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Experiment on entrepreneurial discovery: an attempt to demonstrate the conjecture of Hayek and Kirzner

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Abstract

Friedrich Hayek conjectured that the free enterprise system is most effective in making discoveries. Israel Kirzner refines the conjecture as follows: the availability of profit opportunities tends to evoke *entrepreneurial* discovery. We hoped to demonstrate the conjecture in an outdoor experiment. We asked subjects to transfer water from one bucket to another. There were two methods of doing so, an obvious method and a nonobvious and much superior method. We varied the payment schedules to see if higher potential rewards would more readily evoke discovery of the superior method. The hoped-for demonstration was not achieved. The investigation holds several lessons for those who would attempt to demonstrate the entrepreneurship conjecture. Investigators must make the opportunity discoverable but not obvious, operationalize motivation (not merely vary monetary rewards), and separate entrepreneurial discovery from other types of discovery (such as that had by deliberate problem solving).

JEL classification: A1; DO

Keywords: Discovery; Entrepreneurship; Epiphany; Interpretive shift; Problem solving

1. Introduction

In a famous article, "Competition as a discovery procedure", Hayek (1978) says that a chief virtue of the free enterprise system is its evocation of the discovery (and fulfillment) of opportunities for social betterment. As Hayek suggests, the discovery virtue is poorly featured in the two modes of discourse dominant in the economics profession: equilibrium model building and statistical significance. Equilibrium model building proceeds upon knowledge assumptions in which interpretation, if not information, is common and static. Within the paradigm, building in scope for discovery of new information is very

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cumbersome, building in scope for new partial interpretation is even more cumbersome, and building in scope for new encompassing interpretation, in equilibrium, is impossible.

The other dominant mode of discourse, statistical significance, also fails in addressing discovery. Across observations, the conditions for discovery are too particularistic to specify or control for. "If we do not know the facts we hope to discover by means of competition, we can never ascertain how effective it has been in discovering those facts that might be discovered" (Hayek, 1978, p. 180). A discovery that fails to happen is like the dog in the night that did not bark. The investigator cannot know if it is a case of a silent dog or of no dog at all (Romer, 1994, p. 26; Kirzner, 1985, p. 146).

That the two formal modes of discourse are ineffectual at addressing the discovery conjecture throws researchers back on less paradigmatic methods, such as case studies, history, policy analysis, thought experiments, and introspection. In search of an empirical demonstration of the discovery conjecture, however, Hayek (1978, p. 180) makes two suggestions. First, by comparing the economic performances of societies with different degrees of freedom, researchers might discern that the freer societies are the more prosperous. Hayek's suggestion has been carried out by research organizations that construct indices of economic freedom in countries throughout the world, and correlate economic freedom and economic growth.[1] Their findings conform to Hayek's own impression of the historical record: it appears that freedom causes growth. Hayek fails to note, however, that such historical/statistical findings do not necessarily bear out the discovery conjecture. It may be that freedom causes growth for reasons highlighted by mainstream economics: more competition, more efficiency in production and consumption, more certainty in investment, lower transaction costs, lower deadweight losses, less rent seeking, and so on.

Hayek's (1978, p. 180) other idea for empirical illustration is offered wistfully: "we might conceivably test [a discovery conjecture] in artificially created real situations, where the facts which (may be discovered) are already known to the observer." We pursued Hayek's suggestion. We designed a rather simple experiment that rewarded each subject in cash according to the amount of water he transferred from one plastic bucket to another. One method of transferring water was obvious and another, much superior, method was nonobvious. By varying the rewards for transferring water, we sought to demonstrate that entrepreneurial discovery of the superior method depends on motivation.

Economic experimentalists have explored the relation between monetary rewards and search intensity (Schotter and Braunstein, 1981; Harrison and Morgan, 1990), but, as far as we know, none has investigated *entrepreneurial* discovery. Psychologists have done experiments testing whether creativity (which is akin to entrepreneurship) is affected by previous activities or changes in the setting (Dunker, 1945; Adamson, 1952; Scheerer, 1963; Weisberg, 1993, pp. 96–102). In Dunker's famous experiment, for example, the creative act is to empty out a box of tacks and use the box as a candleholder. To our knowledge, however, such experiments have never involved variations in monetary rewards. It appears that ours was the first attempt to carry out Hayek's suggestion for demonstrating a discovery conjecture.

[1] There are two on-going, large-scale projects creating indices of economic freedom. The one coordinated by the Fraser Institute in Vancouver finds a recent edition in (Gwartney and Lawson, 2000) and rates the economic freedom of 123 countries for the year 1997. The project coordinated by the Heritage Foundation in Washington, DC finds a recent edition in (O'Driscoll et al., 2000) and rates 161 countries for the year 1999.

The results of our experiment were disappointing but instructive. A report on the experiment may help researchers formulate meaningful versions of the discovery conjecture and develop methods for testing. Our failure is useful for what it teaches about the difficulty of working empirically with the idea of entrepreneurial discovery. Not only is it very difficult to control the motivation for entrepreneurial discovery, it is difficult merely to identify discovery as *entrepreneurial* discovery, even when it happens right in front of the investigator.

2. Entrepreneurial discovery

A broad formulation of the discovery conjecture would be that the more free a society is, the better it discovers social opportunities. Another formulation would be as follows: freedom causes prosperity *principally because* freedom generates discovery. Such formulations are impractical for experimental testing. The notion of discovery is very broad. Also, experimentalists, except those of a dystopian sort, cannot vary and manipulate people's freedom. To arrive at a narrower conjecture, we refine discovery and the causal factor.

Stigler (1961) pioneered the study of search. In stories of search or respondence to stochastic blips, agents discover new knowledge, but the new knowledge is merely new information. For example, comparison shoppers search over vendors and discover an array of prices and product qualities. Such new knowledge fits into their overall interpretation. They obtain new information but they do not discover new interpretations of what they themselves are up to. As Ricketts (1994, p. 60) says: "It is rather as if we are searching for something of which we once had full knowledge but have inadvertently mislaid."

Profounder sorts of discovery involve shifts in interpretation. An actor may puzzle over certain parts of his situation seeking a better understanding or interpretation of those parts. Problem solving is engaged in deliberately by the self-conscious agency of the mind. When successful, it produces a partial interpretive shift. But partial interpretive shifts can occur in two other, undeliberate, ways. A person might stumble upon a new interpretation, obvious once he encounters the opportunity. Or he might arrive at a new nonobvious interpretation by virtue of efforts of the mind's other-than-self-conscious agencies. In this case the insight strikes him with a certain epiphany and wonder. This sort of discovery qualifies as an entrepreneurial discovery.

To complete a typology of discovery we ought to consider also interpretive shifts of a fundamental (rather than partial) sort. Fundamental interpretive shifts are not the result of problem solving or other deliberate efforts. They also, however, may be divided into cases in which one stumbles into an obvious opportunity and cases in which the discovery comes by virtue of the mind's other-than-self-conscious agencies.

A full typology is offered in Fig. 1. The rows express three grades of interpretive shift: no interpretive shift (mere information), partial interpretive shift, and fundamental interpretive shift. The columns combine different explanations for the occurrence of the discovery. The terms "obvious" and "nonobvious" refer to the following question: Is the nature of the opportunity obvious or nonobvious once the opportunity has been encountered by the self-conscious agency of the mind? The nature of mere information is, by definition, obvious (hence the Xs in the top row). The term "deliberate" means that the work involved in

	Obvious & Deliberate	Obvious & Undeliberate	Nonobvious & Deliberate	Nonobvious & Undeliberate
No Interpretive Shift (mere information)	realization in a framework of Search	realization in a framework of Respondence	X	X
Partial Interpretive Shift	solution to easy Problem Solving	minor Serendipity	solution to difficult Problem Solving	Entrepreneurial Discovery (or minor Epiphany)
Fundamental Interpretive Shift	X	Serendipity	X	Entrepreneurial Discovery (or Epiphany)

Fig. 1. Typology of discovery.

realizing the discovery has been set by the mind's self-conscious agency as a task. It is a deliberate task. "Undeliberate" means that the discovery has not been the result of work by the self-conscious agency. "Undeliberate", therefore, may refer either to discoveries gotten by way of chance encounters (i.e. dumb luck) or to discoveries gotten by virtue of the work of the other-than-self-conscious mind. The processes that yield a fundamental interpretive shift are, by definition, undeliberate (hence the Xs in the bottom row).

In the top row, mere information, we find realization within a framework of search (which is an active, deliberate task) and, in the next cell, realization within a framework of respondence to incoming pieces of information (respondence is passive). The middle row, for partial interpretive shift, shows solutions to problem solving (which is "easy" when the solution is obvious and "difficult" when the solution is nonobvious), minor serendipity when the shift comes from stumbling upon an obvious opportunity, and entrepreneurial discovery (or minor epiphany) when the shift comes by virtue of work by the other-than-self-conscious mind. In the bottom row we have fundamental interpretive shifts corresponding again to serendipity and entrepreneurial discovery (or epiphany).

This typology (which refines that at Klein, 1999, p. 61) corresponds to distinctions made by Kirzner. He distinguishes search and respondence: "[The information] one obtains from the advertising message thrust before one's eyes was, more likely than not, *not* deliberately searched for" (Kirzner, 1979, p. 142). He distinguishes between problem solving

(the deploying of attention) and entrepreneurship: "what sets [entrepreneurship] apart from knowledge as a resource [that is, from problem solving] is reflected in [one's] lack of self-consciousness concerning it" (Kirzner, 1979, p. 169; see also p. 258 no. 14; Kirzner, 1985, p. 22). As for serendipity, Kirzner (1979, p. 159) writes of Robinson Crusoe "climbing a tree to look far out to sea—without realizing at all that his action will yield him fruit" and explicitly distinguishes such cases from entrepreneurial discovery. He describes entrepreneurial discovery as "undeliberate but motivated" (Kirzner, 1985, p. 14).

In our experiment, it was the entrepreneurial sort of discovery—epiphany—that we sought to evoke.

3. The discovery conjecture investigated

The various sorts of discovery might all be important factors in economic prosperity. A regime of freedom—low taxes, secure private property, minimal restrictions on voluntary agreements, etc.—might advance all sorts of discovery, and improve the alignment between the individual's opportunity and social betterment. Kirzner (1985, p. 30) maintains that "the most impressive aspect of the market system is the tendency for [profit] opportunities to be discovered".

When Kirzner speaks of discovery, he means specifically entrepreneurial discovery (or epiphany). Kirzner views human beings not as mere optimizers but as creatures with both a deliberate faculty and a somewhat separate interpretive faculty. The interpretive faculty arrives at new formulations of the framework within which deliberate choice takes place.[2] After arriving at a better formulation it attempts to communicate the insight to "us"—the deliberate faculty. The interpretive faculty is separate in the sense that at the deliberate or self-conscious level we do not know what the interpretive faculty is up to or how it functions. We simply receive signals, experienced as insights. To us the interpretive faculty appears as a mere propensity for epiphanies.

Although we cannot fathom the workings of the interpretive faculty we may nonetheless maintain, says Kirzner (1985, p. 14), that it has motivation. The faculty is aroused in a setting of opportunity, as though opportunity gave off a scent (Kirzner, 1979, p. 29). Kirzner (1985, p. 28) maintains that "human beings tend to notice that which it is in their interest to notice". Upon such reasoning Kirzner offers an explanation for the epiphany virtue of economic freedom: low taxes and freedom of contract put before the individual great opportunities that are well aligned to social betterment and that exercise and arouse the interpretive faculty. Under a regime of economic freedom, substantial and socially beneficial epiphanies occur more often not only because more opportunities exist but also because people's interpretive faculties are more advanced and more aroused.

Our experimental investigation attempted to demonstrate a core component of Kirzner's theory. We attempted to put a nonobvious opportunity before experimental subjects and vary the gain from discovering the opportunity. In other words, we sought to operationalize motivation of the interpretive faculty. We had hoped to observe that when the "scent" of opportunity was stronger, subjects would be more likely to discover the opportunity.

[2] Kirzner call this faculty "alertness."

4. Problems of designing a discovery experiment

Although neither of us has had any other experience designing experiments, we are sure that the goal of our experiment poses challenges that are exceptional. The experiment had to present an opportunity for entrepreneurial discovery without actually telling the subject to search for such an opportunity. Were the subject explicitly cued to engage in a search or to solve a problem, any successful discovery would be the result of deliberate effort, not epiphany. For example, if the payment schedule offered a bonus for transferring an amount of water far exceeding the amount doable by the obvious method, subjects would be cued to look for another method.

We believed that the experiment should require the performance of some physical task rather than a written exercise. A written exercise could confound the experiment in several ways. More abstract and intellectual than physical tasks, solving a written problem would have depended greatly on such things as the subject's reading and analytic aptitudes. Furthermore, intellectual puzzles and challenges offer a motivation of their own; our subjects, college students, naturally strive to prove themselves on any written test. Discovering the entrepreneurial insight under these conditions would more properly be classified as problem solving than entrepreneurship.

We considered several physical tasks. Some we ruled out because they relied on strength or other physical prowess, others because they might inspire heroic and possibly dangerous feats. We settled on moving objects from one location to another and decided that the interpretive breakthrough would involve recognition that a small table, placed inconspicuously at the site, could be inverted and used as a carrier. We considered various movable objects, such as bricks, tennis balls, and golf balls. Finally, we settled on water in the hope that

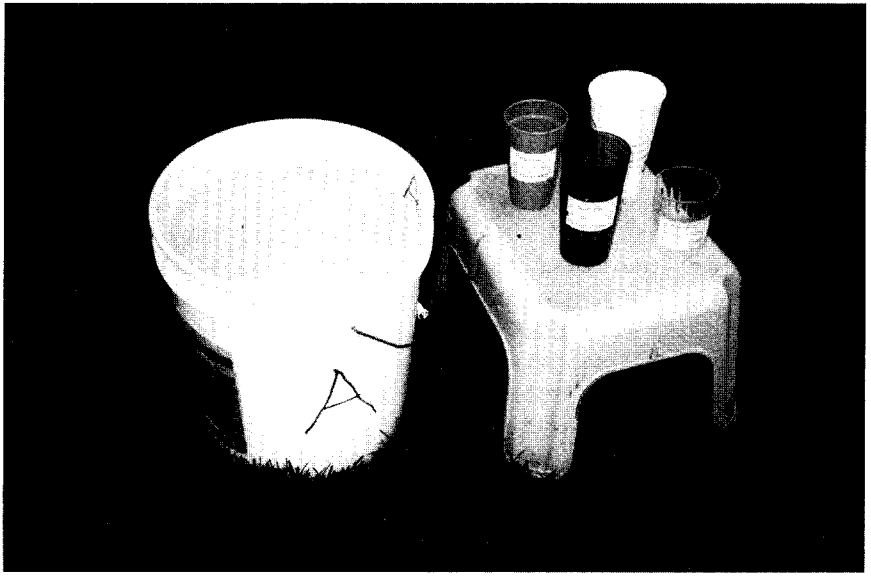


Photo 1. Water bucket and four vessels.

the subjects might think their success would depend on avoiding spillage rather than on discovering a better way to transfer it.

Subjects would be taken to the site of the experiment where they would see two plastic buckets, one full of water and one empty. Beside the full bucket would be a plastic footstool on which sat four plastic vessels of different sizes (see Photo 1). Printed instructions posted near the bucket would encourage the subject to transfer as much water as possible to the empty bucket (about 15 ft away). The instructions would indicate a simple payment schedule for the amount of water he transferred. The instructions would specify that he could not move either bucket and that he could make only one trip from the full to the empty bucket. No other restrictions would be included in the instructions.

The obvious method of transferring the water was to use the four vessels, submerging each in the full bucket and then carrying all four, filled to the brim, to the empty bucket (see Photo 2). The superior and nonobvious method entailed a novel interpretation of the equipment: the footstool itself could be inverted and used as a vessel—indeed, a vessel with capacity much greater than the other four combined. The best method to transfer water would thus be to invert the footstool, fill it with water using the smaller vessels, fill the latter, and then carry all five to the empty bucket (see Photos 3a and b). We would attempt to operationalize the causal variable, motivation, by varying the schedule of payments for water transferred.

To eliminate the possibility that gender differences might dilute our results, we decided to recruit only male students (Santa Clara University undergraduates). So as not to draw from the pool of potential subjects, we recruited mostly female assistants. Assistants were to be of two types: *attendants* who would sit with waiting subjects in one of our classroom

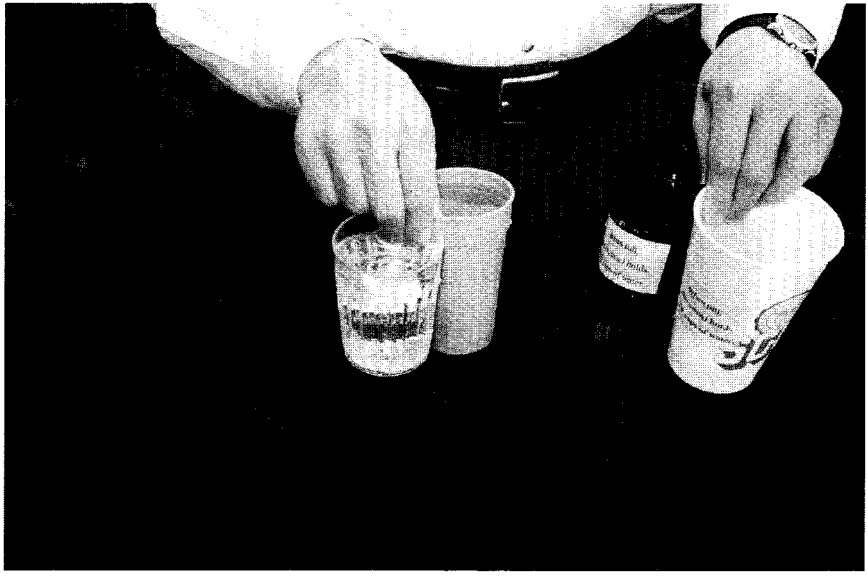
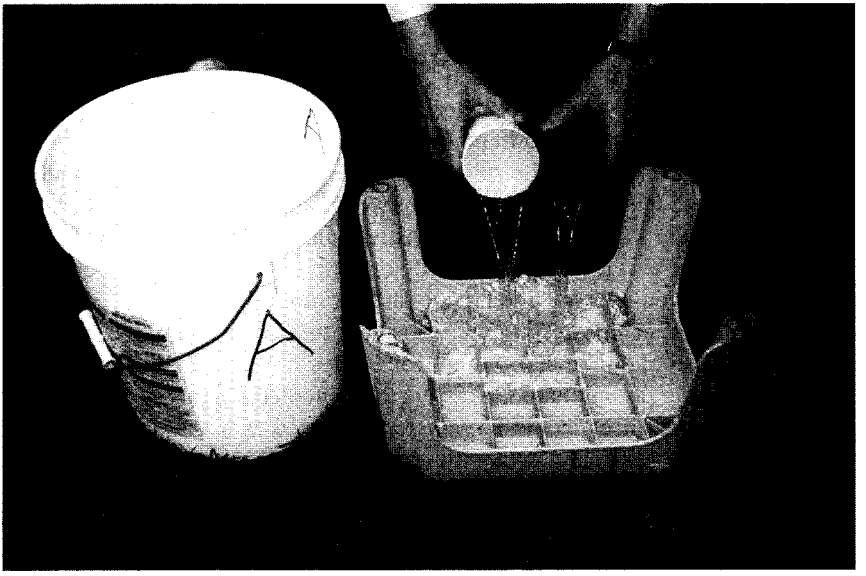
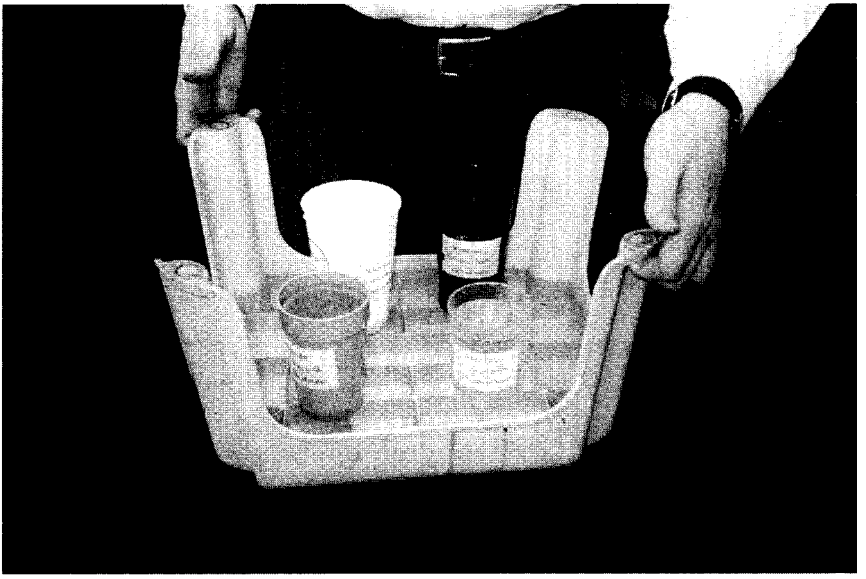


Photo 2. The obvious method of transferring water.



(a)



(b)

Photo 3. The nonobvious and much superior method of transferring water.

"holding pens", and *monitors* who would escort subjects one at a time from a holding pen to her site and observe as he did the experiment. Each holding pen (five in total) would feed two or three sites (11 in total). The experiment was to utilize a team of 19 people, including us (Demmert manned the cashbox and Klein roamed around checking on sites).

5. Refining the experiment: dry runs

Experiments by economists typically are administered to numerous subjects simultaneously in a classroom or lab. Our experiment more closely resembles creativity experiments conducted by psychologists (Dunker, 1945; Adamson, 1952). In those experiments, as in ours, subjects must be taken in isolation, making the experiment time and labor intensive. Moreover, we would not be able to repeat the experiment because once word of the stool trick got out our entire subject population would be contaminated.

We refined the experiment through a series of dry runs (no pun intended). We conducted three such dry runs with teenagers off campus. Each dry run involved between five and eight subjects and used genuine and immediate cash payments. In the first, none of the five subjects inverted the stool. We rewrote the instructions, altered the payment schedules, and changed the time allotted to each subject. In the second, five of eight inverted the stool. Again we tinkered. In the third, two of five inverted the stool. We were encouraged in that, taken together, the dry runs suggested that the inversion opportunity was neither so obvious that subjects were bound to see it, nor so nonobvious that subjects were bound to miss it. We were discouraged, however, in that there appeared to be no connection in the dry runs between discovery and monetary rewards.

The dry runs also revealed certain confounds. Some of the subjects missed or neglected the rule about making only one trip and raced back and forth between the buckets. In the final instructions of the actual experiment we placed substantial emphasis on a single trip. Evidently, this was not enough, as this basic misunderstanding still plagued the experiment.

In one of the dry runs, a subject used a cup to cast water airborne from one bucket to the other, with considerable success. We subsequently put more distance between the buckets. Another subject filled his sneakers with water and carried them along with the cups we had provided. Hoping that small numbers were masking the validity of our conjecture (and running way behind in spending our grant money), we tinkered some more and planned for the big day.

6. The payment schedules

We settled on four different forms labeled 1A, 1B, 2A, and 2B. Each began by telling the subject that he would automatically receive a minimum US$ 12 payment: "OUR APPRECIATION: For helping us in our study, we will pay you $12 in cash today." Beyond this, the schedules differed with respect to the opportunity they presented for *additional* earnings. Specifically, the marginal payoffs for cups transferred (where "cups" means the unit of volume, as in two cups to the pint) were as follows:

Form	Schedule for earning additional money
1A	If you do not transfer at least seven cups of water, you receive **no additional money**. If you transfer at least seven cups, you receive an additional 10 cents for every cup transferred.
1B	If you do not transfer at least seven cups of water, you receive **no additional money**. If you transfer at least seven cups, you receive an additional dollar for every cup transferred.
2A	Transfer as much water as you can. [I.E. this form provided a zero marginal payoff for additional water transferred.]
2B	You will receive an additional 50 cents for every cup of water transferred.

Forms 1A and 1B create a threshold of seven cups. Provided that he transfers at least seven cups the subject receives an additional payment per cup—10 cents for form 1A, US$ 1 for form 1B. The purpose of the threshold was to lead the subjects to figure that the purpose of the experiment was to test how carefully they filled and carried the four plastic vessels. The combined volume of the four vessels was slightly more than seven cups, and the volume of each was prominently marked. We hoped that these details about volumes would help to anchor in the subject's mind the obvious (and inferior) means of transfer. With the obvious formulation anchored, form 1B's higher rewards, we hoped, would induce a higher rate of interpretive breakthrough to the superior formulation.

Forms 2A and 2B are simpler, as they do not create a threshold. We had hoped that form 2B's payment of 50 cents per cup would induce a higher rate of interpretive breakthrough.

7. The actual experiment

The experiment was set for Saturday, 15 May 1999. We advertised "$12 for 12 minutes of your time" to male students in the campus paper and by mass e-mails. The experiment, we said, would be "simple, pleasant, and uncompromising". We warned of a wait and suggested that they bring along a book or homework. We had recruited the assistants in advance but told them nothing of the experiment until we assembled them for instructions just prior to the actual experiment. We are confident that the subject population was not "contaminated" with knowledge of what was in store.[3]

The morning of the experiment we deposited the equipment at each of the 11 sites. We convened the 17 assistants, explained the experiment, distributed and reviewed a set of guidelines, assigned positions, toured the sites and readied the equipment. The instructions for subjects were printed so that forms 1A and 1B appeared on opposite sides of a single

[3] The exit questionnaires asked the subject: "Had you heard anything prior to doing the experiment about the kind of tasks you would be asked to do?" One student responded, "Yes, my friend described this exact experiment to me." We have expunged this subject entirely (he is not included in the 135 on which we report). Oddly, he did *not* invert the stool. He had instruction form 1A, so excluding him weakens the result we desired.

sheet, and forms 2A and 2B likewise. At each site, either the 1A/1B or the 2A/2B sheet would be posted on a clipboard near the water bucket. To reduce the hazard that would arise if site-specific factors affected whether subjects made the discovery, we instructed the monitors to reverse her instruction sheet with each trial. Thus, each site would perform the alternating sequence A, B, A, B, A, B, ... Six sites used the 1A/1B sheet and five used the 2A/2B sheet.

The monitors were told to reset the equipment after each trial, escort the next subject to the site, indicate the instructions, and announce, once the subject finished reading the instructions, "I am starting the clock now"—for 3 min, as indicated on the instruction form. There was not to be any other communication between the subject and the monitor. The monitor was to observe casually from a distance and fill out an observation form (recording information on site, monitor's name, subject's name, instruction form, whether the subject inverted the stool, amount of water transferred, and open-ended observations). She would then fill out a payment chit, indicating the instruction form, cups transferred, and whether the subject inverted the stool. The subject brought the chit to the cashier for payment and answered one of two exit questionnaires. There was an exit questionnaire for those who inverted and one for those who did not.

The basic logistics of the experiment ran fairly smoothly. To start, male students arrived in ample numbers. The male students were briefed about what was soon to come: they would go in groups to holding pens, fill out a registration form, wait to be escorted to a site, find instructions there, have 3 min to perform the experiment, and finally go to a specified room for payment. The monitors performed their tasks with a few mishaps and irregularities but basically as we intended. If the experiment was flawed, the flaws lay in experimental design.

8. Basic results of the experiment

Running simultaneously 11 test sites, we put 135 undergraduate male subjects through the experiment in about two hours. The division of the subjects among the four different payment schedules was as follows: 35 subjects had form 1A, 37 form 1B, 32 form 2A, 31 form 2B. Total expenditures on payments to experimental subjects was about US$ 2100 (total expenditures including equipment, dry-runs, and assistants was about US$ 4000).

Most of the subjects who completed the experiment transferred water in one of the two expected ways (carrying cups or inverting the stool). Many, however, did not read or understand the instructions and reacted in confounded ways. Using the monitors' observations, we identified the following sorts of *problem cases*:

The subject	Number of such subjects
Made more than one trip	22
Moved the bucket	1
Ran out of time	8
Transferred zero cups of water (for reasons unknown)	5
Other cases of basic misunderstanding[a]	1

[a] One subject misread the instructions to say that he could not lift or move the plastic cups; he transferred water in his mouth!

Table 1
All 135 subjects by form (payment schedule) and whether they inverted the stool

Form	Marginal reward (US$)	Subjects who did not invert (%)	Subjects who inverted (%)	Total subjects
2A	0	24 (75.00)	8 (25.00)	32
1A	0.10	24 (68.75)	11 (31.43)	35
2B	0.50	21 (67.75)	10 (32.26)	31
1B	1.00	24 (64.86)	13 (35.14)	37
Total		93 (68.89)	42 (31.11)	135

The χ^2 of Table 1 is 0.86, with three degrees of freedom and a P-value of 0.84. The χ^2 after merging the cell frequencies for forms 1A and 2A, and forms 1B and 2B is 0.47, with one degree of freedom and a P-value of 0.50, or a Fisher's exact test-value of 0.58 giving a P-value of 0.31 for a one-sided test.

Table 2
The 98 "problem-free" subjects by form (payment schedule) and whether they inverted the stool

Form	Marginal reward (US$)	Subjects who did not invert (%)	Subjects who inverted (%)	Total subjects
2A	0	18 (72.00)	7 (28.00)	25
1A	0.10	17 (65.38)	9 (34.62)	26
2B	0.50	17 (70.83)	7 (29.16)	24
1B	1.00	12 (52.17)	11 (47.83)	23
Total		64 (65.53)	34 (34.69)	98

The χ^2 of Table 2 is 2.57, with three degrees of freedom and a P-value of 0.46. The χ^2 after merging the cell frequencies for forms 1A and 2A, and forms 1B and 2B into a 2×2 table is 0.52, with one degree of freedom and a P-value of 0.47, or a Fisher's exact test-value of 0.53 giving a P-value of 0.31 for a one-sided test.

Whether the problem cases ought to be expunged is not entirely clear.[4] As it happens, the problem cases do not much affect the results.

Retaining all 135 subjects, the results are reported in Table 1. We arranged the columns least to most additional money per cup. Because forms 1A and 1B involve a threshold of seven cups, consider the pair-wise comparisons. The percentages inverting the stool of 1A subjects versus 1B subjects: 31.43 percent versus 35.14 percent. The percentages inverting of 2A subjects versus 2B subjects: 25.00 percent versus 32.26 percent. The differences are in the direction of the conjecture, but are too small to provide a demonstration of anything.

If we expunge the 37 problem cases, leaving 98 subjects, we have the results reported in Table 2. Percent inverting the stool of 1A subjects versus 1B subjects is 34.62 percent versus 47.83 percent. For 2A subjects versus 2B subjects we have 28.00 percent versus 29.16 percent. The differences are still in the "right" direction, but not significant in any sense. For 1A subjects versus 2B subjects, the small difference is in the "wrong" direction.

[4] One might argue that attention to the instructions was a function of the cash opportunities, yet, since 57 percent of the problem cases had the high reward forms (1B or 2B), this does not appear to have been the case.

9. Reflections

There are several reasons to doubt that the experiment tested the "motivation stimulates entrepreneurial discovery" conjecture. First, it is doubtful that we operationalized motivation. Economic experimentalists wrestle with the presence of nonmonetary factors such as decision making costs, and have sought to mitigate the problem by using larger monetary payments (Smith and Walker, 1993). In our case, an impasse between potential monetary rewards and motivation is immediately indicated by the fact that some 25 percent of the subjects did not comprehend the instructions well enough to abide by them. The situation was highly artificial and peculiar. Many subjects may have acted under the general understanding of "the more water the more money" (as one subject wrote on his exit questionnaire) regardless of the payment schedule.

But more significant concerns about motivation stem from the fact that money is not the only motive. Form 2A offers no additional money and says, "Transfer as much water as you can." In writing the instructions we had to walk the fine line between merely setting for the subject a deliberate task and offering our approbation for his having performed the task well. An imagined or implicit approbation—or, for that matter, the subject's own pride or sense of sport—would be a form of motivation independent of monetary rewards. Also, the admiration of the female monitor may also have motivated the male subjects. Indeed, the experiment seems to have evoked entrepreneurship in ways unintended. Although the instructions said, "Do not speak to the monitor", in two instances the monitor was asked out for a date!

The subjects were penned up for up to 90 min, talking freely with friends, classmates, or dorm-mates. The advertisements said to expect a wait and bring something to read but almost none of them did. Although they did not know in advance the task of the experiment, they probably anticipated that after the experiment they would swap stories of their own performance (they had been told that they would "be allowed up to 3 min to perform your experiment task"). It is likely that peer rivalry was operating.

The presence of nonmonetary motivations might mean that the variations in monetary rewards generated only small differences in total motivation. Using the stool would increase one's water transferring ability by about 24 cups, which would mean an additional US$ 24 for a subject with form 1B. But we cannot be sure that in the situation even the promise of an additional dollar per cup significantly affected overall motivation.

Besides teaching us subtleties of motivation, hindsight has taught us the evanescence of entrepreneurial discovery. The exit questionnaire for those who inverted the stool asked:

Which of the following two sentences better describes your experience? (check one):

- I deliberately searched for the best way to transfer the water and came up with the idea of using the stool.
- The idea of using the stool just came to me.

The "deliberately searched" option was checked by 76 percent. It seems that many subjects approached the task in a mode of *problem solving*, exactly what we had hoped to avoid by making the task physical. In as much as subjects deliberately puzzled over how to transfer water, the experiment did not test *entrepreneurial* discovery at all. The next question asked: "After thinking of using the stool, did you have any second thoughts about doing so?" The

response of one subject perfectly depicts our failing: "None, I figured that it was the trick and I figured it out."

Those who did not invert the stool also answered an exit questionnaire. They were asked if they thought of turning over the stool, and 39 percent said they did. The next question asks: "If you did think about using the stool, why didn't you use it?" Answers included:

"I was lazy."
"I didn't feel any motivation to."
"I don't know, I guess I'm an idiot."
"I thought you could only use the cups."
"It just seemed a bit unorthodox."
"I didn't want to look like I was fumbling with all the equipment+spilling water everywhere."

Of the respondents who did not invert the stool yet said they had thought of doing so, 44 percent had high-reward opportunities (either form 1B or 2B), so cash payoffs do not explain why they did not go through with the idea.[5]

It seems, therefore, that many came up with the idea of inverting the stool but did not judge the idea to be worthwhile (perhaps because they were unsure of its legality). In Kirzner's theory of entrepreneurial discovery, there is no impasse between perceiving an opportunity and seizing it: if the agent does not act on the idea, then he did not perceive it to be a *profit opportunity*. Only ideas that are indeed acted on are deemed to have been perceived as profit opportunities (Kirzner, 1979, p. 169; Kirzner, 1985, p. 23). The experiment, then, besides having problems of controlling motivation and of separating entrepreneurship from problem solving, may have failed to make available a maneuver that, once noticed, would be considered by the subject to be a profit opportunity.

Our experience highlights the place of problem solving. Those who inverted the stool were "thinking outside the box", but in as much as they set out to solve a conceptual problem, they worked within a larger, more fundamental box, within which the subject's deliberate thoughts remained. Problem solving is the deliberate effort to get a new *partial interpretation* of one's situation. This description seems to fit the subjects' behavior better than either "search for information" or "entrepreneurial discovery".

Kirzner describes entrepreneurial discovery as "undeliberate but motivated". In Somerset Maugham's short story "The Verger" he tells of a man recently put out of work looking along the street for a smoke. When he fails to find one the idea of opening a tobacco shop comes to him. The experience is not a process of deliberate problem solving. Indeed, the man thinks to himself: "Strange, how things come to you when you least expect it." This tale of undeliberate discovery of a nonobvious new interpretation has undeniable intuitive appeal and relevance. It seems to us to be real and to deserve accommodation in economic discourse. And it may not have been absent in the experiment: of the exit-questionnaire respondents who inverted the stool, 24 percent checked "The idea of using the stool just came to me" rather than "I deliberately searched for the best way to transfer the water".

[5] It should be noted that subjects filled out the exit questionnaires in a hectic and noisy room where they conversed freely about the experience. It is possible that some subjects who had never thought of inverting the stool were ashamed of not having seen the "trick" and lied about having thought of it.

Whether "undeliberate but motivated" discoveries are important in an economic system, and whether such beneficial discoveries are sensitive to public policy, remain questions that formal methods fail to answer one way or the other. If we think that such matters may be important, it appears that we will have to continue to approach them through such less formal methods as introspection, thought experiments, case studies, interviews, and policy analysis.

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