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AN EXPERIMENTAL STUDY OF SINGLE-ACTOR ACCIDENTS

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I. Introduction

THE incentive effects of various legal rules governing liability for accidents have been the subject of much controversy among lawyers and of much formal study among economists.[1] To lawyers, the deterrent effect of a legal rule of strict liability relative to one of negligence or negligence with contributory negligence bears on the policy choice among rules. During the past twenty-five years, the legal debate over the empirical question of deterrence has often turned not on actual deterrence effects but on the economic models of accident law that *predict* the deterrence effects of various legal rules.[2]

In this article, we experimentally investigate three hypotheses derived

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[1] John P. Brown, Toward an Economic Theory of Liability, 2 J. Legal Stud. 323 (1973), set out what has now become the standard model. Other work includes Peter A. Diamond, Single-Activity Accidents, 3 J. Legal Stud. 107 (1974); Peter A. Diamond & James A. Mirrlees, On the Assignment of Liability: The Uniform Case, 6 Bell J. Econ. & Mgmt. Sci. 487 (1975); Jerry Green, On the Optimal Structure of Liability Laws, 7 Bell J. Econ. 553 (1976); Robert Cooter, Lewis Kornhauser, & David Lane, Liability Rules, Limited Information, and the Role of Precedent, 10 Bell J. Econ. 366 (1979); Steven Shavell, Strict Liability versus Negligence, 9 J. Legal Stud. 1 (1980). For recent surveys of the theoretical literature, see William Landes & Richard Posner, The Economic Structure of Tort Law (1987); and Steven Shavell, Economic Analysis of Accident Law (1987) (hereinafter Economic Analysis).

[2] On this score, consider, for example, Guido Calabresi & Jon T. Hirschoff, Toward a Test for Strict Liability in Torts, 81 Yale L. J. 1055, 1060 (1972); Shavell, Economic Analysis, *supra* note 2; Howard A. Latin, Problem-Solving Behavior and Theories of Tort Liability, 73 Cal. L. Rev. 677 (1985).

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from these models concerning the incentive effects of the rules of strict liability and negligence. We find that, though under negligence rules subjects' choices of care levels correspond to the theory, the models do not predict well otherwise. We observed neither the predicted behavioral equivalence of a rule of strict liability and of negligence with the due care standard set at its optimal (that is, cost-minimizing) level nor, when agents chose both activity and care levels, the predicted difference in activity levels. More important, the legal rule apparently has a great effect on the way subjects learn over the horizon of the experiment. In all strict liability experiments, subjects set excessively high care levels in the early rounds of the experiments and then decreased them over time. In the final rounds, subjects chose care levels significantly below those predicted by the theory.

Under a negligence rule, no such pattern is observed. As will be seen, these differential learning patterns greatly affect the performance of these rules. For instance, the rule of negligence consistently outperformed the strict liability rule in terms of accident costs. This result occurred both in experiments in which the care standard was set optimally and in those in which it was set too strictly. Such a domination of rules obviously bears on the choice of liability policy, as a policymaker facing incomplete information is unlikely to know the optimal care level. Results suggest that the performance of the negligence rule may be robust to overly strict specifications of the standard of care.

We proceed as follows. In Section II, the economic model of liability will be outlined and our hypotheses stated and derived. Section III will describe our experimental procedures and design. Section IV will present our results, and Section V will offer some concluding remarks and discuss some planned extensions of this research.

II. The Economic Theory and Our Hypothesis

In this article we consider the simplest possible accident model in which the actions of a single individual determine the expected frequency of occurrence of a loss. We follow the economic literature in characterizing an "accident" as a loss, the expected frequency of which is determined by the actions of one or more individuals. The legal rule determines who in society shall bear the loss. Common law rules have generally restricted loss bearing either to the person (often designated the "victim") on whom the loss would fall in the absence of a legal rule or to some other person (designated the "injurer") causally related to the occurrence of the loss.[3]

[3] Virtually all economic analyses of accidents focus on "economic," as opposed to "personal" (or "noncompensable"), losses. In the models, the agents' choices determine the

The Theory

Let x denote the level of care adopted by the agent/injurer. We assume x is nonnegative. The cost of care is r per unit. Further, let $p(x)$ denote the probability that a loss of amount A occurs given that an agent has adopted a care level of x. We assume that $p'(x) < 0$, and $p''(x) > 0$. Assuming risk neutrality, the social optimum is given by minimizing over x:

$$W(x) = rx + p(x)A, \tag{1}$$

which has the first-order condition

$$p'(x) = -r/A. \tag{2}$$

Let x^* solve this problem.

The agent's choice of x will depend on the legal rule that determines liability for losses. Anglo-American common law has focused on legal rules that condition liability on the level of care chosen and bound liability from above by the amount of the loss A. In the single-agent context, all legal rules can be characterized by a single parameter called the standard of care, X. Let $L(x,X)$ represent the agent's share of liability as a function of the standard of care and his choice of care level. Then $L(x,X)$ has the following form:

$$L(x,X) = \begin{cases} 1 & x < X, \\ 0 & x \geq X. \end{cases}$$

A standard of care, $X = \infty$, is generally called "strict liability" because the agent always bears the entire loss, while $X = 0$ is a rule of no liability. Any positive finite X yields a "negligence" rule with standard of care X.

The agent's choice of care level $\hat{x}(X)$ will be a function of the standard of care X. Clearly, a risk-neutral actor will choose $\hat{x}(X)$ to minimize

$$rx + p(x)AL(x,X). \tag{3}$$

Under strict liability, the agent adopts the socially optimal level of care. One easily determines the actor's optimal response to a negligence rule with standard of care $X < \infty$. Clearly, it is never optimal to choose $\hat{x}(X) > X$ because increasing $\hat{x}(X)$ increases the cost of taking care without reducing expected liability costs below zero. Consider, then, the agent's choice of x in the interval $[0,X]$. Either he adopts $\hat{x}(X) = X$ or he adopts that $\hat{x}(X) < X$, which minimizes his costs given that he bears the cost of the

distribution of a random variable, the loss. The legal rule then merely assigns a "property right" to whatever loss is realized. This description of a loss excludes from consideration many personal injuries. For a discussion of personal loss, see Shavell, Economic Analysis, *supra* note 2.

accident. This cost-minimizing $\hat{x}(X) = x^*$ is the socially optimal level of care. Thus, the agent will adhere to the standard of care as long as

$$rX \leq rx^* + p(x^*)A. \tag{4}$$

Let $\tilde{X}$ be the largest X satisfying (4). For all $X \leq \tilde{X}$, $\hat{x}(X) = X$, while for $X > \tilde{X}$, $\hat{x}(X) = x^* < X$. If we specify $p(x) = 1/x$, as we do in the experiments that follow, then

$$x^* = (A/r)^{1/2}, \tag{5}$$

$$\tilde{X} = 2x^*. \tag{6}$$

Inequality (4) has the following implications. When X is set equal to or less than $\tilde{X}$, agents choose care levels equal to X, while if X is set above $\tilde{X}$, agents abandon X and choose a care level of x^*.

The economic theory of accident law has additional implications when we permit the agent a second decision variable. The frequency of accidents depends generally not only on the level of care adopted by the actor but also on the intensity with which he chooses to engage in the activity. Introducing the choice of activity level, denoted by s, requires several modifications of equations (1) and (3). First, the actor must benefit in some way from increases in activity level. Second, the functional relationship of activity and care levels to both the cost of care and the frequency of accidents may take any number of forms. In the experiments below, we adopt a functional form in which the optimal level of care is independent of the choice of activity level. Such a specification models some important accident situations, such as driver's care, the optimal level of which is independent of miles driven. It is more significant that the independence assumption presents the most favorable circumstances in which to test the theory because subjects may more easily learn the optimal activity level and care level. Consequently, we adopt the specification of agent utility,

$$V(s,x;X) = u(s) - s[rx + AL(x,X)/x]. \tag{7}$$

Identifying the social optimum with strict liability yields, in addition to the first-order condition (2) for x, the first-order condition of s:

$$u'(s) = rx + A/x. \tag{8}$$

Let $s(x)$ solve (8) with $s^* = s(x^*)$, the optimal activity level given the optimal choice of care.

Consider now a rule of negligence with $X = x^*$. We have seen that when the agent has a choice only of care level, this rule is equivalent to strict liability as the actor will choose $x = x^*$ in both. When a choice of activity level is introduced, however, the first-order condition for s with optimal care levels accounted for becomes

$$u'(s) = rx^*. \tag{8'}$$

Let s_n denote the solution to (8′). The term s_n is the actor's optimal choice of activity under a rule of negligence with the standard of care set optimally at x^*. As we assume that u is strictly concave, equations (8) and (8′) imply $s_n > s^*$. Equation (8′) indicates that when activity levels as well as care levels are chosen, more activity will be engaged in when negligence, rather than strict liability, is the rule.

Our Hypotheses

These theoretical results yield the following three hypotheses.

HYPOTHESIS 1: RULE EQUIVALENCE. If a rule of negligence sets the due-care standard at the socially optimal level of care, then the level of care taken by a potential injurer is identical to that which would be taken under a rule of strict liability.

HYPOTHESIS 2: CARE STANDARD ABANDONMENT. If the due-care standard is set slightly above the socially optimal level, then rational economic actors will adhere to the standard of care; if the standard of care is set sufficiently above the socially optimal level, then rational economic agents will abandon it and choose that level of care consistent with the strict-liability rule.

HYPOTHESIS 3: ACTIVITY AND CARE LEVEL. When an economic agent chooses both an activity level and a care level, his activity level under a rule of negligence with the due-care standard set at the optimal level of care will exceed his activity level chosen under strict liability.

In short, the economic theory predicts that, when agents choose only levels of care, if a standard of care is appropriately set (that is, set at the socially optimal level) the rules of negligence and strict liability are equivalent. However, rational economic agents will adhere to our inappropriately set standard of care (in other words, one that is set artificially high) until some critical point when the agents will abandon them and choose ones that are lower but consistent with the rule of strict liability. Finally, for appropriately set standards of care, economic agents will always engage in more potentially dangerous activities when a rule of negligence is used than when a strict-liability rule is in place.

One difference between legal theorists and economists concerns hypothesis 2. According to some lawyers, agents will choose to obey the law even if such obedience runs counter to their self-interest, narrowly defined. Two distinct hypotheses might explain this postulated behavior.

Our hypothesis 2′ rests on the idea that the legal standard serves as a focal point; agents adhere to the standard because it resolves their decision problem quickly and without cost. This explanation motivates our hypothesis 2′.

HYPOTHESIS 2′: NEGLIGENCE STANDARDS AND FOCAL POINTS. Even when a specified standard of care is set sufficiently above the socially optimal level, there will be a tendency for economic agents to adhere to it, rather than abandon it, and to set care levels above those induced by strict liability.

Note that hypothesis 2′ does not follow from the economic theory but is simply a behavioral hypothesis.

Adherence to the legal standard, even when that adherence runs counter to the agent's self-interest, might also result from the normative (or moral) force of legal rules. As we are dissatisfied with our attempt to test this idea in the laboratory, this article does not treat this possibility in detail.[4]

III. EXPERIMENTAL PROCEDURES

A total of ten experiments were run to test the hypotheses listed above. All experiments were run on personal computers with a set of 113 subjects recruited from undergraduate economics classes at New York University. Each experiment lasted approximately one hour. Payoffs were denominated in a fictitious currency called francs and converted into dollars at the end of the experiment at rates which were known to the subjects. Average payoffs were in the range of $12.75. These payoffs seemed more than enough to motivate the subjects.

The Experiment

A typical experiment was conducted as follows.[5] Students arrived at a computer lab and were seated and given written instructions. After the subjects read the instructions, an experiment administrator would first read them aloud and then answer any questions. The instructions informed subjects that they were engaged in a decision-making experiment that would last for 35 periods. In each period they would be asked to choose a "decision number" from the set of integers between 1 and 100, inclusive. Choosing this "decision number" had two consequences.

[4] The alternative hypothesis might be phrased as *hypothesis 2″: Adherence and Language*. At least among laboratory subjects, the cloaking of liability rules in more value-laden language should lead to greater adherence to them by a population of economic agents.

[5] Copies of the sets of instructions are available from the authors.

First, there was a cost of r francs per decision number chosen. The parameter r was varied across experiments but was the same within any experiment. Second, the decision number chosen determined the probability that an "event" would occur which would cost him A francs. The probability of an event occurring in any round was determined by the function $p(x) = 1/x$, and this function was described to the subjects graphically in the instructions. If a rule of strict liability was in place during an experiment, then the subject had to pay A any time an event occurred. If a rule of negligence was in place, the subject only had to pay A when an event occurred if he chose a decision number below the announced "critical number" (care standard). In any round of the experiment, the subject would choose a decision number and enter it into the computer. The computer would then inform the subject whether an event had occurred or not. Payoffs were determined as follows. At the beginning of each round, a subject would be given an endowment of E francs. All costs incurred would be subtracted from this endowment. Hence, if a subject chose a decision number of x and an event occurred which he was liable to pay for, his payoff would be $E-rx-A$. If he was not liable, his payoff would be $E-rx$.

Given the probability of event function $1/x$, the parameters in the experiment were then E, A, r, and X (the liability rule). After the completion of any round of the experiment, subjects proceeded to the next identical round. Payoffs at the end of the experiment were simply the sum of the payoffs in each round.

Choosing Parameters

Our ability to choose parameters for the experiment was constrained by the equilibrium condition (4) for single-decision experiments and (4) and (8) or (8′) for multidecision experiments. In addition, we strove to provide incentives for our subjects both to maximize and to avoid negative payoffs. In all single-decision experiments, it was impossible for negative payoffs to result. Negative payoffs were theoretically possible for multidecision experiments; for these, we supplemented the final payoff to subjects with a fixed, preannounced dollar endowment, to absorb "reasonable" losses that might have occurred. No such losses did, in fact, occur.

Experimental Design

Table 1 presents our experimental design. As can be seen, ten experiments were performed. Two of these, experiments 3 and 6, attempted to test the normative effect of legal rules. We do not discuss these experi-

TABLE 1

EXPERIMENTAL DESIGN

Experiment	Parameters			Liability Rule	Equilibrium Care, x	Equilibrium Activity, s	Language	No. of Subjects
	E	A	r					
1	1,000	900	1	strict liability	30	N.A.	low	11
2	1,000	900	1	negligence	30	N.A.	low	11
3	1,000	900	1	negligence	30	N.A.	high	12
4	2,000	400	16	strict liability	5	N.A.	low	10
5	2,000	400	16	negligence	5	N.A.	low	10
6	2,000	400	16	negligence	5	N.A.	high	14
7	2,000	400	16	negligence	5	N.A.	low	12
8	2,000	400	16	negligence	8	N.A.	low	14
9	440*	400	16	strict liability	5	2	low	7
10	440*	400	16	negligence	5	4	low	12

NOTE.—N.A. = not applicable.
* In these experiments $U(s) = 1,560\ s^{1/6}$.

ments here.[6] In experiments 1, 2, and 3 the parameter values were set at $E = 1{,}000$, $r = 1$, and $A = 900$. The cost-minimizing decision number is $x^* = 30$, with an equilibrium probability of 1/30. Experiment 1 contained a strict liability rule, while experiment 2 had a negligence rule with $X = 30$. Clearly, a comparison of the results of experiments 1 and 2 presents us with a test of hypothesis 1.

Because we feared that the equilibrium of experiments 1–2 (with $x^* = 30$) would determine too few events (the expected number is only 1.16 at equilibrium) and, hence, too little opportunity for subjects to learn, we decided to run a similar set of experiments in which, at equilibrium, the probability of an event or accident occurring was considerably higher. Hence, in experiments 4–8 we set $E = 2{,}000$, $r = 16$, and $A = 400$. This yields a cost-minimizing x^* of 5, an equilibrium probability of event of 1/5, and seven expected events at equilibrium. In these experiments, experiment 4 was a strict-liability experiment and experiment 5 a negligence experiment with the due-care standard set at five.

Experiments 7 and 8 used the same parameter values as experiments 4–6 and were run to test hypotheses 2 and 2′. In experiment 7, the negligence standard was set at 18. Since, from (4) and (6), we know that whenever $X > 2x^*$, the prescribed due-care standard should, under hypothesis 2, be abandoned and x^* chosen, we would expect to observe an x of 5 chosen here. Hypothesis 2′, by contrast, predicts adherence, even to this too-high standard of care. In experiment 8, we set $X = 8$. Since this does not violate (4), we expect a care level of 8 to be observed.

Experiments 9 and 10 investigate the theory of multidecision accidents. In these experiments, in addition to choosing decision levels, subjects were asked to choose an activity level between zero and 6 in each round. In addition to a fixed endowment of $E = 440$, the subsets received a variable endowment determined by the function $u(s) = 1{,}560s^{1/6}$. Hence,

[6] In experiment 3 we repeated the negligence experiment of experiment 2 but with modified instructions. More precisely, the instructions in experiment 3 were identical to those in experiment 2 except that events were called "accidents," decision numbers were called "care levels," and critical numbers were called the "legal care standard." This experiment was run to test hypothesis 2″ since, if the law is expected to have a moral force of its own, we would expect that this force would be greatest when richer types of language are used. Experiment 6 was identical to 5 except for the use of rich language.

A comparison of the results of experiment 3 to those of experiment 2 and those of experiments 5 and 6 was meant to test the normative effect of law. Such a comparison is presented in Figures 1 and 2. As can be seen, while the use of a richer type of language had virtually no effect on the behavior of subjects in the latter rounds when the negligence standard was set at 5 (Figure 2), it tended to nudge care levels below those observed for the low-language case when the care standard was set at 30 (Figure 1), as it was in experiment 2. This result is pervasive; the "normative" force of the law appears to have induced agents not only to act against their self-interest but also to ignore the focal point effect postulated in hypothesis 2′. Given this paradoxical result, we deferred study of the normative effects of law.

in the beginning of each round after subjects chose their activity levels, they were endowed not only with their initial endowment of 440 but also with an amount of francs equal to their utility as derived from the number of activities they chose. All costs and losses were subtracted from this initial endowment. Note that when a subject chooses $s = 1$, the experiment is identical to those of the single-decision experiments 4–6, as $E = 440 + 1{,}560 = 2{,}000$. Experiment 9 was a strict-liability experiment while experiment 10 was a negligence experiment with $X = 5$. Because we feared that these experiments would be harder for subjects to understand, we used experienced subjects in them, namely, subjects who had already performed in some single-activity experiment. By comparing the results of experiments 9 and 10, we can perform a test of hypothesis 3.

IV. Results

To present our results, we will investigate our hypotheses in sequence. Thereafter, we will discuss the efficiencies exhibited by our various liability rules. Finally, we will discuss the effect of our liability rules on how subjects learn to adapt their behavior. For a general overview of the results, we present Table 2, which presents the means, medians, and standard deviations of subject care (and activity level) choices over the first 15, second 10, and last 10 rounds of the experiments. Due to the sensitivity of means to outliers in small samples, we will do most of our descriptive and statistical analysis using medians, as these are robust to the movements of outliers.[7]

Hypotheses

Hypothesis 1. Hypothesis 1 is investigated by comparing the results of experiments 1 and 2, and 4 and 5. Figure 3 compares the median

[7] A brief examination of Table 2 suggests that the use of means rather than medians would not alter the relative comparison between strict liability and negligence, although other conclusions might be modified. Compare experiment 1 (strict liability) to experiment 2 (negligence). In both, the theory predicts that the injurer should adopt the socially optimal decision number of 30. In the early rounds, the mean choice under strict liability exceeds the mean choice under negligence. In late rounds, the mean choice under strict liability is below the mean choice under negligence. This pattern is identical to the pattern of median choices. Moreover, under strict liability, the mean choice in late rounds is, in fact, less than the predicted (optimal) choice. Under negligence, however, the mean choice exceeds the predicted choice, a not surprising result because the standard of care effectively sets a lower bound to the injurer's choice. The pattern of means in experiments 4 and 5, when the predicted and optimum choice is 5, follows the same pattern. Note that, in the strict-liability experiment, the mean, though below 5, remains close to 5 because the range of choices below 5 is small relative to the range available above.

Our discussion of efficiencies in Section IV below confirms the observations made above. The text of Section IV reports efficiencies based on the medians. In notes 9 and 10 *infra*, we report the efficiencies based on the means.

decision number chosen by subjects in experiments 1 and 2 over each round of the experiments. As can be seen, while care levels start out being far larger in the strict-liability-rule experiment (experiment 1) than in the negligence experiment (experiment 2) (for example, 51 vs. 31 in round 1), eventually, after approximately round 26, they become smaller (for example, 6 vs. 30 in round 35). Figures 4 and 5 show the observed medians, round by round, and the predicted optimal care levels in these experiments.

Because experiments 1 and 2 defined equilibrium care levels of 30 and accident probabilities of 1/30, we feared that the extremely low frequency of accidents at the equilibrium could be responsible for the lower-than-predicted care level associated with subjects in experiment 1. To investigate whether this was indeed the problem, we ran experiments 4 and 5, whose results are presented in Figures 6, 7, and 8. Here again, however, we see the same pattern. While subjects in the negligence experiment (experiment 5) appear to choose their predicted care level of 5 practically from round 1 on, subjects in the strict-liability experiment (experiment 4) again start out choosing excessive care levels (a median of 35 in round 1) and eventually lower these levels below both those predicted by the theory and those observed in experiment 5 (a thirty-fifth round median of 3 as opposed to a thirty-fifth round median of 5 in experiment 5).

To test this hypothesis more rigorously, we first tested whether the round-by-round medians observed in experiments 2 and 5 (the negligence experiments) came from a population with a median of 30 and 5, respectively. In no round of either experiment could this hypothesis be rejected at the 5 percent level of significance. The same could not be said of the strict-liability experiments (experiments 1 and 4). In experiment 4, for example, in seven of the first 8 rounds we could reject the hypothesis that the observed median came from a population whose median was 5 in favor of the one-tail alternative hypothesis that it was higher, while in five of the last six rounds of this experiment we could reject the same null hypothesis in favor of a lower alternative. The null hypothesis could not be rejected at the 5 percent level of significance in any consistent manner in experiment 1. However, a Wald-Wolfowitz test does reject the null hypothesis that the observations in experiments 1 and 2 came from the same populations.

In summary, in our laboratory experiments, strict liability and negligence do not seem to yield equivalent behavioral results. We will discuss what consequences this fact might have for social policy later.

Hypotheses 2 and 2′. To test hypotheses 2 and 2′, we compare the results of experiments 7 and 8 to those of experiment 4. If the theory were to predict correctly, we should observe care levels of 5 in both experiments 4 and 7 and care levels of 8 in experiment 8. Figure 9 presents the

TABLE 2

CARE AND ACTIVITY LEVELS, EXPERIMENTS 1–10,

	ROUND								
EXPERIMENT	1	2	3	4	5	6	7	8	9
1:									
Mean	57.54	46.90	48	54.36	45.09	44	52	42	46
Median	51	37	48	51	41	38	44	37	37
SD	33.33	35.16	27.41	32.38	30.52	26.75	27.70	27.39	29.40
2:									
Mean	44.27	38.54	39.72	39.18	39.18	46.09	42.09	42.09	39.90
Median	31	30	31	31	30	31	31	31	31
SD	27.32	27.74	30.62	29.44	29.52	30.96	30.21	33.27	31.04
3:									
Mean	26.33	23.08	23.5	22.75	23.58	24.58	21	20.83	20.16
Median	30	26.5	29.5	30	30	30	28.5	27.5	26.5
SD	9.860	9.482	9.699	10.26	11.78	9.767	10.48	11.22	12.15
4:									
Mean	39.7	30.2	26.8	19.5	26.6	19.3	20.6	12	9.5
Median	35	25	14	18.5	11.5	13.5	13	8.5	5
SD	28.16	22.85	22.56	13.92	28.33	13.08	21.38	8.694	7.392
5:									
Mean	17.3	24.6	11.2	10.8	11.4	10	5.1	12.5	5.7
Median	4.5	5.5	4	4	6.5	6	4.5	4.5	4.5
SD	22.73	27.98	14.91	15.83	10.88	8.544	2.913	20.45	5.020
6:									
Mean	17.30	16	15	15.46	17.38	18.23	12.46	11.92	14.46
Median	10	7	8	7	15	10	9	9	7
SD	16.05	13.62	12.13	13.22	13.49	18.49	10.39	8.642	13.66
7:									
Mean	10.33	11	9.333	8.25	7.833	10.25	10.83	9	7.083
Median	11.5	9	5.5	5	5.5	7.5	6	6	5.5
SD	7.408	8.406	8.730	6.417	5.927	7.980	12.98	7.280	5.219
8:									
Mean	11	10.72	9.818	10.27	10.54	11.27	6.090	6.818	7.181
Median	8	8	8	8	8	7	5	6	5
SD	8.034	9.245	10.43	7.224	7.253	14.72	3.776	4.085	5.373
9:									
Activity Level:									
Mean	3.428	3.428	4.428	3.285	3.142	3.285	3.714	2.285	3.857
Median	3	3	5	3	2	3	4	1	5
SD	1.590	1.498	1.399	1.905	2.030	2.185	1.979	1.577	2.231
Care Level:									
Mean	21.14	18.57	16.14	11	12.42	15.85	14.85	11.42	13.85
Median	15	20	10	4	4	10	5	5	6
SD	19.10	15.91	15.55	16.22	16.48	16.40	16.29	15.51	13.70
10:									
Activity Level:									
Mean	3.583	4.583	4	4.083	4.75	3.333	4.083	3.833	3.833
Median	3.5	4	4	4	5	3	4	4	4
SD	1.320	1.114	1.154	1.320	1.361	1.649	1.037	1.280	1.213
Care Level:									
Mean	7.166	7.416	9.916	6.25	7.75	12	5	4.666	5.25
Median	5	5	5	5	5	5	5	5	5
SD	4.930	4.443	12.94	2.165	9.747	20.42	.816	.942	.829

TABLE 2 (*Continued*)

Experiment	Round 10	11	12	13	14	15	16	17	18
1:									
Mean	50.63	42.54	41.36	41.45	46.36	38	34	46.45	43.63
Median	50	35	31	35	40	28	24	50	49
SD	28.46	27.51	27.98	27.88	26.63	24.35	27.54	28.70	23.13
2:									
Mean	46.27	38.45	39	38.63	36.90	38.45	38.18	38.36	37.90
Median	31	31	31	31	31	31	31	31	31
SD	32.81	29.98	29.44	29.68	31.27	30.52	30.78	30.52	30.98
3:									
Mean	22	19.5	20.41	22.91	21.25	21	21.33	20.33	20.08
Median	30	27	26.5	29	28.5	27.5	28.5	24.5	23.5
SD	11.53	12.15	11.39	10.41	10.55	10.55	11.27	10.75	10.79
4:									
Mean	8.6	15.2	6.9	9.9	4.9	7.3	15.2	7.3	5.9
Median	4.5	5	4	5.5	3.5	5	7	7	4.5
SD	8.581	23.71	7.091	10.28	2.947	6.356	20.21	4.220	4.369
5:									
Mean	6.2	12.8	5.5	5.5	13.4	14.8	15	9.9	13.4
Median	4.5	5	4	4	4.5	7.5	5	4.5	5
SD	4.214	18.93	5.103	3.556	21.51	16.74	15.51	13.08	14.26
6:									
Mean	12.61	10.46	13.46	13	10.15	12.92	12.30	11.53	12.84
Median	5	5	7	6	6	10	5	10	10
SD	11.37	7.742	12.34	11.46	7.262	12.52	10.76	7.499	10.08
7:									
Mean	7.916	15.75	7.583	11.41	9.166	14.5	10	13.41	9.5
Median	5.5	6	5	13	5.5	9	7	9	6
SD	6.563	19.84	6.277	7.239	7.436	16.45	7.527	11.62	7.088
8:									
Mean	6.454	13.54	10.90	14.36	7.545	9.181	6.545	12.27	7.181
Median	6	5	8	6	7	5	6	8	6
SD	3.576	20.48	11.55	24.03	5.789	9.301	4.356	18.51	5.828
9:									
Activity Level:									
Mean	3	3.571	3	4	3.285	3.571	3.857	3.285	4.428
Median	4	3	3	5	3	4	4	3	4
SD	1.851	1.916	1.690	2	1.979	1.761	1.726	1.979	1.178
Care Level:									
Mean	8.571	9.428	9.857	6.714	7.857	8	6.571	6.714	6.857
Median	4	4	5	5	4	4	4	3	5
SD	8.973	10.25	10.61	5.573	11.55	11.05	5.876	7.703	5.717
10:									
Activity Level:									
Mean	3.333	3.25	3.75	3.916	3.583	4.166	3.833	3.75	3.666
Median	4	3.5	4	4	4	4	4	3.5	4
SD	.942	1.479	1.010	1.114	1.255	1.280	.552	1.089	1.105
Care Level:									
Mean	4.833	5	5.166	8.166	13.33	5.083	4.75	5.083	4.916
Median	5	5	5	5	5	5	5	5	5
SD	1.572	1.354	1.343	8.203	25.85	.493	.924	1.656	1.037

TABLE 2 (*Continued*)

	ROUND								
EXPERIMENT	19	20	21	22	23	24	25	26	27
1:									
Mean	36.72	32.81	31.18	40.90	35.09	31.27	28	27.72	22.09
Median	37	33	30	40	37	37	37	30	25
SD	22.84	23.73	23.15	23.87	23.25	18.60	15.64	16.79	16.14
2:									
Mean	37.63	37.09	37.45	37.90	37.54	35.63	36.63	35.09	35.81
Median	31	31	31	31	31	31	31	30	31
SD	31.34	31.12	31.12	30.72	30.45	31.98	31.09	31.83	31.74
3:									
Mean	18.91	19.33	19.75	25.41	25.58	21.41	21.5	19	20.75
Median	22	22	22.5	28.5	27	30	30	22	27
SD	11.36	11.21	11.45	25.35	22.17	11.48	11.56	10.85	11.15
4:									
Mean	6.6	6.9	8.8	7.6	7.8	6.2	4.9	6.3	6.6
Median	5	5.5	5.5	6	5	3.5	3.5	4.5	5
SD	3.583	3.672	5.473	5.462	5.741	5.617	4.323	4.290	5.023
5:									
Mean	7.5	13.9	8.2	6.2	8.2	5.3	18.6	6.6	8.3
Median	5.5	5	5	5	5	5	5	5	5
SD	4.716	21.48	6.046	6.144	5.114	2.368	26.26	5.782	8.764
6:									
Mean	10.23	11.07	8.923	11.76	10.84	9.384	10.38	10.69	11.46
Median	8	8	5	5	7	5	5	5	5
SD	7.806	9.294	6.450	14.68	8.663	8.553	7.641	9.650	12.83
7:									
Mean	9.666	8.833	12.75	10.58	11.58	11	8.833	13.5	14.58
Median	6.5	6	6.5	7	7	7	5	5.5	7
SD	6.649	6.962	11.66	7.308	7.376	7.257	6.938	18.13	16.83
8:									
Mean	10	11.90	8.909	12.09	6.818	10.45	6.636	6.272	8.272
Median	8	6	6	6	6	8	8	6	6
SD	12.66	18.66	6.855	19.18	6.464	13.63	3.282	3.694	8.613
9:									
Activity Level:									
Mean	4.428	4.285	3.571	3	3.571	3.571	3.857	3.857	3.857
Median	5	5	4	3	4	4	4	5	4
SD	1.916	1.905	1.761	1.690	1.590	1.840	1.807	2.030	1.807
Care Level:									
Mean	6.285	3.714	3.142	3.428	3.857	5.857	3.571	4	3.714
Median	3	3	3	4	3	3	4	3	4
SD	7.722	1.665	.638	.728	1.355	5.816	.494	1.851	1.030
10:									
Activity Level:									
Mean	3.833	4.333	4.083	4.083	4.416	4.083	3.416	4	3.833
Median	4	4	4	4	4	4	3.5	4	4
SD	.986	1.027	.953	1.037	1.187	1.114	1.114	.912	1.518
Care Level:									
Mean	4.75	4.75	4.666	4.916	5.166	4.75	4.833	10.08	12.83
Median	5	5	5	5	5	5	5	5	5
SD	1.089	.829	.745	.759	.552	1.233	1.213	16.86	26.29

TABLE 2 (*Continued*)

EXPERIMENT	ROUND 28	29	30	31	32	33	34	35
1:								
Mean	25.72	19.54	23.81	25.36	19.54	18.72	25.36	21.45
Median	25	19	23	15	14	18	10	6
SD	16.90	13.72	13.44	27.15	13.95	14.52	27.29	26.09
2:								
Mean	37.72	36.72	36.63	37.81	37.27	34.90	34.09	33.45
Median	31	31	30	31	31	30	30	30
SD	30.71	31.13	31.16	30.56	30.81	32.06	32.59	33.07
3:								
Mean	18.66	20.25	19.41	21.25	20	21.5	21.5	16
Median	21.5	26	22	30	28	30	30	13
SD	10.27	11.27	10.57	11.52	11.53	11.55	11.47	11.32
4:								
Mean	5.2	5.6	4.9	4.4	4.1	4.3	4.6	4.2
Median	4	4.5	4.5	3.5	3	4	3	3
SD	3.893	3.773	3.360	3.469	2.426	2.647	3.878	3.655
5:								
Mean	9.6	7.8	6	7.9	15.8	6.4	7.2	5.9
Median	5	5	5	5	5	5	5	5
SD	9.329	7.249	3.687	7.006	28.34	3.382	6.446	3.238
6:								
Mean	9.769	9.846	8.384	9.384	8.692	7.923	10.46	7.230
Median	5	5	5	5	5	5	5	5
SD	9.439	7.940	7.869	10.94	10.56	7.975	13.86	6.314
7:								
Mean	9.583	9.666	8.666	11.33	9.75	10.41	8.333	9.5
Median	6	6	6	6.5	6.5	7	6.5	7
SD	6.885	6.195	5.676	8.984	6.709	6.885	6.032	5.866
8:								
Mean	9.545	11.90	7.090	8	14.18	7.454	10.45	11
Median	8	7	7	5	8	7	7	4
SD	11.33	14.27	5.664	9.155	19.67	7.278	11.32	15.23
9:								
Activity Level:								
Mean	2.714	3.857	3.571	3.857	3.428	3.571	3.428	3.285
Median	2	4	4	5	3	3	4	4
SD	1.905	1.807	2.060	1.884	1.761	1.916	1.989	1.829
Care Level:								
Mean	3	5.285	3	4.285	8.571	4.142	7.142	3.857
Median	3	4	3	4	6	4	4	4
SD	.755	4.060	.534	1.160	8.909	1.124	7.139	1.245
10:								
Activity Level:								
Mean	4.333	3.916	4	3.916	4.083	4.166	4.333	4.166
Median	4	4	4	4	4	4	4	4
SD	1.178	1.497	1.154	1.114	.953	1.142	1.105	1.067
Care Level:								
Mean	5.166	4.75	4.75	4.666	5	4.833	5	5.5
Median	5	5	5	5	5	5	5	5
SD	.372	1.163	1.010	1.027	.707	.687	.408	1.384

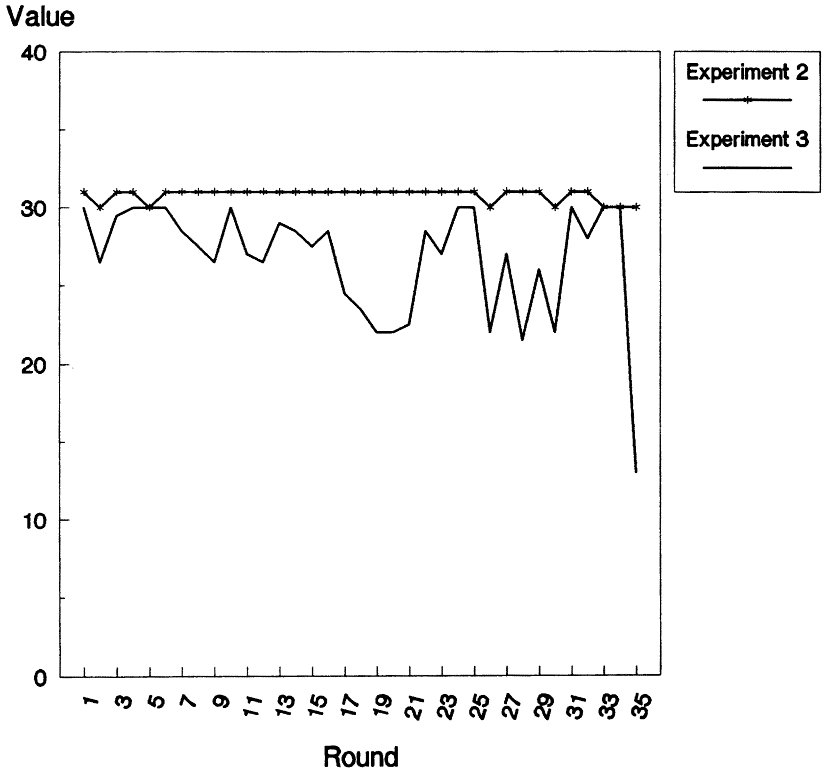

FIGURE 1.—Observed median care levels: experiments 2 and 3

round-by-round medians for these three experiments. As we see, in experiment 7, subjects did, in fact, abandon the prescribed standard of care of 18 in favor of lower ones.

A median test clearly rejects the hypothesis that 18 is the median for the observed data in 33 of the 35 rounds of experiment 7 in favor of a lower alternative. This rejection contradicts hypothesis 2′. While we cannot reject the hypothesis that subjects in experiment 7 chose care levels at the socially optimal level of 5, it does appear that they chose care levels above those chosen by subjects in experiment 4. In fact, care levels observed in experiment 7 are above those observed in experiment 4 (the strict liability experiment with $x^* = 5$) in all rounds after round 9.

In experiment 8, the due-care standard is set at 8, which is above the efficiency level of 5 but below the critical value of $2x^* = 10$. Hence, we

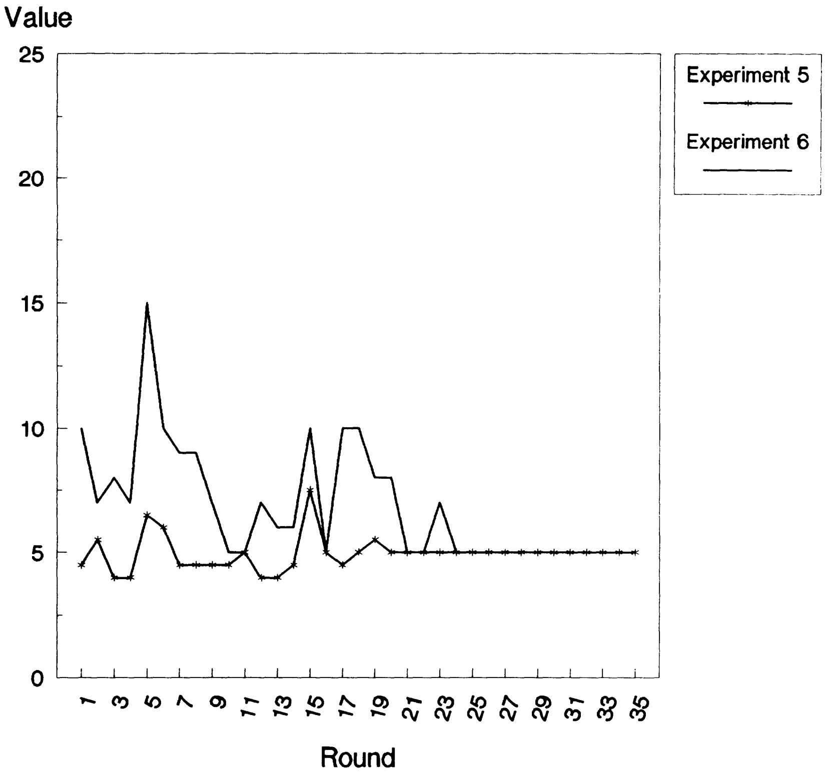

FIGURE 2.—Observed median care levels: experiments 5 and 6

should observe adherence to and not abandonment of the standard. As Figure 9 indicates, this is, in fact, what we see. Subjects appear to adhere to the due-care standard in this experiment. In fact, a median test run round-by-round indicates that the hypothesis that the median of the observed observations came from a population whose median is eight cannot be rejected in any round. The same test run to determine whether the population median was 5 rejects that hypothesis at the 5 percent level of significance in five of the first 12 rounds of the experiment.

HYPOTHESIS 3. Comparisons of the results of experiments 9 and 10 furnish us with the data to test hypothesis 3. In both experiments, the optimal choice of care level is $x = 5$. Under strict liability (experiment 9), both the optimal and equilibrium-level of activity, s^*, is 2, although the payoff difference between a choice of $s = 1$ and $s = 2$ is small. Under

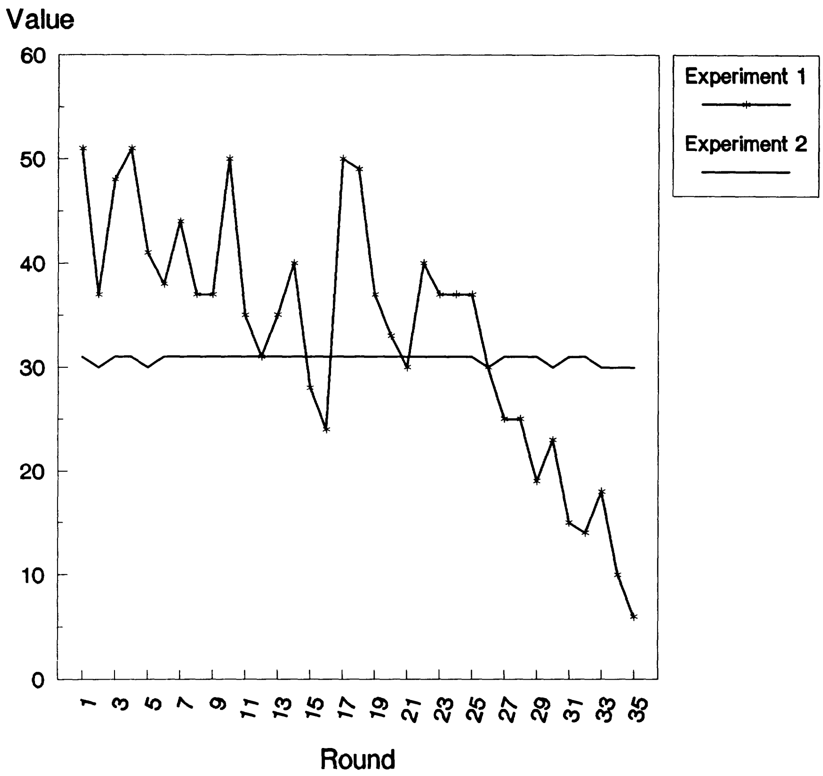

FIGURE 3.—Observed median care levels: experiments 1 and 2

negligence (experiment 10), while the socially optimal activity level remains 2, the equilibrium level $\hat{s} = 4$, although the difference between $s = 4$ and $s = 5$ is small. Hypothesis 3 therefore predicts that we would observe greater levels of activity in experiment 10 than in experiment 9. The median care levels observed in these experiments are presented in Figure 10, while the median activity levels are presented in Figure 11. As can be seen, in terms of the care levels chosen by our subjects in these two experiments, we observe the same pattern exhibited in the comparisons of the results of experiments 1 and 2, and 4 and 5. Again, care levels in the strict-liability experiment start out above those of the negligence experiment and then decrease, finally ending up below them. The behavior of the median care levels in experiments 4 and 9 indicate similar, if not identical, behavior. However, it is interesting to note that, in the early rounds of experiment 9, care levels tend to be below those observed in

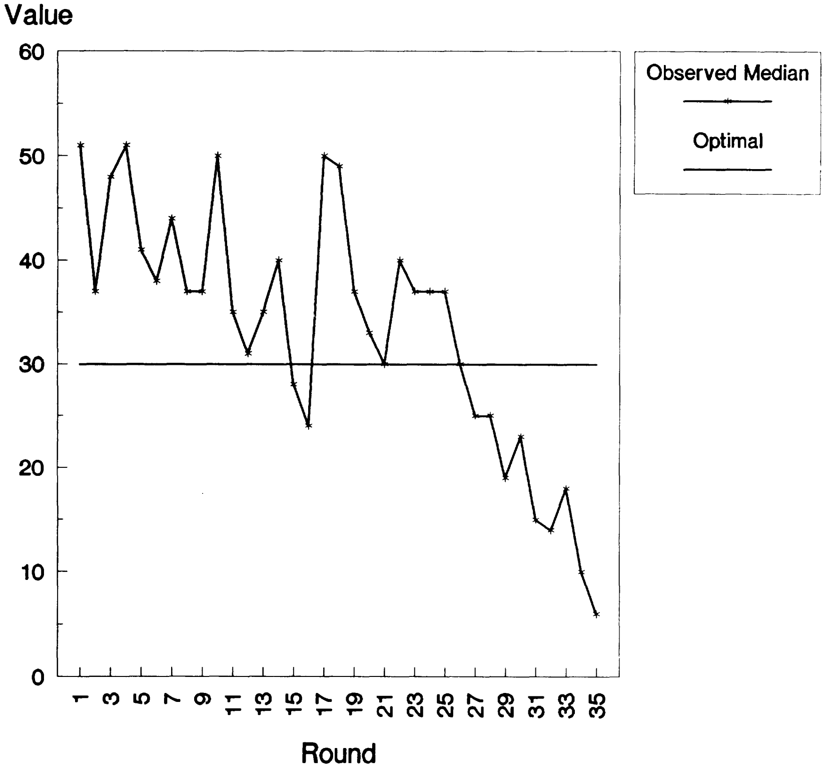

FIGURE 4.—Observed median and optimal care levels: experiment 1

experiment 4, where no activity levels were chosen. In addition, while in experiments 1 and 2, and 4 and 5, it took approximately twenty-five periods for the median care levels of subjects in strict-liability experiments to fall below those of the negligence experiments, in experiments 9 and 10, it took approximately only nine periods. This difference may have resulted from the use of experienced subjects in experiments 9 and 10.

In Figure 11, which plots the round-by-round activity-level medians chosen in experiments 9 and 10, the activity levels chosen under strict liability seem more variable but there does not seem to be a significant difference in their levels. For example, a round-by-round test of the hypothesis that the data observed in experiment 10 came from a population which had the same median as that observed in experiment 9 indicates that this hypothesis could only be rejected in one round, round 19 at the 5 percent level of significance.

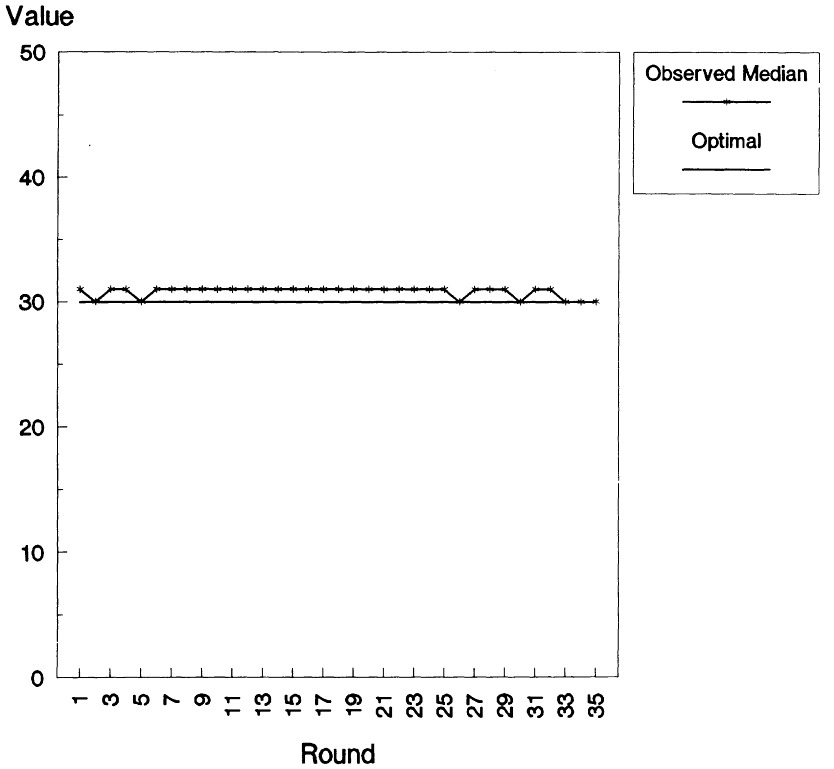

FIGURE 5.—Observed median and optimal care levels: experiment 2

Efficiencies and Public Policy

From a social policy point of view, the relevant question is which of the rules of law—negligence or strict liability—is more efficient in minimizing the ex ante expected costs of accidents and accident prevention. To answer this question, we need only look at the care levels chosen by our subjects and use them to calculate the associated costs of care and expected accidents. A major methodological question arises here, however, over which observations should be used in making these calculations. Typically, in economic experiments, all calculations are performed on the data generated in the last round of the experiment (or at least on data generated at the end of the experiment). This procedure is adopted in the belief that, in the real world, economic agents have greater experience in the situations they deal with on a daily basis. To replicate this experience

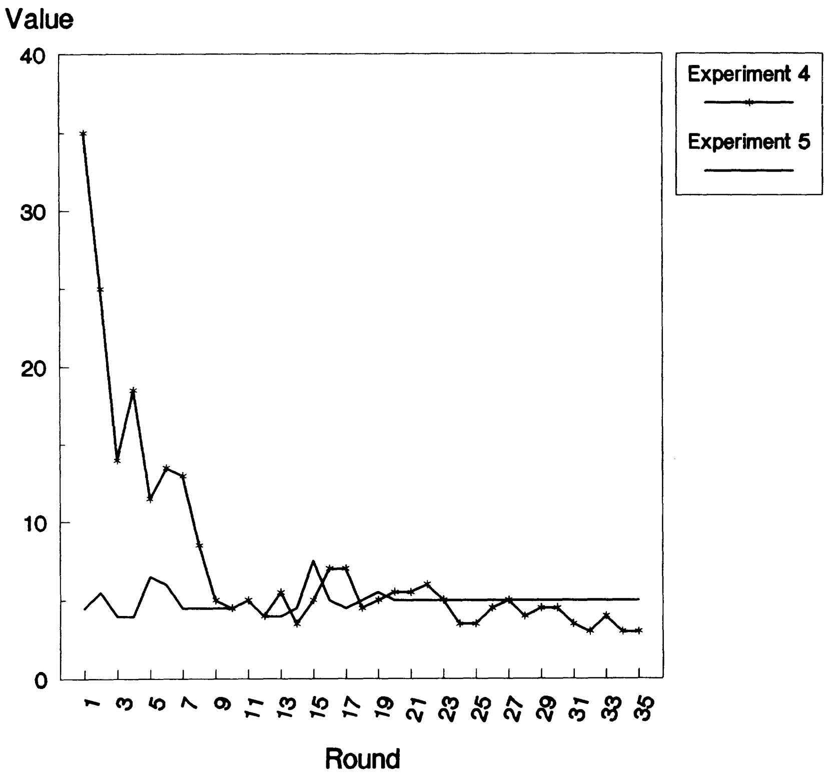

FIGURE 6.—Observed median care levels: experiments 4 and 5

in the lab, economic experiments are repeated a number of times and only at the end of the experiment has enough experience been gained to present the experimenter with meaningful data.

Subjects in the real world may not have as much experience as our subjects do when they reach the end of the experiment.[8] For instance,

[8] "Experience" is important because economic agents typically learn. They may, however, learn a variety of different lessons. Often, in economic experiments, the agents do not know some relevant economic parameter, such as market demand or market supply; through experience they "learn" sufficiently for the results to mimic competitive markets. In other economic experiments, though the subjects know all relevant parameters, they require experience to understand the nature of the strategic interaction of their choices.

In our experiments, subjects know all relevant economic parameters (so that a simple calculation would permit them to determine their best response to the situation) and they face no strategic interaction. Experience here serves to make real or concrete the probability of an event or accident as a function of their care level x (known to them as $1/x$).

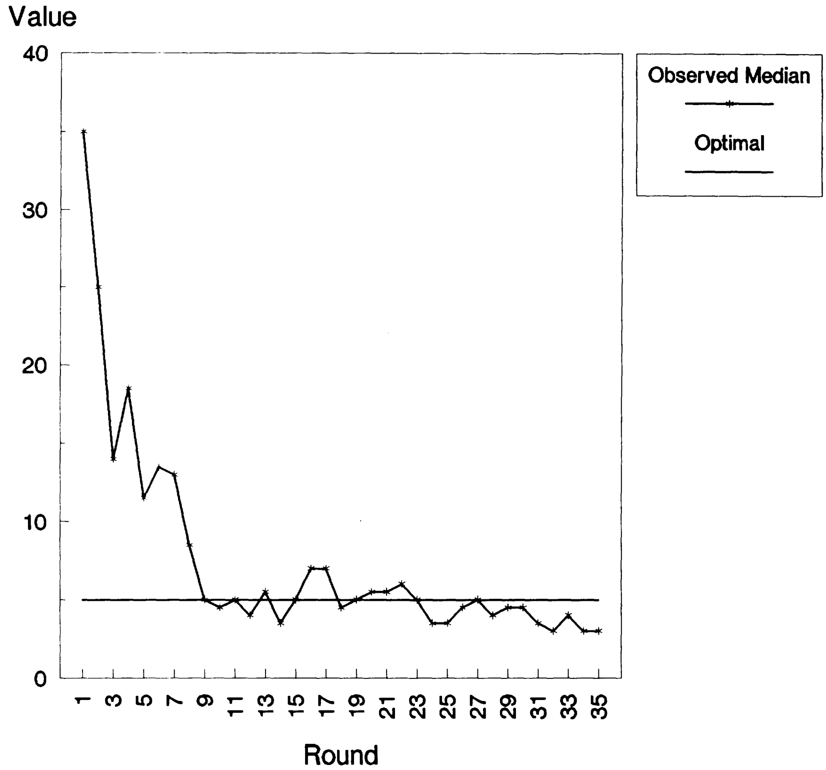

FIGURE 7.—Observed median and optimal care levels: experiment 4

people buy car insurance year after year, but in most cases they never make a claim or have an accident. Doctors pay malpractice insurance and may go an entire career without ever being sued (or without ever being sued more than once or twice). In our experiments, especially those in which the optimal care level is five, subjects may experience a substantial number of events or accidents that allow them to acquire experience that people in the real world never obtain. As a result, if we use our latter-round observations for our efficiency calculations, our calculations may lack outside validity. To remedy this, we present two sets of calculations, one based on data from the first ten and one on data based on the last ten rounds. The efficiency index we use is simple. Using equation (1) for any given subject with choice of care level x, let $W^i(x)$ be the expected costs of accident losses plus the cost of care. We then defined $E_i(x) = W_i(x)/W_i(x^*)$. The efficient choice of care level x^* implies that

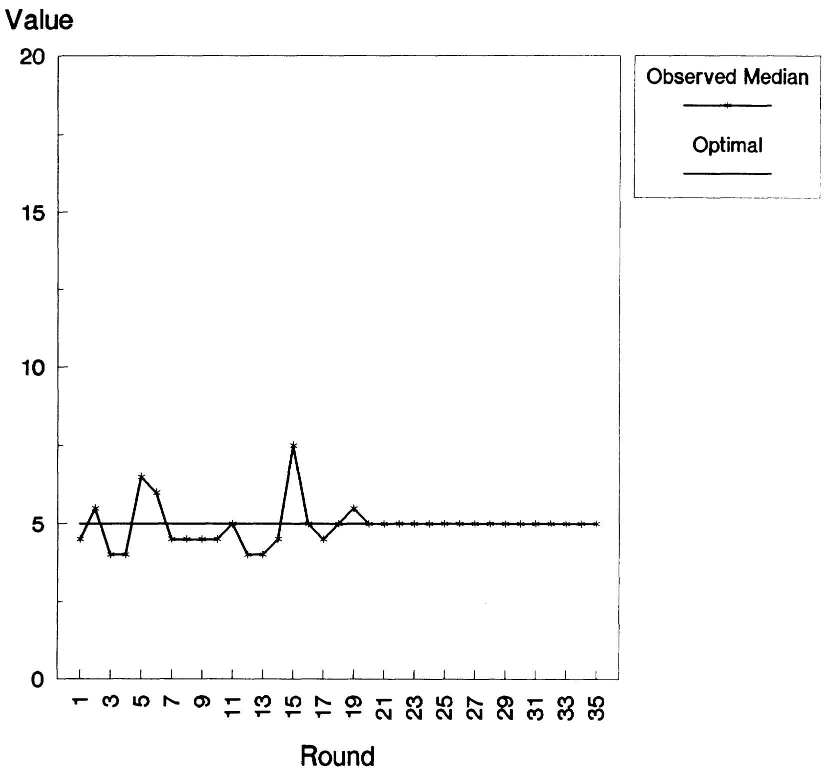

FIGURE 8.—Observed median and optimal care levels: experiment 5

$E_i(x^*) = 1$. Efficiency decreases as $E_i(x)$ rises; $[E_i(x) - 1]100$ gives the percentage of excess expected costs incurred by the subject.

Table 3 presents our efficiency indices for experiments 1 and 2, and 4 and 5; it also presents the number of events occurring in the first ten and last ten rounds of these experiments. There are two natural ways to calculate sample efficiencies. First, one might calculate the average efficiency for each choice of each subject in each of the first (or, correspondingly, last) ten rounds (the "mean of the efficiencies" approach). Second, one might consider the efficiency of the *median* choice in each round and average these ten median efficiencies ("the mean of the medians" approach). Consistent with our prior use of medians rather than means, we adopt this latter practice. The mean of the medians dampens the effects of outlier behavior and hence yields lower (thus, better or improved) efficiency indices. The qualitative results of the two sample

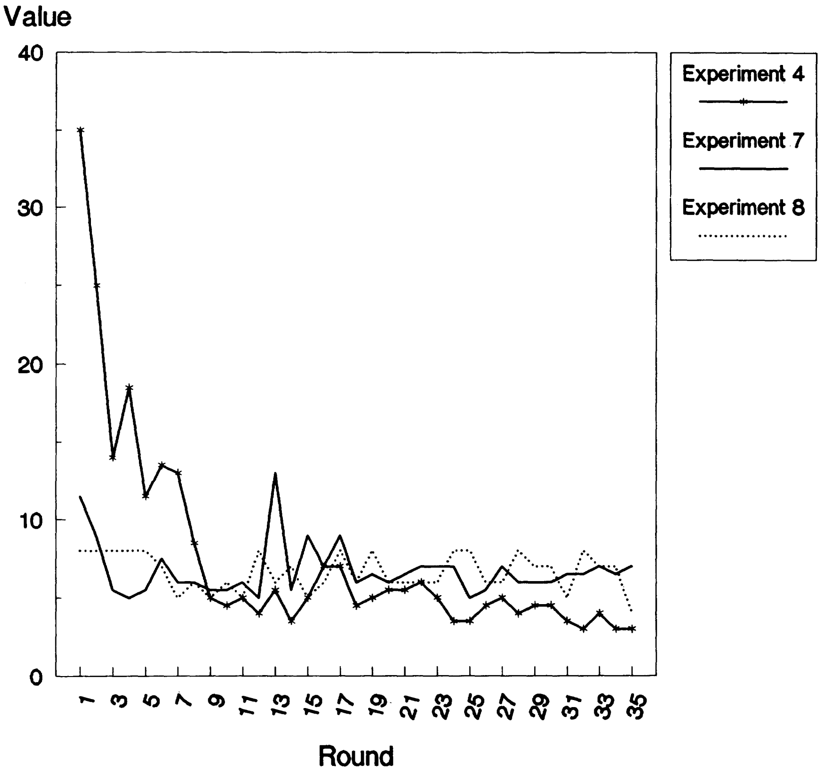

FIGURE 9.—Observed median care levels: experiments 4, 7, and 8

measures differ both when we compare strict liability to negligence with the standard of care set optimally and when we compare the efficiency of the last ten rounds of experiment 4 (strict liability $X = 5$) to the last ten rounds of experiments 7 (negligence $X = 18$) and 8 (negligence $X = 8$). In note 9 below we present the statistics for the mean of the efficiencies approach.

As we can see, due to the observed pattern of overprecaution in strict-liability experiments during the early rounds and underprecaution in later rounds, our efficiency measures indicate that, while the negligence rule exhibits approximately optimal levels of efficiency in all rounds, the strict-liability rule does not. Since $[1 - E_i(x)]100$ measures the extent to which observed ex ante costs exceed their optimal levels, we see that in both negligence experiments (experiments 2 and 5), the efficiencies observed under the negligence rule did not differ from their optimal levels by more than .02 percent. In the strict liability experiments (experiments 1

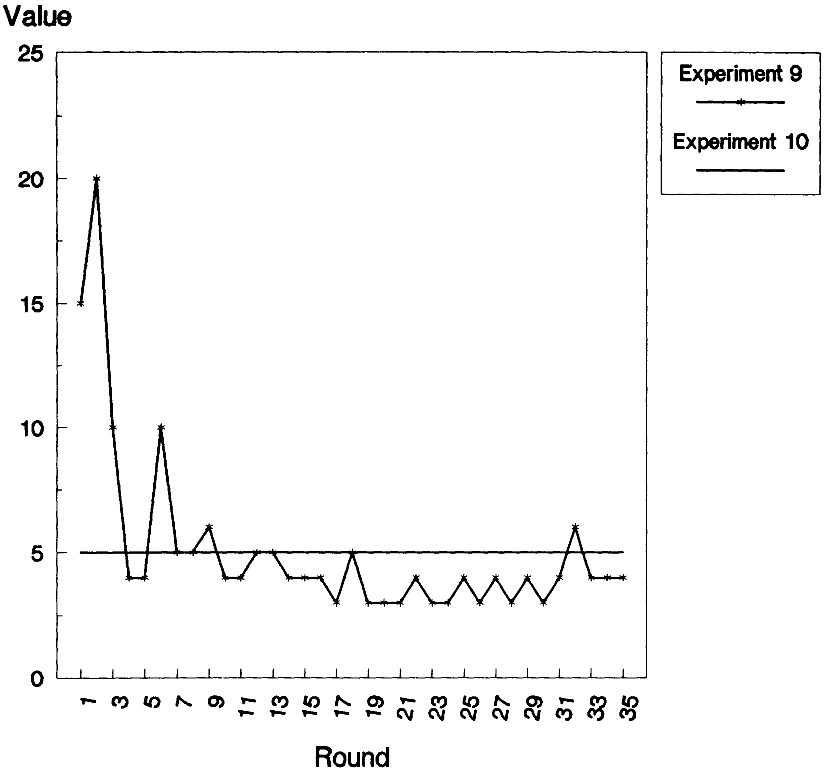

FIGURE 10.—Observed median activity levels: experiments 9 and 10

and 4), we see that in the early rounds, efficiencies differed from their optimal levels by 2.5 percent and 73 percent in the first ten rounds of experiments 1 and 4, respectively, while they differed from their optimal levels in the latter rounds by 31 percent and 5.3 percent, respectively. It is interesting to note, however, that these deviations from optimality in the early and late rounds occurred for different reasons. In the early rounds, subjects engaging in strict-liability experiments incurred high costs by choosing excessive care levels. Hence, although they had fewer events or accidents, their increased cost of care substantially exceeded this accident-cost saving. In the later rounds, their inefficiency stemmed from taking too little care. Here, their care-cost saving was more than exceeded by their increased cost of accidents.[9]

[9] Table 4 is the equivalent table using the "mean of the efficiencies" index. As Table 4 indicates, using the "mean of the efficiencies" to measure sample efficiency, negligence no

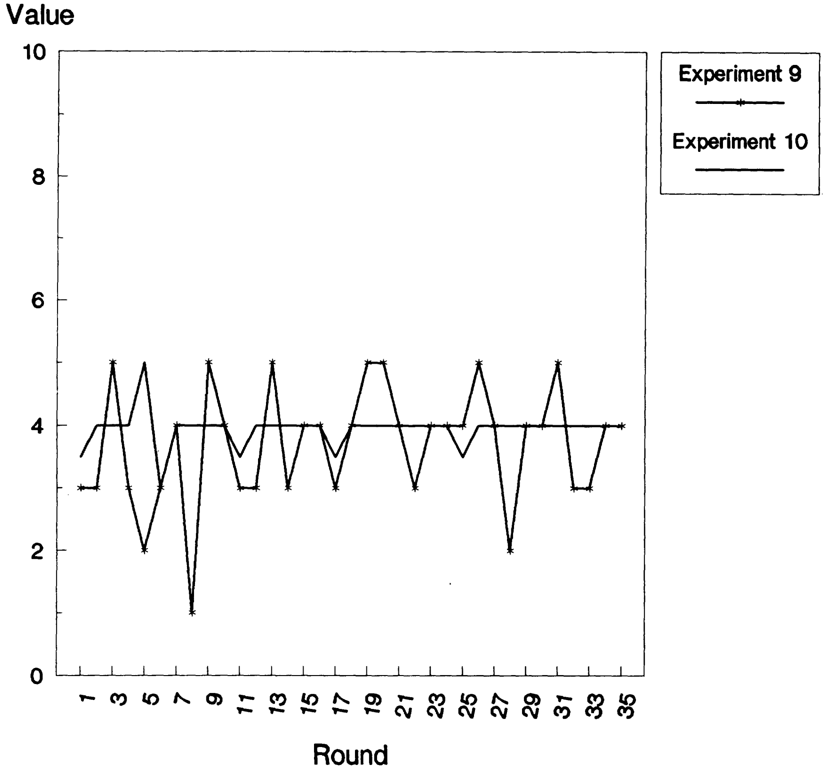

FIGURE 11.—Observed median care levels: experiments 9 and 10

These experiments discuss only the results of experiments in which the due-care standard is set at the socially optimal level. In experiments 7 and 8, the due-care standard was set above the optimal level. In one case, experiment 7, it was set at such an excessive level that individual rationality dictates that it be abandoned, while in the other, experiment 8, individual rationality dictates that it be adhered to. Table 6 presents our efficiency measures for these experiments. Since these rules, *if adhered to,*

longer dominates strict liability. The mean of the efficiencies approach is, however, very sensitive to outliers. When we recalculate the sample efficiency, eliminating outliers, the dominance of negligence over strict liability reemerges. (An "outlier" in the experiments in which $x^* = 30$ is $x = 1$, as the subject then surely incurs a cost of 901. When $x^* = 5$, an outlier is defined as $x = 100$ or $x = 99$, in which case the subject incurs a cost of at least 1,584.) Table 5 presents the mean of the efficiencies index with outliers removed, adjusting the means for outliers by excluding 10 of 620 observations. The results reported in this table are qualitatively identical to those reported in Table 3.

TABLE 3

EFFICIENCY: STRICT LIABILITY AND OPTIMAL NEGLIGENCE COMPARED MEAN OF MEDIANS

			EFFICIENCIES		NO. OF ACCIDENTS	
EXPERIMENT	EQUILIBRIUM CARE LEVEL, x^*	CARE STANDARD, X	First 10 Rounds	Last 10 Rounds	First 10 Rounds	Last 10 Rounds
1	30	N.A.	1.025(+)	1.3129(−)	14	8
2	30	30	1.0004	1.0002	5	9
4	5	N.A.	1.7299(+)	1.0530(−)	13	35
5	5	5	1.0133	1.0	26	11

NOTE.—(+) and (−) indicate that efficiencies fell short of their optimal level because of excessive (+) or insufficient (−) levels of care. N.A. = not applicable.

TABLE 4

EFFICIENCY: STRICT LIABILITY AND OPTIMAL NEGLIGENCE COMPARED MEAN OF THE EFFICIENCY INDEX

			EFFICIENCIES	
EXPERIMENT	EQUILIBRIUM CARE LEVEL, x^*	CARE STANDARD, X	First 10 Rounds	Last 10 Rounds
1	30	N.A.	1.683(+)	2.256(−)
2	30	30	1.739	1.661
4	5	N.A.	2.5(+)	1.3189(−)
5	5	5	1.7845	1.350

NOTE.—(+) and (−) indicate that efficiencies fell short of their optimal level because of excessive (+) or insufficient (−) levels of care. N.A. = not applicable.

TABLE 5

EFFICIENCY: STRICT LIABILITY AND OPTIMAL NEGLIGENCE COMPARED ADJUSTED MEAN OF THE EFFICIENCIES INDEX

			EFFICIENCIES	
EXPERIMENT	EQUILIBRIUM CARE LEVEL, x^*	CARE STANDARD, X	First 10 Rounds	Last 10 Rounds
1	30	N.A.	1.434*	2.136†
2	30	30	1.238‡	1.536§
3	5	N.A.	2.422†	1.310
4	5	5	1.7845	1.2648†

NOTE.—N.A. = not applicable.
* 2 of 100 observations excluded.
† 1 of 100 observations excluded.
‡ 4 of 110 observations excluded.
§ 1 of 110 observations excluded.

TABLE 6

EFFICIENCY: STRICT LIABILITY AND OPTIMAL NEGLIGENCE ACTIVITY LEVELS COMPARED MEAN OF MEDIANS

EXPERIMENT	EQUILIBRIUM CARE LEVEL, X^*	CARE STANDARD, X	EFFICIENCIES		NO. OF ACCIDENTS		EFFICIENCIES IF CARE STANDARD ADHERED TO
			First 10 Rounds	Last 10 Rounds	First 10 Rounds	Last 10 Rounds	
7	5	18	1.0680	1.0329	37	12	1.68
8	8	8	1.0652	1.0511	24	17	1.125

TABLE 7

EFFICIENCY: STRICT LIABILITY AND NEGLIGENCE CARE LEVELS COMPARED

Experiment	Equilibrium Care Level, X^*	Care Standard, X	Efficiencies: First 10 Rounds	Efficiencies: Last 10 Rounds	Efficiencies If Care Standard Adhered To
7	5	18	1.596	1.469	1.68
8	8	8	1.33	1.19	1.125

would determine inefficient behavior, we present these efficiency levels along with those observed.[10]

Under the negligence rule, our observed efficiencies in experiment 7 are everywhere less than those that would result if subjects adhered to the standard of care. If, in experiment 7, subjects had met the standard of care by choosing $x = X = 18$, we would have observed an efficiency measure of 1.68. In all periods, we observed a lower value, with the mean of the median efficiencies close to the optimal value of one. In experiment 8, adherence to the standard, which is predicted, would yield an efficiency of 1.125. We observed in both the first and the last ten rounds a value less than this but one higher than the optimal efficiency of one.

These results offer an interesting perspective on the choice between a negligence rule and a rule of strict liability. On efficiency grounds, strict liability dominates negligence, even ignoring the effect of the rules on activity levels. For any set of parameters, strict liability always yields efficient results. The negligence rule yields optimal results only when the due-care standard is set optimally or above some critical level. Courts that set the standard of care, however, rarely have the relevant information at their disposal. Thus, it would appear that only luck would yield optimal results under a negligence rule.

The results of our experiments suggest a bounded-rationality justification for negligence. Subjects face, under the strict-liability rule, a too burdensome task of calculation. Consequently, they adopt inappropriate behaviors. Under a negligence rule, the standard of care apparently acts as a calculation aid that focuses the attention of subjects on care levels that are approximately optimal. When the due-care standard is set optimally, the negligence rule seems to function extremely well, outperforming strict liability dramatically. When the standard is set too strictly, subjects seem not to be misled and to take approximately optimal levels of

[10] Table 7 uses the "mean of the efficiencies" index.

care. The calculation task involved under strict liability did seem to lead to inappropriate dynamic behavior (overprecaution followed by underprecaution) on the part of subjects as they attempted to *learn* the appropriate care level to take. Comparison of Table 6 to experiment 4 in Table 3 confirms this story. The efficiency of the negligence rule even with the standard set too strictly is roughly at least as good as and often superior to the efficiency of strict liability. None of our experiments, of course, investigated the efficiency of a negligence rule with the standard of care set too leniently.

V. Concluding Remarks

These experiments suggest that, though individuals do not behave according to the economic theory of unilateral accidents when they must choose activity as well as care levels and when they are faced by a rule of strict liability, they *do* behave *under negligence rules* according to the predictions of the theory. This is true when care levels *only* are in question. We believe that limitations on individuals' problem-solving abilities explain this pattern of results.

Under strict liability, subjects lack guidance on how to approach the decision problem presented. They begin their search for a solution at excessively high levels of care and then reduce their care levels to below the optimum. The subjects thus learn, in the sense that they adjust their behavior in response to experience under strict liability; they simply fail to learn the right lesson. Under a negligence rule, the standard of care places an upper bound on the subjects' search for a solution. When the standard is set excessively high, the subjects somehow learn that they should abandon the standard. This explanation of the superior performance of negligence rules to strict liability suggests at least one further experiment. The superiority of the negligence rule should decline as the standard of care gets further and further from the optimum. In the limit, we should observe no difference when the standard of care is nearly infinite. Moreover, we have not tested the performance of negligence rules when the standard of care is set too leniently, though we believe that, in this circumstance, subjects would, as the theory predicts, adhere to the standard of care. If the standard of care were then set sufficiently leniently, a strict liability rule, which also induced underdeterrence, might outperform negligence.

This pattern of results bears on serious questions of public policy. Under our preferred measure of efficiency, a negligence rule, contrary to the theory, outperforms a rule of strict liability largely because of the learning behavior noted above. We are, of course, hesitant to base public policy decisions solely on the outcome of one set of experiments on unilateral accidents. Not only do these results have to be replicated by others and supplemented by investigations like those suggested in the above paragraph, but also real-world accidents differ in at least two important ways from the unilateral accidents studied. First, in most accident situations, the probability of an accident depends on the choices of more than one party. Second, many accident situations involve not only the economic loss modeled in our study but also the risk of physical injury to the actor. We hope to address these questions in further experimental studies.