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ABSTRACT

Survival analysis computes functions for occurrence or non-occurrence of an event over a time period for a particular group of subjects. This study compared survival analyses to traditional ANOVAs and Chi-square analyses on a data set of imitation scores of 18-month-old toddlers. The 48 subjects were randomly assigned to two experimental conditions, which involved observing videotapes of same-sex peer models or observing opposite-sex peer models, all demonstrating specific target acts on six sets of test objects (hammer, train, doll, tea set, collapsible cups, and a pull-apart toy). After observing the video, the subjects were given the sets of test objects, and subjects' responses were videotaped for later scoring. Results yielded differences in the predicted direction for target acts. For four of the six sets, subjects who observed same-sex models, produced these target acts significantly more often and earlier in the response period than subjects viewing opposite sex models. The survival analysis was easily applied to a data set that was cumbersome to analyze in more traditional ways. (WP)

AN EXAMPLE OF SURVIVAL ANALYSIS WITH BEHAVIORAL DATA: COMPUTING THE HAZARDS OF SAME-SEX IMITATION IN TODDLERS

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ABSTRACT

Survival analyses are compared to traditional ANOVAs and Chi-square analyses on a data set of imitation scores of 18-month-old toddlers (N = 48). Because survival analyses can use both whether or not a subject produces an imitative act and when in the response period these acts are produced, the resulting statistics offer a more powerful description of group differences than analyses that must look at this information separately. This use of survival analysis offers an example of applying a novel technique to relatively simple, familiar, and straightforward behavioral data from children.

INTRODUCTION

Survival Analysis

Survival analysis (Luke, 1993; Norusis, 1990; Singer & Willett, 1991) has become increasingly popular in epidemiological and clinical research. It computes functions for occurrence or non-occurrence of an event over a time period for a particular group of subjects, and it is very useful for studying phenomena such as survival rates for health conditions or success rates for treatment programs. Survival analyses use all available information, both the number of occurrences and when in the time period they occur, to compute hazard functions (conditional probabilities of occurrence for each interval in the time period) for each experimental group. Hazard functions can be compared across experimental groups by fairly simple rank statistics to see if a treatment significantly changes the probability (and the time-course of the probability) of an event's occurrence.

Because of its clinical connotations, survival analysis is rarely used for studying data in such realms as social or cognitive development. The authors came to survival analysis as an option only after numerous attempts to study information from different forms of data using traditional analyses. The experiment that produced this data set was designed to study preferential same-sex imitation in 18-month-old toddlers (Hanna & Barnat, 1994).

Preferential Same-Sex Imitation

Gender affiliation, a preference for same-sex playmates and same-sex role models, is a strong and well-documented phenomenon in childhood. Although the beginnings of a preference for same-sex playmates has been observed in toddlers, there is little evidence for preferential same-sex imitation in children under 2 years of age.

Children under 2 years of age are unreliable at identifying the sex of others (either by pointing to the correct picture when asked to show the boy or girl, or by naming them correctly). They are also unreliable at identifying their own sex (either by placing a picture of themselves in the correct pile or naming themselves). It may be that preferential same-sex imitation has not been found in toddlers because they are not yet aware of these labels, and so do not place themselves in the same group as same-sex others and do not select same-sex others as models. Or it may be that same-sex preferential imitation has not been found in toddlers because procedures and analyses have not been sensitive enough to detect it.

Preferential same-sex imitation in older children is strongly influenced by such factors as the age or status of the model, and the gender-stereotyped nature of the observed behavior. In this study, 18-month-old subjects were shown same-age peers demonstrating target acts on neutral and gender-stereotyped objects. The nature of the resulting data — time codes of when, if ever, in the response period the subjects produced particular target acts — leads to a variety of analyses.

PROCEDURE

Subjects were randomly assigned to two experimental conditions (observing same-sex peer models, $n = 24$, or observing opposite-sex peer models, $n = 24$). Equal numbers of boys and girls participated in each condition. Subjects observed either a videotape of three 19-month-old girls (shown in Figure 1), or a videotape of three 19-month-old boys (also shown in Figure 1), all demonstrating specific target acts on six sets of test objects (shown in Figure 2). Figure 3 displays the assignment of subjects to conditions and the procedure. After observing the video, the subjects were given the sets of test objects (one set at a time for a 20-s response period each), and subjects' responses were videotaped for later scoring. Independent scorers then coded the subjects' responses, noting both whether or not subjects produced a particular target act, and if so, when it was produced in the 20-s response period.

ANALYSIS 1: PARAMETRIC STATISTICS

Analysis on number of target acts produced. A 2 (experimental condition: same-sex models/opposite-sex models) x 2 (sex of subject) x 6 (test object set) mixed ANOVA for number of target acts produced (test object set is the repeated measure) revealed no significant between-subject effects, $F\text{s} < 1.0$. Subjects did not perform significantly differently overall based upon whether they observed same-sex versus opposite-sex models or whether they were a boy or a girl (means presented in Figure 4). Within-subject effects were significant for test object set, $F(5, 220) = 12.97$, $p < .001$, indicating that subjects performed differently on individual sets of test objects. There was also a significant three-way interaction between experimental condition, sex, and test object set, $F(5, 220) = 4.09$, $p < .01$.

Analysis on latency of target acts produced. Table 1 presents the mean latencies at which subjects produced all target acts, and the mean latencies to produce the first target act for each set of test objects. A 2 (experimental condition: same-sex models/opposite-sex models) x 2 (sex of subject) ANOVA for mean latency to produce target acts yielded no significant effects, ps > .10. A 2 (experimental condition: same-sex models/opposite-sex models) x 2 (sex of subject) ANOVA on mean latency to produce the first target act across the sets of test objects found a marginal effect for experimental condition, $F(1,44) = 2.93$, $p < .10$, with no other significant effects or interactions, ps > 1.0.

Table 1

Mean Latency in Seconds to Produce All Target Acts and to Produce the First Target Acts on Each Set of Test Objects by 18-Month-Old Boy and Girl Subjects in Each Condition

Condition	Mean latency of all target acts		Mean latency of first target acts	
	M	SD	M	SD
Boys				
Same-sex model (n = 12)	5.44	2.20	3.50	1.42
Opposite-sex model (n = 12)	7.96	3.45	6.70	4.21
Girls				
Same-sex model (n = 12)	6.61	3.31	5.12	3.74
Opposite-sex model (n = 12)	6.08	2.50	5.34	2.62

Note. Maximum score = 19.99.

ANALYSIS 2: NON-PARAMETRIC STATISTICS

Each set of test objects was associated with two target acts that were demonstrated in a target sequence. For example, on the hammer set, the first target act was to place the peg in the hole of the block, and the second target act was to hammer on top of the peg (demonstrated by the models in Figure 1). Subjects received a yes/no score for each of these target acts, and also for the target sequence (if the two target acts were performed in the correct order). In order to examine each set of test objects as a whole, the yes/no coding for individual target acts and sequences was combined across the set of test objects, and a dichotomous score created by comparing low-responding subjects who produced none or only one of the target acts to high-responding subjects who produced both target acts. The high-responding group automatically contained those who produced the target sequence as well, because producing the target sequence relied on producing both target acts.

Figure 5 presents the dichotomous data for each set of test objects for boy and girl subjects in each experimental condition. The analyses showed significant effects for boys in the same-sex versus opposite-sex conditions for two sets: the hammer set, $\chi^2(1, N = 48) = 5.37$, $p < .05$, and the collapsible cup set, $\chi^2(1, N = 48) = 4.55$, $p < .05$. The differences on the other test object sets did not reach significance, $ps > .09$.

ANALYSIS 3: SURVIVAL ANALYSIS

This technique computes probabilities for an event's occurrence for each interval in a response period by dividing the number of events occurring in that interval by the number of subjects in the sample who have not yet experienced the event. For the latency data in this experiment, survival analysis is helpful by taking into account how many subjects did or did not produce particular target acts as well as when in the response period any were produced. The survival functions produced by subjects within each experimental condition or sex of subject can be compared using a non-parametric rank test (Lee-Desu Statistic in SPSS).

Survival analyses comparing functions across the two experimental conditions (same-sex models, opposite-sex models) yielded differences in the predicted direction for the first target acts on the hammer set, $p < .01$, the train set, $p < .05$, and the tea set, $p < .06$; and the second target act on the collapsible cup set, $p < .05$. Subjects who observed same-sex models produced these target acts significantly more often and earlier in the response period than subjects who observed opposite-sex models. Figures 6 through 13 present inverted cumulative survival functions and hazard functions for these target acts.

Separate survival analyses within each sex of subject found that the significant effects were the result of 18-month-old boys on the hammer set, the train set, and the collapsible cup set, $ps < .05$, with a marginal effect on the tea set as well, $p < .07$. Analyses on the girls' data revealed an effect only on the hammer set, $p < .06$, all other $ps > .30$.

CONCLUSION

In this example, survival analysis is easily applied to a data set that was cumbersome to analyze in more traditional ways. The statistics and graphics that were generated by survival analysis are readily interpretable and clearly illustrate group differences in the data. The ANOVAs and Chi-Square analyses used to analyze the imitative behavior of 18-month-old toddlers found few effects of observing same-sex versus opposite-sex models. However, survival analyses showed that boys who observed same-sex models produced selected target acts significantly more often and earlier in the response period than boys who observed opposite-sex models.

It is our hope that by providing this example, we can encourage others in our field to apply new techniques to behavioral data in a fresh approach to statistical exploration.

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Figure 1

The toddler models

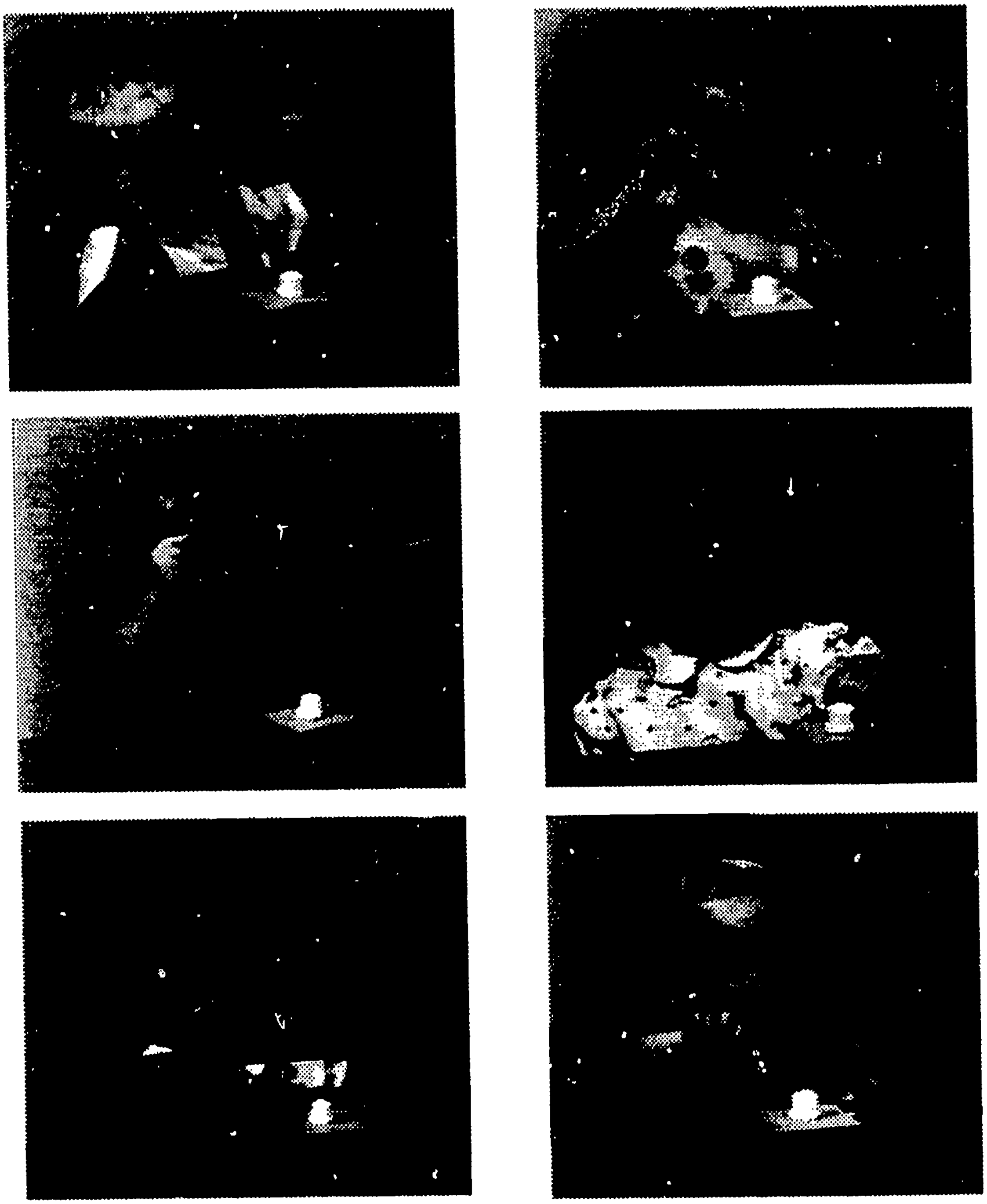

FIGURE 2
The Six Sets of Test Objects Used as Stimuli

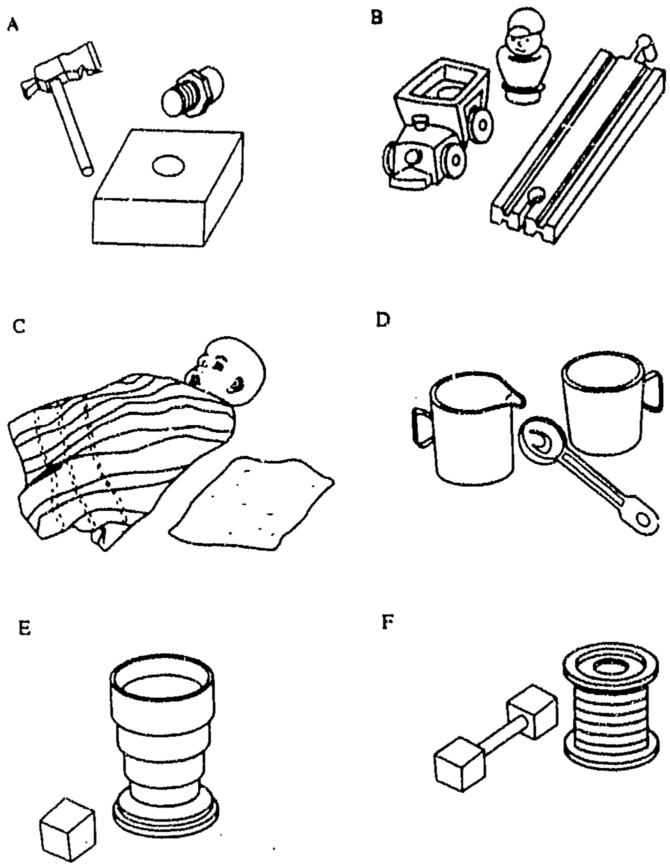

FIGURE 3
Assignment of Subjects to Conditions and Procedural Flow-Chart

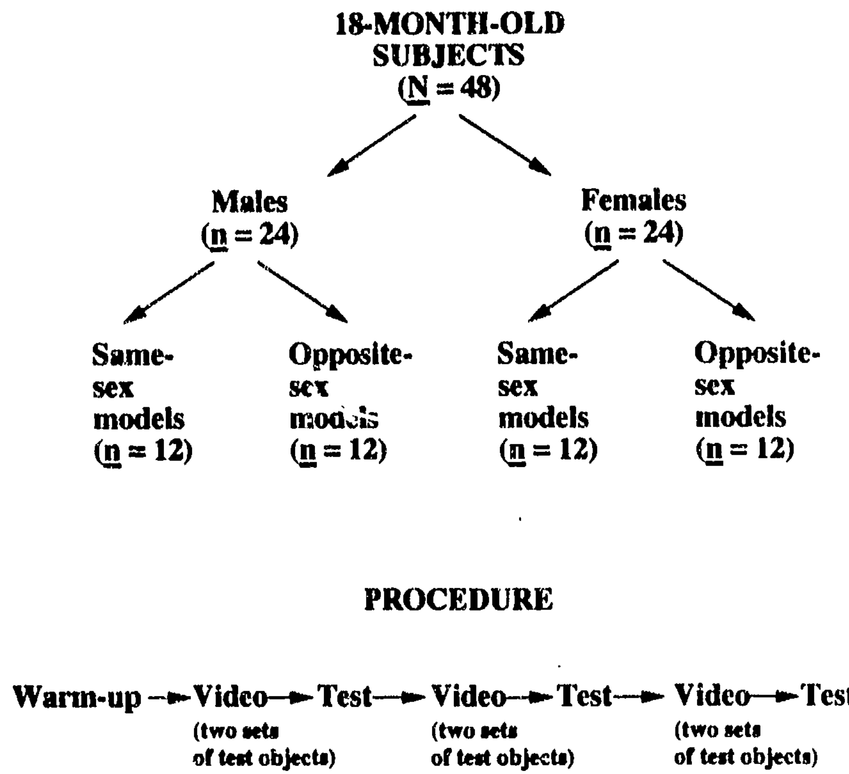

FIGURE 4
Means for total number of target acts produced by boy and girl subjects in each condition

(no significant differences)

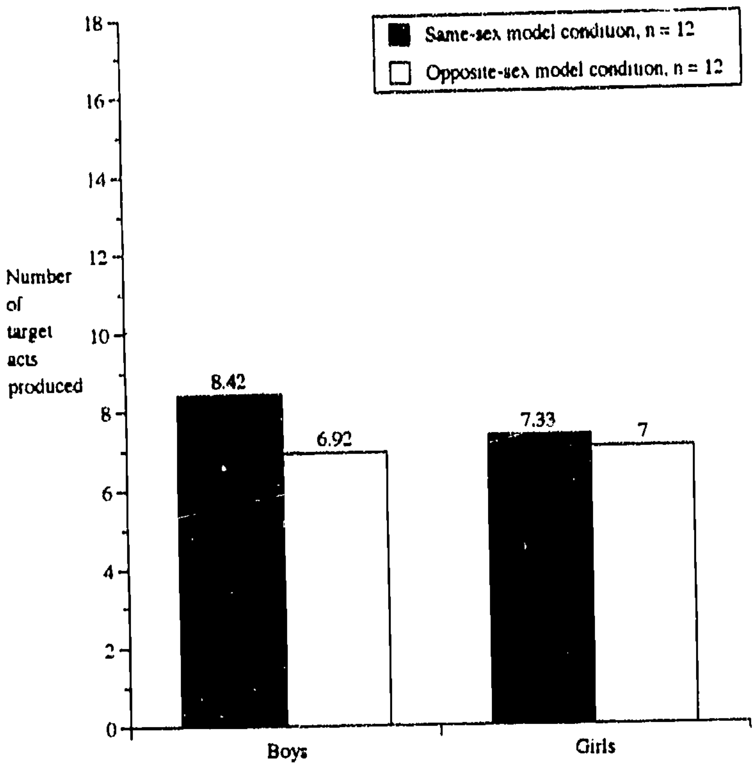

FIGURE 5
The number of boys and girls in each condition who produced both target acts for each set of test objects

(significant differences between boys in the same-sex model condition versus boys in the opposite-sex model condition on two sets, the hammer set and the cup set)

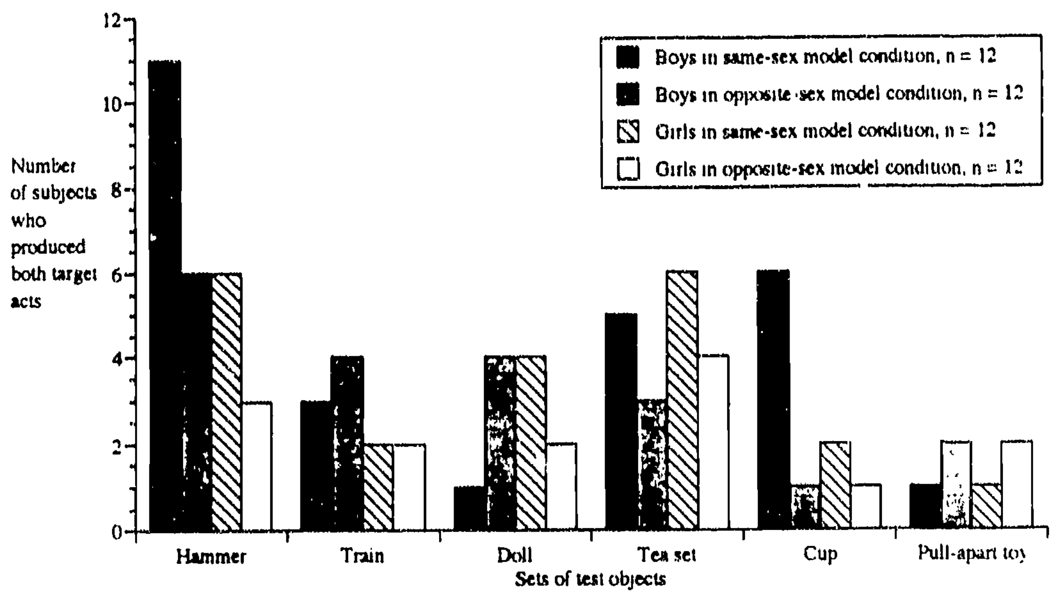

FIGURE 6
THE HAMMER SET
Cumulative proportion functions on the target act of placing a peg in a block of wood in order to hammer on it

(significant differences between boys and girls in the same-sex model condition versus boys and girls in the opposite-sex model condition)

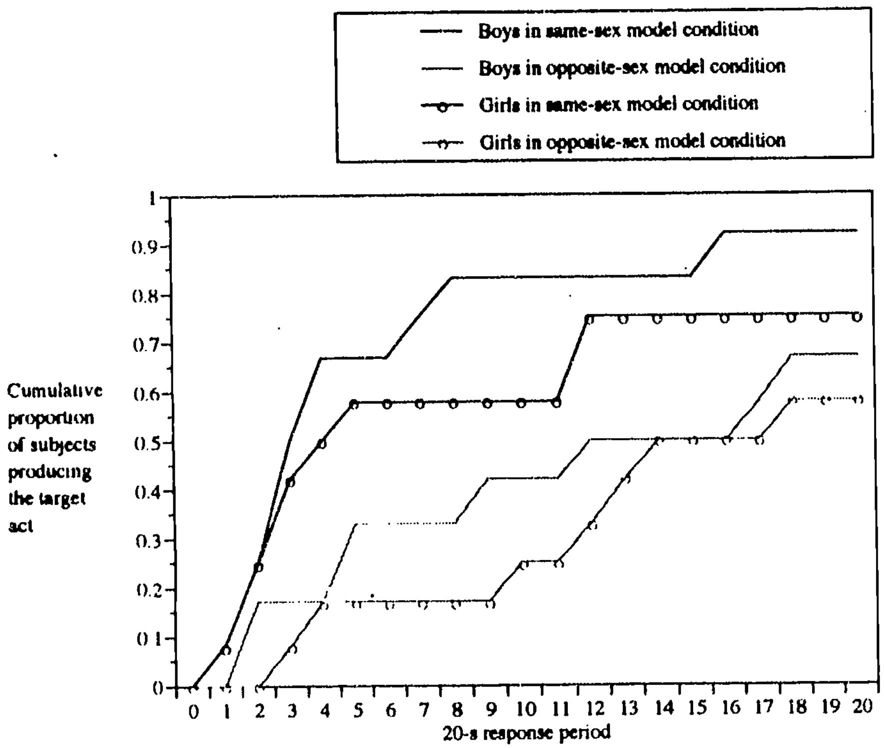

FIGURE 7
Hazard functions on the hammer set

The conditional probability of a subject producing the target act of placing the peg in the block for each second of the response period, given that he or she has not already done so

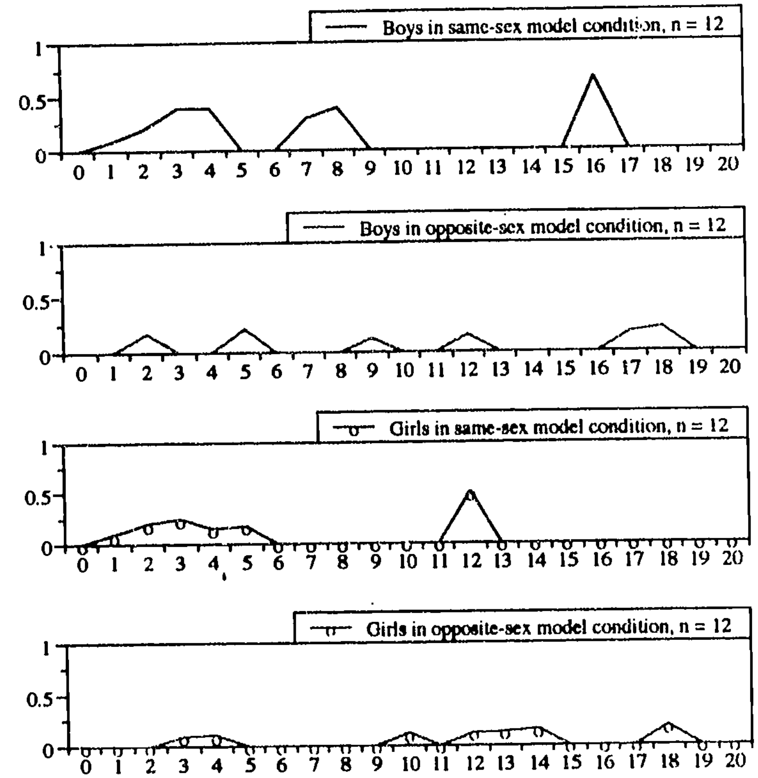

FIGURE 8
THE TRAIN SET
Cumulative proportion functions on the target act of placing the driver in the engine

(significant difference between boys in the same-sex model condition versus boys in the opposite-sex model condition)

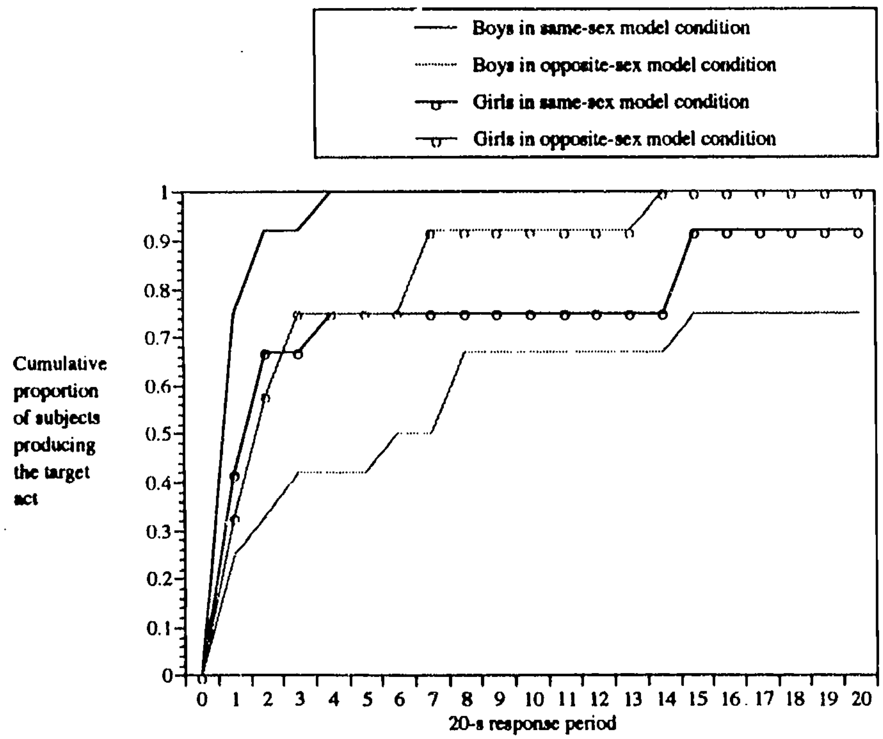

FIGURE 9
Hazard functions on the train set

The conditional probability of a subject producing the target act of placing the driver in the engine for each second of the response period, given that he or she has not already done so

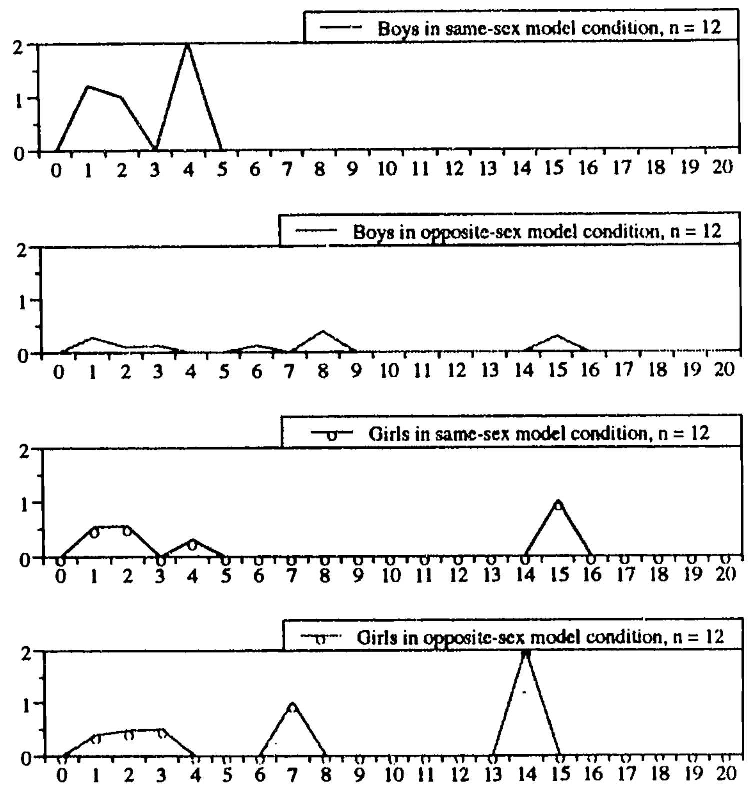

FIGURE 10
THE TEA SET
Cumulative proportion functions on the target act of pouring from the pitcher into the cup

(significant difference between boys in the same-sex model condition versus boys in the opposite-sex model condition)

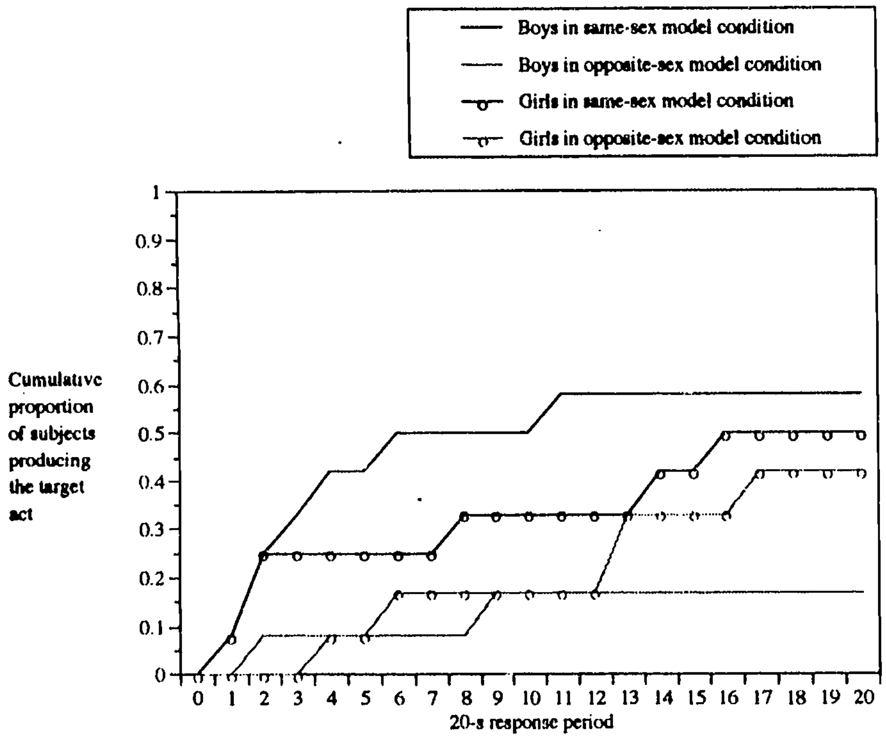

FIGURE 11
Hazard functions on the tea set

The conditional probability of a subject producing the target act of pouring for each second of the response period, given that he or she has not already done so

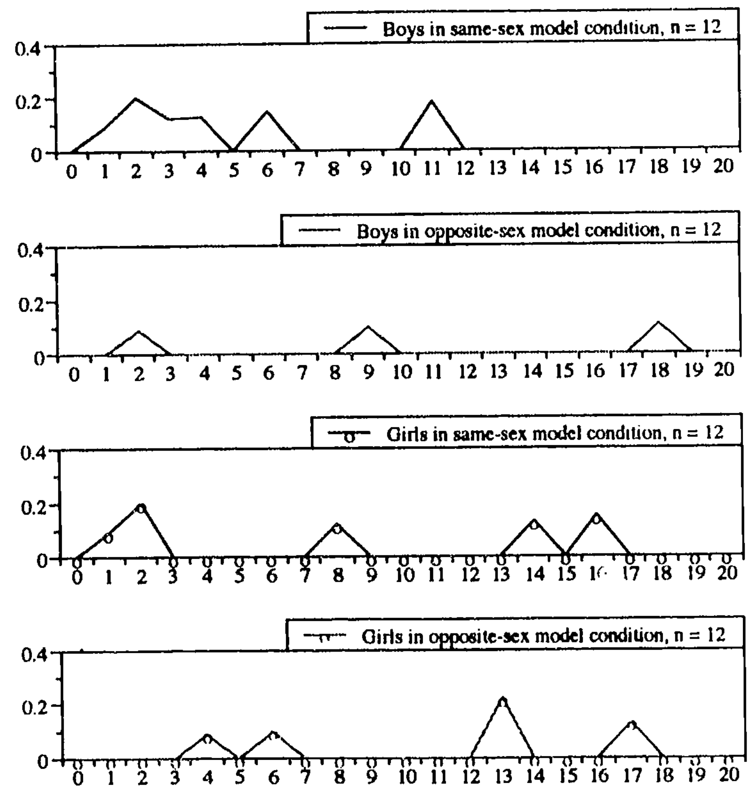

FIGURE 12
THE COLLAPSIBLE CUP SET
Cumulative proportion functions on the target act of collapsing the cup

(significant difference between boys in the same-sex model condition versus boys in the opposite-sex model condition)

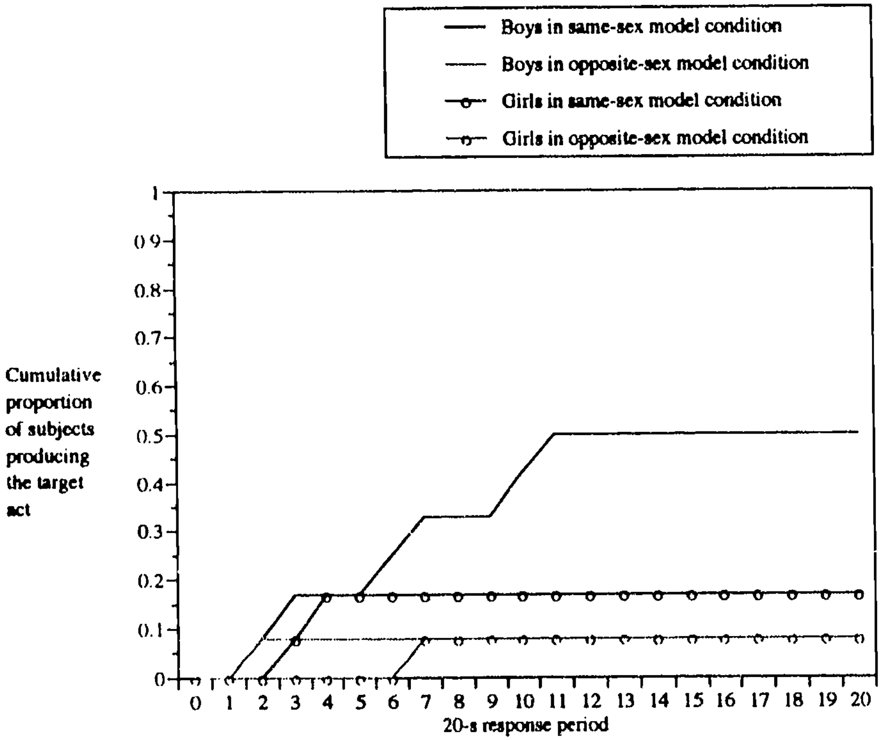

FIGURE 13
Hazard functions on the collapsible cup set

The conditional probability of a subject producing the target act of collapsing the cup for each second of the response period, given that he or she has not already done so