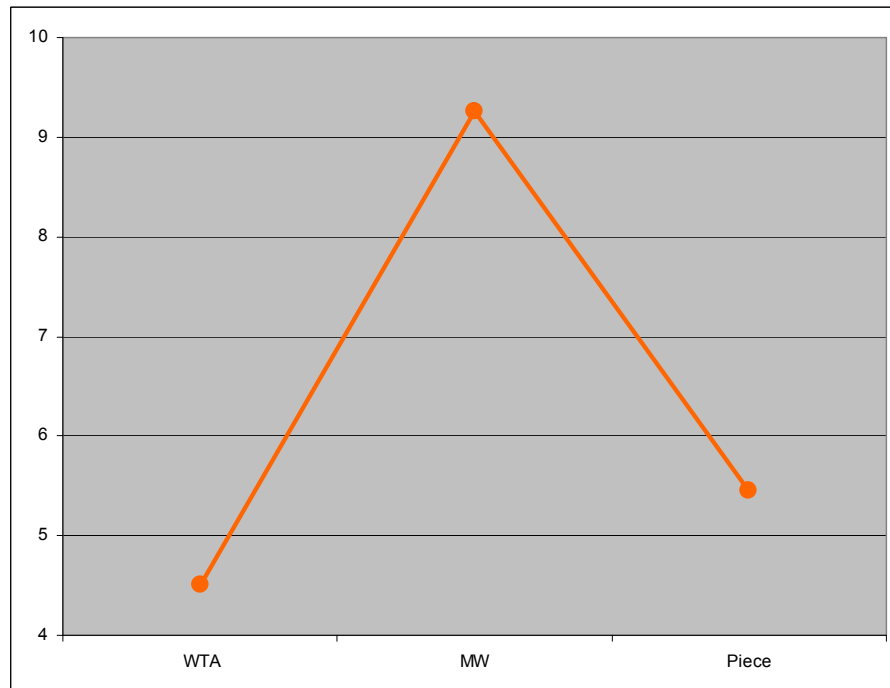
Figure 32: Performance over three levels of incentives in Stage 2
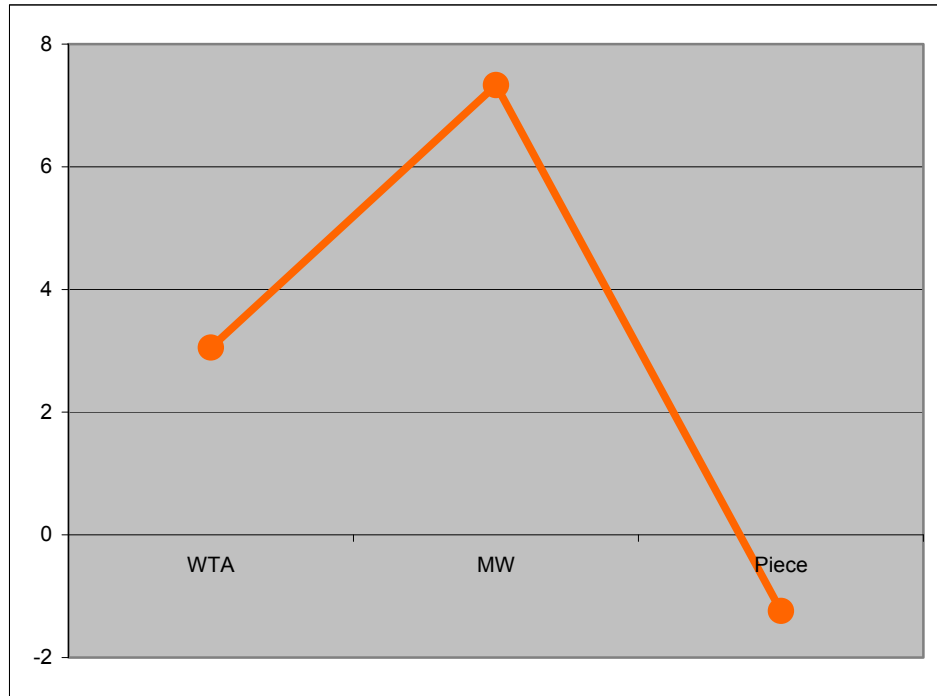
Appendix B.

Videos

Video 1: A real participant's translating behaviour in the first work session (task effort: time spent on the task and average pupil size change)

etd9345-video-1-real-participant's-translating-behaviour-first-work-session-task-effort-time-spent-task-and-.mp4

Video 2: A real participant's learning behaviour in the learning session (learning effort: leftward eye saccades and the time spent proportionately on patterns)

etd9345-video-2-real-participant's-learning-behaviour-learning-session-learning-effort-leftward-eye-saccades.mp4

Video 3: A real participant's practice behaviour in applying/transferring learning (learning transfer: whether the button is clicked and how soon the button is clicked)

etd9345-video-3-real-participant's-practice-behaviour-applyingtransferring-learning-learning-transfer-whethe.mp4

Video 4: A real participant's behaviour in applying/transferring learning in the second work session (learning transfer: whether the button is clicked and how soon the button is clicked)

etd9345-video-4-real-participant's-behaviour-applyingtransferring-learning-second-work-session-learning-tran.mp4

Video 5: A quick run through the experimental procedure (muted)

etd9345-video-5-quick-run-through-experimental-procedure-muted.mp4

Appendix C.

Tables

Table 1: Measurements of effort and learning transfer

Panel A: measurements of task effort and learning effort in Stage 1 and Stage 2

	Last practice session	The first work session	Learning session	The second work session
Effort expended on the task	Pupil size change on a symbol-matching area	Pupil size change on a symbol-matching area		
Effort expended on the task	Time duration on a symbol-matching area	Time duration on a symbol-matching area		
Effort direction (for benchmarking with Libby and Lipe's (1982) encoding effort)			Time duration[35] when the participants exhibit leftward eye movements on patterns	

[35] Liu et al. (2012) suggest that "increasing practice time increases the skill level" (p. 41).

Effort toward problem-solving			The number of leftward saccades on patterns	

	Last practice session	Pre-learning session	Learning session	Post-learning session
Learning transfer (the probability of retrieval)				The number of patterns correctly identified with a button click, relative to the number of patterns available
Learning transfer (the time taken to retrieve)				The length of time that elapses between when the first half of the pattern reappears, and when the participants

				click the button correctly

Panel C: three levels of incentive plans for measurements of task effort and learning effort

Three levels of incentive plans	Incentive plans (without relative performance feedback)	Incentive plans (with relative performance feedback)
Multiple-winner incentive groups (G1 & G3)	Multiple-winner scheme (G1)	Multiple-winner scheme with relative performance feedback (G3)
Winner-takes-all incentive groups (G2 & G4)	Winner-takes-all scheme (G2)	Winner-takes-all scheme with relative performance feedback (G4)
Piece-rate incentive groups (G5 & G6)	Piece-rate scheme (G5)	Piece-rate scheme with relative performance feedback (G6)

Table 2: Descriptive Statistics of variables

Panel A: descriptive statistics of key variables in each group: G1, G2, G3, G4, G5, and G6

Descriptive Statistics

Variable	MW G1	WTA G2	MW wF G3	WTA wF G4	Piece G5	Piece wF G6
Effort Measures						
1) Effort Intensity (%)	1.15	0.29	4.53	-3.33	-1.43	-3.22
2) Effort Duration (%)	12.81	9.47	21.08	23.30	-13.07	-3.80
Stage 1: Performance (%)	9.87	4.96	8.64	4.04	8.66	2.26
Learning Effort measures						
1) Effort Direction: fixation time on patterns	26.86	20.84	26.70	24.39	23.85	22.16
2) Effort Toward Problem-Solving	147.07	108.40	138.73	125.33	126.47	111.80
Learning Transfer						
1) Probability of Retrieval (%)	66.09	62.01	72.74	63.72	52.50	50.67
2) Time Taken to Retrieve	4.72	6.84	4.30	4.49	4.68	4.53
Stage 2: Performance (%)	5.84	-0.53	8.82	6.64	-2.32	-0.16
Contribution of learning transfer to Stage 2 performance (%)	15.52	12.73	17.90	14.46	10.74	9.86
Stage 2 performance / Last practice (%)	16.00	4.41	17.91	10.70	6.28	1.86

Number of participants = 90

Panel B: descriptive statistics of key variables

Variable	Mean	Median	Std. Dev.	Minimum	Maximum
Effort Measures					
1) Effort Intensity (%)	8.30	-0.13	41.43	-53.72	240.74
2) Effort Duration (%)	0.43	0.37	6.33	-12.24	24.42
Stage 1: Performance (%)	6.40	5.42	10.85	-16.13	38.36
Learning Effort measures					
1) Effort Direction: fixation time on patterns	24.13	24.94	7.31	9.35	40.28
2) Effort Toward Problem-Solving	126.30	120.50	49.94	27.00	246.00
Learning Transfer					
1) Probability of Retrieval (%)	61.50	66.67	17.82	18.18	90.91
2) Time Taken to Retrieve	4.91	4.08	3.03	0.99	20.41
Stage 2: Performance (%)	3.05	3.08	11.23	-25.00	32.53
Contribution of learning transfer to Stage 2 performance (%)	13.53	14.07	5.77	0.00	26.36
Stage 2 performance / Last practice (%)	9.53	9.05	15.45	-22.06	46.67

Number of participants = 90

Panel C: key variables for each condition groups in Stage 1

Effort intensity

	Mean	Median	STD	Min	Max	N
G1	2.54	3.76	4.62	-5.46	11.71	15
G2	0.56	-1.68	7.78	-8.33	17.53	15
G3	4.60	2.41	7.19	-2.85	24.42	15
G4	-2.28	-1.30	5.87	-11.33	7.25	15
G5	-0.93	-0.54	5.26	-12.24	9.01	15
G6	-1.88	-1.32	4.49	-9.47	8.11	15

Effort duration

G1	12.81	14.87	25.69	-36.27	77.47	15
G2	9.47	2.12	32.25	-35.41	94.49	15
G3	21.08	0.75	69.80	-42.88	240.74	15
G4	23.30	9.08	48.15	-30.80	149.02	15
G5	-13.07	-4.74	16.34	-53.72	5.21	15
G6	-3.80	-5.80	25.86	-42.80	73.20	15

Stage 1: Performance

G1	9.87	9.21	10.82	-4.00	38.36	15
G2	4.96	0.00	13.94	-11.11	36.67	15
G3	8.64	5.45	10.19	-7.08	27.14	15
G4	4.04	1.49	8.99	-14.89	18.18	15
G5	8.66	12.50	10.11	-13.58	21.13	15
G6	2.26	3.30	10.02	-16.13	21.51	15

Panel D: key variables for each condition groups in Stage 2

Effort Direction: fixation time on patterns

	Mean	Median	STD	Min	Max	N
G1	26.86	29.67	6.34	14.49	33.87	15
G2	20.84	21.96	6.37	10.37	27.25	15
G3	26.70	26.91	7.98	13.23	40.28	15
G4	24.39	23.85	8.69	9.89	39.73	15
G5	23.85	24.45	5.73	13.41	33.79	15
G6	22.16	22.45	7.48	9.35	34.52	15

Effort Toward Problem-Solving

	Mean	Median	STD	Min	Max	N
G1	147.07	148.00	43.62	60.00	210.00	15
G2	108.40	108.00	46.43	48.00	196.00	15
G3	138.73	156.00	52.64	69.00	208.00	15
G4	125.33	133.00	56.31	27.00	246.00	15
G5	126.47	128.00	47.20	37.00	212.00	15
G6	111.80	111.00	49.29	52.00	221.00	15

Probability of retrieval

	Mean	Median	STD	Min	Max	N
G1	0.66	0.67	0.15	0.40	0.91	15
G2	0.62	0.60	0.16	0.33	0.86	14
G3	0.73	0.73	0.13	0.50	0.91	15
G4	0.64	0.67	0.15	0.33	0.85	15
G5	0.52	0.51	0.17	0.29	0.75	14
G6	0.51	0.48	0.22	0.18	0.82	14

Time taken to retrieve

	Mean	Median	STD	Min	Max	N
G1	4.72	4.17	2.58	2.48	12.06	15
G2	6.84	5.30	5.36	1.54	20.41	14
G3	4.30	3.36	2.50	0.99	8.58	15
G4	4.49	3.68	2.37	2.69	10.51	15
G5	4.68	4.32	1.96	1.39	8.54	14
G6	4.53	4.49	1.83	2.05	7.64	14

Stage 2: Performance

	Mean	Median	STD	Min	Max	N
G1	5.84	5.88	7.01	-9.90	19.15	15
G2	-0.53	-1.10	11.27	-25.00	17.48	15
G3	8.82	7.87	10.78	-10.00	32.53	15
G4	6.64	2.83	12.98	-8.70	32.53	15
G5	-2.32	-4.21	12.46	-23.94	18.64	15
G6	-0.16	-3.57	8.45	-14.73	12.36	15

Contribution of learning transfer
to Stage 2 performance

	Mean	Median	STD	Min	Max	N
G1	0.16	0.16	0.05	0.10	0.26	15
G2	0.13	0.14	0.06	0.00	0.21	15
G3	0.18	0.18	0.05	0.11	0.26	15
G4	0.14	0.14	0.04	0.07	0.23	15
G5	0.11	0.12	0.05	0.00	0.17	15
G6	0.10	0.09	0.06	0.00	0.22	15

Table 3: The ANOVA test for key variables in Stage 1 and Stage 2

Panel A: the ANOVA test for the difference in effort intensity in 3 levels of incentives and 2 levels of feedback in Stage 1[36]

Source	DF	SS	Mean Squre	F value	Pr>F
Model	5	546	109	3.04	0.0144
Error	84	3021	36		
Corrected	89	3568			

R-square	Coeff. Var	Root MSE	DV mean
0.15	1383	6	0.43

Source	DF	Anova SS	Mean Square	F value	Pr >F
Incentives	2	447	223	6.21	0.0030
Feedback	1	7	7	0.21	0.6502
Feedback*Incentives	2	92	46	1.28	0.2842

Panel B: the ANOVA test for the difference in effort intensity in 3 levels of incentives and 2 levels of feedback in Stage 1 (with Gender)[37]

Source	DF	SS	Mean Squre	F value	Pr>F
Model	6	613	102	2.87	0.0137
Error	83	2955	36		
Corrected	89	3568			

R-square	Coeff. Var	Root MSE	DV mean
0.17	1375	6	0.43

Source	DF	Anova SS	Mean Square	F value	Pr >F
Incentives	2	447	223	6.28	0.0029
Feedback	1	7	7	0.21	0.6485
Feedback*Incentives	2	92	46	1.29	0.2806
Gender	1	66	66	1.86	0.1759

[36] Statistical power equals 0.9623380 (assuming: medium effect size, f = 0.5; alpha = 0.05, and n = 90; number of groups = 6; numerator d.f. = 5; using G*Power 3 software for post hoc power analysis) (Faul et al. 2009). This means the likelihood of rejecting the null hypotheses when it is incorrect is 96 percent.

[37] Gender is a dummy variable: 1 for female and 0 for male. In lieu of Gender, I do not find a significant coefficient, at the 10 percent level, for any of MBA student status (t = 0.25, p = 0.6204) and work experience (t = 1.47, p = 0.1137).

Panel C: the ANOVA test for the difference in effort duration in 3 levels of incentives and 2 levels of feedback in Stage 1

Source	DF	SS	Mean Squre	F value	Pr>F
Model	5	15194	3039	1.86	0.1109
Error	84	137570	1638		
Corrected	89	152763			

R-square	Coeff. Var	Root MSE	DV mean
0.10	488	40	8.30

Source	DF	Anova SS	Mean Square	F value	Pr >F
Incentives	2	12603	6302	3.85	0.0252
Feedback	1	2459	2459	1.50	0.2239
Feedback*Incentives	2	132	66	0.04	0.9606

Panel D: the ANOVA test for the difference in effort duration in 3 levels of incentives and 2 levels of feedback in Stage 1 (with Gender)

Source	DF	SS	Mean Squre	F value	Pr>F
Model	6	15378	2563	1.55	0.1727
Error	83	137386	1655		
Corrected	89	152763			

R-square	Coeff. Var	Root MSE	DV mean
0.10	490	41	8.30

Source	DF	Anova SS	Mean Square	F value	Pr >F
Incentives	2	12603	6302	3.81	0.0262
Feedback	1	2459	2459	1.49	0.2264
Feedback*Incentives	2	132	66	0.04	0.9610
Gender	1	184	184	0.11	0.7398

Panel E: the ANOVA test for the difference in effort direction in 3 levels of incentives and 2 levels of feedback in Stage 2

Source	DF	SS	Mean Squre	F value	Pr>F
Model	5	433	87	1.68	0.1481
Error	84	4327	52		
Corrected	89	4759			

R-square	Coeff. Var	Root MSE	DV mean
0.09	30	7	24.13

Source	DF	Anova SS	Mean Square	F value	Pr >F
Incentives	2	317	159	3.08	0.0513
Feedback	1	7	7	0.14	0.7102
Feedback*Incentives	2	109	54	1.06	0.3526

Panel F: the ANOVA test for the difference in effort direction in 3 levels of incentives and 2 levels of feedback in Stage 2 (with Gender)

Source	DF	SS	Mean Squre	F value	Pr>F
Model	6	517	86	1.68	0.1351
Error	83	4243	51		
Corrected	89	4759			

R-square	Coeff. Var	Root MSE	DV mean
0.11	30	7	24.13

Source	DF	Anova SS	Mean Square	F value	Pr >F
Incentives	2	317	159	3.10	0.0503
Feedback	1	7	7	0.14	0.7091
Feedback*Incentives	2	109	54	1.06	0.3499
Gender	1	84	84	1.64	0.2044

Panel G: the ANOVA test for the difference in effort toward problem-solving in 3 levels of incentives and 2 levels of feedback in Stage 2

Source	DF	SS	Mean Squre	F value	Pr>F
Model	5	16762	3352	1.37	0.2430
Error	84	205203	2443		
Corrected	89	221965			

R-square	Coeff. Var	Root MSE	DV mean
0.08	39	49	126.30

Source	DF	Anova SS	Mean Square	F value	Pr >F
Incentives	2	12477	6239	2.55	0.0838
Feedback	1	92	92	0.04	0.8466
Feedback*Incentives	2	4193	2096	0.86	0.4276

Panel H: the ANOVA test for the difference in effort toward problem-solving in 3 levels of incentives and 2 levels of feedback in Stage 2 (with Gender)

Source	DF	SS	Mean Squre	F value	Pr>F
Model	6	17976	2996	1.22	0.3049
Error	83	203989	2458		
Corrected	89	221965			

R-square	Coeff. Var	Root MSE	DV mean
0.08	39	50	126.30

Source	DF	Anova SS	Mean Square	F value	Pr >F
Incentives	2	12477	6239	2.54	0.0851
Feedback	1	92	92	0.04	0.8470
Feedback*Incentives	2	4193	2096	0.85	0.4298
Gender	1	1214	1214	0.49	0.4842

Table 4: T-test for key task effort in Stage 1

Panel A: t-test for the main effect of three levels of incentives on effort intensity (H1a, H1c, and H1e)

	Condition					
	Multiple-Winner [1]	Winner-takes-all [2]	Piece rate [3]	Prob. [1-2]	Prob. [1-3]	Prob. [2-3]
Effort intensity (pupil size at the last 1/3 of time versus at the first 1/3 of time) (controlled for individual difference)	3.57	-0.86	-1.41	0.011	0.001	0.725
				t-value [1-2]	t-value [1-3]	t-value [2-3]
				2.640	3.530	0.350
Number of participants	30	30	30			

Panel B: t-test for the main effect of three levels of incentives on effort duration (H1b, H1d, and H1f)

	Condition					
	Multiple-Winner [1]	Winner-takes-all [2]	Piece rate [3]	Prob. [1-2]	Prob. [1-3]	Prob. [2-3]
Effort duration (controlled for individual difference)	16.94	16.39	-8.43	0.963	0.016	0.005
				t-value [1-2]	t-value [1-3]	t-value [2-3]
				0.050	2.470	2.940
Number of participants	30	30	30			

Panel C: sensitivity analysis for the main effect of three levels of incentives on effort intensity

	Condition					
	Multiple-Winner [1]	Winner-takes-all [2]	Piece rate [3]	Prob. [1-2]	Prob. [1-3]	Prob. [2-3]
Effort intensity (pupil size at the last 1/2 of time versus at the first 1/2 of time) (controlled for individual difference)	2.52	-0.47	-0.61	0.027	0.013	0.911
Effort intensity (pupil size at the last 1/4 of time versus at the first 1/4 of time) (controlled for individual difference)	2.77	-1.19	-2.08	0.039	0.005	0.617
Effort intensity (pupil size at the last 1/5 of time versus at the first 1/5 of time) (controlled for individual difference)	2.84	-1.52	-2.32	0.039	0.006	0.677
Effort intensity (pupil size at the last 1/6 of time versus at the first 1/6 of time) (controlled for individual difference)	2.77	-1.74	-2.31	0.045	0.011	0.775
Number of participants	30	30	30			

Table 5: Pearson correlation test for key task effort and performance in Stage 1

Panel A: correlations among G1, G2, G3, G4, G5, and G6 (H2a and H2b)

Variables	Performance	[1]
[1] Effort intensity	0.266	
(controlled for individual difference)	*0.011*	
[2] Effort duration	0.080	0.302
(controlled for individual difference)	*0.453*	*0.004*

Number of participants = 90

Panel B: correlations among G1, G2, G3, G4, G5, and G6

Variables	Performance	[1]	[2]	[3]	[4]
[1] Effort intensity	0.266				
(controlled for individual difference)	*0.011*				
[2] Effort duration	0.080	0.302			
(controlled for individual difference)	*0.453*	*0.004*			
[3] Search distance per translation	-0.342	0.186	0.506		
(controlled for individual difference)	*0.001*	*0.079*	*<.0001*		
[4] Search time per translation	-0.332	0.155	0.652	0.874	
(controlled for individual difference)	*0.001*	*0.145*	*<.0001*	*<.0001*	
[5] Correction rate	0.112	-0.155	-0.009	-0.013	0.033
(controlled for individual difference)	*0.295*	*0.146*	*0.935*	*0.903*	*0.755*

Number of participants = 90

Panel C: correlations among G1, G2, G3, G4

Variables	Performance	[1]
[1] Effort intensity	0.383	
(controlled for individual difference)	*0.003*	
[2] Effort duration	0.116	0.234
(controlled for individual difference)	*0.376*	*0.071*

Number of participants = 60

Panel D: correlations among G1, G2, G3, G4

Variables	Performance	[1]	[2]	[3]	[4]
[1] Effort intensity	0.383				
(controlled for individual difference)	*0.003*				
[2] Effort duration	0.116	0.234			
(controlled for individual difference)	*0.376*	*0.071*			
[3] Search distance per translation	-0.321	0.113	0.436		
(controlled for individual difference)	*0.012*	*0.390*	*0.001*		
[4] Search time per translation	-0.332	0.045	0.617	0.868	
(controlled for individual difference)	*0.010*	*0.733*	*<.0001*	*<.0001*	
[5] Correction rate	0.190	-0.102	-0.007	-0.148	-0.029
(controlled for individual difference)	*0.145*	*0.437*	*0.960*	*0.259*	*0.823*

Number of participants = 60

Table 6: The ANOVA test of the moderating effect of providing relative performance feedback on the link between schemes and task effort (Stage 1)

Panel A: the ANOVA test for H3a: effort intensity (G1 & G3 vs. G2 & G4)

Variable	DF	Coef.	St. Error	t-value	Prob.
Incentive	1	294.59	294.59	7.01	0.011
Feedback	1	2.25	2.25	0.05	0.818
Interaction	1	90.29	90.29	2.15	0.148

Number of participants = 60

Panel B: the ANOVA test for H3b: effort duration (G1 & G3 vs. G2 & G4)

Variable	DF	Coef.	St. Error	t-value	Prob.
Incentive	1	4.63	4.63	0.00	0.964
Feedback	1	1830.97	1830.97	0.82	0.368
Interaction	1	115.92	115.92	0.05	0.820

Number of participants = 60

Panel C: the ANOVA test for H3c: effort intensity (G1 & G3 vs. G5 & G6)

Variable	DF	Coef.	St. Error	t-value	Prob.
Incentive	1	371.40	371.40	12.29	0.001
Feedback	1	4.65	4.65	0.15	0.696
Interaction	1	34.18	34.18	1.13	0.292

Number of participants = 60

Panel D: the ANOVA test for H3d: effort duration (G1 & G3 vs. G5 & G6)

Variable	DF	Coef.	St. Error	t-value	Prob.
Incentive	1	9659.21	9659.21	5.97	0.018
Feedback	1	1152.86	1152.86	0.71	0.402
Interaction	1	3.73	3.73	0.00	0.962

Number of participants = 60

Panel E: the ANOVA test for H3e: effort intensity (G2 & G4 vs. G5 & G6)

Variable	DF	Coef.	St. Error	t-value	Prob.
Incentive	1	4.44	4.44	0.12	0.726
Feedback	1	53.95	53.95	1.51	0.224
Interaction	1	13.36	13.36	0.37	0.543

Number of participants = 60

Panel F: the ANOVA test for H3f: effort duration (G2 & G4 vs. G5 & G6)

Variable	DF	Coef.	St. Error	t-value	Prob.
Incentive	1	9240.96	9240.96	8.61	0.005
Feedback	1	1999.90	1999.90	1.86	0.178
Interaction	1	78.08	78.08	0.07	0.788

Number of participants = 60

Table 7: T-test for key learning effort in Stage 2

Panel A: t-test for the main effect of three levels of incentives on effort direction (H4a, H4c, and H4e)

	Condition					
	Multiple-Winner [1]	**Winner-takes-all [2]**	**Piece rate [3]**	**Prob. [1-2]**	**Prob. [1-3]**	**Prob. [2-3]**
Effort direction (fixation time on patterns)	27	23	23	0.034	0.037	0.837
				t-value [1-2]	**t-value [1-3]**	**t-value [2-3]**
				2.180	2.130	0.210
Number of participants	30	30	30			

Panel B: t-test for the main effect of three levels of incentives on effort toward problem-solving (H4b, H4d, and H4f)

	Condition					
	Multiple-Winner [1]	**Winner-takes-all [2]**	**Piece rate [3]**	**Prob. [1-2]**	**Prob. [1-3]**	**Prob. [2-3]**
Effort toward problem solving	143	117	119	0.047	0.059	0.861
				t-value [1-2]	**t-value [1-3]**	**t-value [2-3]**
				2.030	1.920	0.180
Number of participants	30	30	30			

Table 8: Pearson correlation for key learning effort and performance in Stage 2

Panel A: correlations among G1, G2, G3, G4, G5, and G6

Variable	Performance	[1]	[2]	[3]
[1] Effort direction (fixation time on patterns)	0.351 *0.001*			
[2] Effort toward problem solving (leftward saccades on patterns)	0.273 *0.009*	0.881 *<.0001*		
[3] Probability of retrieval (number of patterns correctly recognized vs all available patterns)	0.478 *<.0001*	0.205 *0.057*	0.072 *0.505*	
[4] Time taken to retrieve vs all patterns correctly recognized	-0.419 *<.0001*	-0.192 *0.074*	-0.097 *0.370*	-0.161 *0.136*

Number of participants = 90

Panel B: correlations among G1, G2, G3, and G4

Variable	Performance	[1]	[2]	[3]
[1] Effort direction (fixation time on patterns)	0.310 *0.016*			
[2] Effort toward problem solving (leftward saccades on patterns)	0.215 *0.099*	0.876 *<.0001*		
[3] Probability of retrieval (number of patterns correctly recognized vs all available patterns)	0.373 *0.004*	0.235 *0.073*	0.104 *0.431*	
[4] Time taken to retrieve vs all patterns correctly recognized	-0.523 *<.0001*	-0.267 *0.041*	-0.140 *0.289*	-0.262 *0.045*

Number of participants = 60

Panel C: correlations between G5 and G6

Variable	Performance	[1]	[2]	[3]
[1] Effort direction (fixation time on patterns)	0.399 *0.029*			
[2] Effort toward problem solving (leftward saccades on patterns)	0.349 *0.058*	0.893 *<.0001*		
[3] Probability of retrieval (number of patterns correctly recognized vs all available patterns)	0.506 *0.006*	0.083 *0.675*	-0.052 *0.792*	
[4] Time taken to retrieve vs all patterns correctly recognized	-0.258 *0.185*	0.072 *0.717*	0.033 *0.868*	-0.086 *0.665*

Number of participants = 30

Table 9: A test of the mediating effect of learning transfer in the link between learning effort and performance in Stage 2 (use all six groups: G1, G2, G3, G4, G5, and G6)

Panel A: effort direction without a mediator

Variable	Coef.	St. Error	t-value	Prob.
Intercept	-9.95	3.86	-2.57	0.012
Effort direction	0.54	0.15	3.51	0.001

Number of participants = 90

Panel B: effort direction with a mediator, the probability of retrieval (H5a)

Variable	Coef.	St. Error	t-value	Prob.
Intercept	-23.38	4.58	-5.10	<.0001
Effort direction	0.42	0.14	2.93	0.004
Probability of retrieval	26.83	5.93	4.53	<.0001

Number of participants = 90

Panel C: effort direction with a mediator, the time taken to retrieve (H5b)

Variable	Coef.	St. Error	t-value	Prob.
Intercept	-0.81	4.37	-0.18	0.854
Effort direction	0.44	0.15	3.02	0.003
Time taken to retrieve	-1.36	0.36	-3.79	0.000

Number of participants = 90

Panel D: effort toward problem-solving without a mediator

Variable	Coef.	St. Error	t-value	Prob.
Intercept	-4.70	3.13	-1.50	0.136
Effort toward problem solving	0.06	0.02	2.66	0.009

Number of participants = 90

Panel E: effort toward problem-solving with a mediator, the probability of retrieval (H5c)

Variable	Coef.	St. Error	t-value	Prob.
Intercept	-22.18	4.41	-5.03	<.0001
Effort toward problem solving	0.06	0.02	2.83	0.006
Probability of retrieval	29.20	5.84	5.00	<.0001

Number of participants = 90

Panel F: effort toward problem-solving with a mediator, the time taken to retrieve (H5d)

Variable	Coef.	St. Error	t-value	Prob.
Intercept	3.17	3.55	0.89	0.374
Effort toward problem solving	0.06	0.02	2.66	0.009
Time taken to retrieve	-1.48	0.36	-4.13	<.0001

Number of participants = 90

Table 10: A test of the mediating effect of learning transfer in the link between learning effort and performance in Stage 2 (use multiple-winner schemes and winner-takes-all schemes: G1 & G3 vs. G2 & G4)

Panel A: effort direction without a mediator

Variable	Coef.	St. Error	t-value	Prob.
Intercept	-5.89	4.66	-1.26	0.212
Effort direction	0.45	0.18	2.49	0.016

Number of participants = 60

Panel B: effort direction with a mediator, the probability of retrieval

Variable	Coef.	St. Error	t-value	Prob.
Intercept	-18.50	6.65	-2.78	0.007
Effort direction	0.35	0.18	1.96	0.056
Probability of retrieval	23.13	9.03	2.56	0.013

Number of participants = 60

Panel C: effort direction with a mediator, the time taken to retrieve

Variable	Coef.	St. Error	t-value	Prob.
Intercept	6.30	5.07	1.24	0.220
Effort direction	0.27	0.17	1.64	0.106
Time taken to retrieve	-1.51	0.37	-4.10	0.000

Number of participants = 60

Panel D: effort toward problem-solving without a mediator

Variable	Coef.	St. Error	t-value	Prob.
Intercept	-0.86	3.87	-0.22	0.825
Effort toward problem solving	0.05	0.03	1.68	0.099

Number of participants = 60

Panel E: effort toward problem-solving with a mediator, the probability of retrieval

Variable	Coef.	St. Error	t-value	Prob.
Intercept	-17.40	6.63	-2.62	0.011
Effort toward problem solving	0.04	0.03	1.68	0.099
Probability of retrieval	25.71	8.90	2.89	0.006

Number of participants = 60

Panel F: effort toward problem-solving with a mediator, the time taken to retrieve

Variable	Coef.	St. Error	t-value	Prob.
Intercept	8.65	4.06	2.13	0.038
Effort toward problem solving	0.04	0.02	1.51	0.136
Time taken to retrieve	-1.60	0.36	-4.43	<.0001

Number of participants = 60

Table 11: A test of the mediating effect of learning transfer in the link between learning effort and performance in Stage 2 (use piece-rate schemes: G5 & G6)

Panel A: effort direction without a mediator

Variable	Coef.	St. Error	t-value	Prob.
Intercept	-15.84	6.60	-2.40	0.023
Effort direction	0.63	0.28	2.30	0.029

Number of participants = 30

Panel B: effort direction with a mediator, the probability of retrieval

Variable	Coef.	St. Error	t-value	Prob.
Intercept	-28.86	7.04	-4.10	0.000
Effort direction	0.60	0.24	2.48	0.020
Probability of retrieval	26.27	8.60	3.05	0.005

Number of participants = 30

Panel C: effort direction with a mediator, the time taken to retrieve

Variable	Coef.	St. Error	t-value	Prob.
Intercept	-9.82	7.65	-1.28	0.211
Effort direction	0.70	0.27	2.59	0.016
Time taken to retrieve	-1.66	0.99	-1.68	0.105

Number of participants = 30

Panel D: effort toward problem-solving without a mediator

Variable	Coef.	St. Error	t-value	Prob.
Intercept	-10.36	4.97	-2.08	0.046
Effort toward problem solving	0.08	0.04	1.97	0.058

Number of participants = 30

Panel E: effort toward problem-solving with a mediator, the probability of retrieval

Variable	Coef.	St. Error	t-value	Prob.
Intercept	-27.16	6.26	-4.34	0.000
Effort toward problem solving	0.09	0.03	2.68	0.013
Probability of retrieval	29.23	8.45	3.46	0.002

Number of participants = 30

Panel F: effort toward problem-solving with a mediator, the time taken to retrieve

Variable	Coef.	St. Error	t-value	Prob.
Intercept	-4.44	6.73	-0.66	0.516
Effort toward problem solving	0.08	0.04	2.20	0.037
Time taken to retrieve	-1.55	1.02	-1.53	0.139

Number of participants = 30

Table 12: The ANOVA test of the moderating effect of providing relative performance feedback on the link between schemes and learning effort (Stage 2)

Panel A: the ANOVA test for H6a: effort direction (G1 & G3 vs. G2 & G4)

Variable	DF	Coef.	St. Error	t-value	Prob.
Incentive	1	259.52	259.52	4.71	0.034
Feedback	1	42.96	42.96	0.78	0.381
Interaction	1	51.47	51.47	0.94	0.338

Number of participants = 60

Panel B: the ANOVA test for H6b: effort toward problem-solving (G1 & G3 vs. G2 & G4)

Variable	DF	Coef.	St. Error	t-value	Prob.
Incentive	1	10166.02	10166.02	4.07	0.049
Feedback	1	277.35	277.35	0.11	0.740
Interaction	1	2394.02	2394.02	0.96	0.332

Number of participants = 60

Panel C: the ANOVA test for H6c: effort direction (G1 & G3 vs. G5 & G6)

Variable	DF	Coef.	St. Error	t-value	Prob.
Incentive	1	213.80	213.80	4.43	0.040
Feedback	1	12.86	12.86	0.27	0.608
Interaction	1	8.80	8.80	0.18	0.671

Number of participants = 60

Panel D: the ANOVA test for H6d: effort toward problem-solving (G1 & G3 vs. G5 & G6)

Variable	DF	Coef.	St. Error	t-value	Prob.
Incentive	1	8472.82	8472.82	3.63	0.062
Feedback	1	1983.75	1983.75	0.85	0.360
Interaction	1	150.42	150.42	0.06	0.801

Number of participants = 60

Panel E: the ANOVA test for H6e: effort direction (G2 & G4 vs. G5 & G6)

Variable	DF	Coef.	St. Error	t-value	Prob.
Incentive	1	2.21	2.21	0.04	0.836
Feedback	1	12.87	12.87	0.25	0.618
Interaction	1	102.83	102.83	2.01	0.162

Number of participants = 60

Panel F: the ANOVA test for H6f: effort toward problem-solving (G2 & G4 vs. G5 & G6)

Variable	DF	Coef.	St. Error	t-value	Prob.
Incentive	1	77.07	77.07	0.03	0.861
Feedback	1	19.27	19.27	0.01	0.930
Interaction	1	3744.60	3744.60	1.50	0.226

Number of participants = 60

Table 13: T-test for non-eye-tracking variables

Panel A: t-test for the main effect of three levels of incentives on non-eye tracking variables

	Condition					
	Multiple-Winner [1]	Winner-takes-all [2]	Piece rate [3]	Prob. [1-2]	Prob. [1-3]	Prob. [2-3]
Stage 1 Performance (%)	9.254	4.502	5.459	0.098	0.162	0.737
Probability of retrieval	0.694	0.629	0.516	0.098	0.000	0.018
Time to retrieve	4.510	5.627	4.603	0.217	0.874	0.241
Stage 2 Performance (%)	7.332	3.054	-1.238	0.134	0.001	0.155
A percentage of learning transfer in Stage 2 performance	16.710	13.600	10.300	0.018	<.0001	0.023
Stage 2 Peformance / Last practice (%)	16.960	7.550	4.070	0.015	0.001	0.398
Number of participants	30	30	30			