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The Effects of Ethanol on Eye Tracking in Rhesus Monkeys and Humans[1]

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ANDO, K., C. E. JOHANSON AND C. R. SCHUSTER. *The effects of ethanol on eye tracking in rhesus monkeys and humans*. PHARMACOL BIOCHEM BEHAV **26**(1) 103–109, 1987.—The effects of ethanol on eye tracking function were compared in rhesus monkeys and humans using a similar experimental procedure. In Experiment 1, 3 rhesus monkeys were trained to visually track a projected image of a disk that oscillated sinusoidally along a horizontal plane on a screen. This training was accomplished using a procedure in which responses on a lever resulted in the delivery of water when the central area of the projected disk image was dimmed for a brief period. Intragastric administrations of ethanol at doses of 0.25 to 2 g/kg were tested during one-day test sessions using a cumulative dose procedure. Pursuit eye movements were disrupted at doses of 0.5 g/kg while lever pressing behavior was not disrupted until a dose of 2 g/kg was reached. In Experiment 2, pursuit eye movements of 6 humans were not disrupted when ethanol was given orally at cumulative doses of 0.25 to 1 g/kg, while microswitch pressing behavior was disrupted in some of the subjects at a dose of 0.5 g/kg. Blood ethanol levels increased in a dose-dependent manner in both species with higher levels in humans than in monkeys. The dose dependent effects observed in both species and qualitative similarities in some of the effects such as saccadic pursuit eye movements suggest that the eye tracking method employing monkeys is useful for predicting drug effects on sensory motor function in humans.

Eye tracking Smooth pursuit eye movements Ethanol Cumulative dose procedure Rhesus monkeys Human subjects Subjective effects

IF a target in front of a normal human subject is oscillated sinusoidally in the horizontal plane, smooth pursuit eye movements can be observed in which the velocity and directional attributes of the movements correspond to these attributes of the target. The effects of ethanol and other drugs on human smooth pursuit eye movements have been studied extensively. Ethanol causes saccadic pursuit eye movements, a decrease in velocity of eye movements, and nystagmus [5,12]. Barbiturates and chloral hydrate show similar effects [5, 7, 8], while diazepam produces a decrease in the amplitude gain of pursuit eye movements [10]. Recently, drug effects on eye tracking have been studied in rhesus monkeys [1,2]. Although the results in monkeys were not identical to those reported in humans by other investigators using different experimental conditions [4], there were enough similarities to suggest that experiments in monkeys may prove useful for predicting drug effects on eye tracking in humans. On the other hand, few attempts have been made to compare drug effects in different species by matching the experimental methods as closely as possible. Such studies would be very important because the results would serve as an excellent test of the degree of similarity between animals and humans and allow a determination of the validity of the animal model in predicting drug effects on eye tracking in humans. In the present study the effects of ethanol on eye tracking in both rhesus monkeys and human subjects were compared using experimental methods in each species that were similar.

METHOD

Experiment 1. Ethanol Effects in Rhesus Monkeys

Subjects. The animals used were three adult male rhesus monkeys weighing between 7.0 and 9.0 kg at the start of the experiment. Prior to the present experiment, these monkeys (5101, 5105, and 6048) had been used in experiments evaluat-

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ing the effects of single doses of phencyclidine, secobarbital, diazepam, methamphetamine, apomorphine, and haloperidol, on eye tracking and had received 8–14 days of repeated administration of methamphetamine [1,2]. Each monkey was housed individually in a metal home cage (62×70×60 cm) located in an animal room that also housed 10 to 15 other monkeys and was fed 100 g of monkey chow (Model No. 5038, Ralston Purina, St. Louis, MO) daily after the experimental session. Daily water intake was limited to 150–200 ml, including water received during the experimental session. Sugar cubes saturated with liquid vitamins were also given after experimental sessions. The experimental sessions were conducted every day except Saturdays, Sundays, and holidays. On days when experimental sessions were not conducted, each monkey was given access to 200 ml of water in its home cage as well as 100 g of chow. On Friday, approximately 1000 ml of additional water was given to each monkey in its home cage after completion of the experimental session. The animal room was illuminated from 8 a.m. to 9. p.m. and the room temperature was kept at approximately 26°C.

Apparatus. The experiment was conducted with each monkey seated in a plastic restraining chair (Plas-Labs, Lansing, MI) placed inside a wooden enclosure (80 cm wide × 86 cm long × 182 cm high). A panel with a response lever (Model No. PRL-001, BRS/LVE, Beltsville, MD) that could be activated by a force of approximately 100 g was mounted on the front of the chair. Head movement was limited by plastic panels at each side and on top of the monkey's head. Water was delivered using a metal nozzle placed into the monkey's mouth.

A white screen (28×59 cm) was mounted directly in front of the monkey inside of the wooden enclosure. The center of this screen was located at eye level 79 cm from the point mid-way between the monkey's eyes. An image appearing as a red disk was projected onto the screen by light-emitting diodes (LED) through an optical path system located above and behind the monkey. This disk consisted of an outer annulus (diameter 2.5 cm) and an inner disk (diameter 1.0 cm) which were projected by separate LEDs. The outer annulus was formed by reflecting the light of one LED off a mirror with a small opening in the center, and the inner disk was projected by a second LED directly through this small opening. The image on the screen appeared as one homogenous disk when the current supply to the 2 LEDs was properly set. When the current to the second LED was decreased, the inner disk appeared dimmed. Although the luminances of the outer annulus and inner disk were not calibrated, the operating currents of the two LEDs and their differences were constantly regulated throughout the experiment.

During an experimental session, the composite disk image oscillated sinusoidally in the horizontal plane (simple harmonic motion) through 30 degrees of visual angle (42.3 cm on the screen) at a frequency of 0.8 Hz by reflecting the image off a mirror affixed to a galvanometer (Gulton Industries, East Greenwich, RI) that was activated by an amplified voltage signal from a signal generator (Model No. 7060, Exact Electronics, Tallamook, OR). Electrooculographic (EOG) recordings were obtained using silver-silver chloride sking electrodes (Model No. 650437, Beckman Instruments, Arlington Heights, IL) placed at the outer canthus of each eye and at the center of the forehead of each monkey. The amplified EOGs were recorded on a frequency modulation cassette recorder (Model No. FRC-1402D, Sony, Tokyo, Japan) and simultaneously displayed on chart paper by a dynograph (Model No. R411, Beckman Instruments, Arlington Heights, IL). Experimental contingencies were arranged and lever pressing was recorded by solid-state programming and recording equipment (BRS/LVE, Beltsville, MD) located in an adjacent room.

Procedure. For two of the monkeys (5105 and 6048) the enclosure was totally darkened during the experimental sessions. For the third monkey (5101) a 15 W lamp mounted on the ceiling of the enclosure was illuminated, since this monkey did not respond consistently when the enclosure was totally darkened.

Training sessions consisted of a series of trials. Trials were signalled by a tone generated by a Sonalert (Model No. 112-01, BRS/LVE, Beltsville, MD). The first lever press response by the monkey (observing response) terminated the tone and the oscillating disk was projected on the screen. The inner disk was dimmed for 0.5 sec under a random time schedule with an average interval of 10 sec. The trial continued until there was a lever press response by the monkey. A response was correct if the monkey pressed the lever during the 0.5 sec period or within 0.1 sec. A correct response resulted in the delivery of 1.5 ml of water. A trial was terminated after water delivery or if the monkey pressed the lever at any other time during the trial (incorrect response). Upon termination of a trial, there was a 3.5 sec time-out followed by presentation of the tone signalling the beginning of the next trial. During training sessions neither ethanol nor water was administered prior to the session and the electrodes were not attached to the monkey. Training sessions were terminated after 99 reinforcers had been delivered.

When the percent of correct responses (100 × correct responses/disk dimmings) was above 95% during training sessions, test sessions were begun. In test sessions, the effects of ethanol on eye tracking function were determined using a cumulative dose procedure. In this procedure the dose-effect relationship for ethanol was determined in multiple blocks of test trials with different doses of ethanol tested on the same day [11]. Each block of trials consisted of a 7 min lever press recording component, during which the eye tracking trials were conducted as previously described for training sessions. This component was followed by a EOG recording component which had 5 segments. In each segment, the usual schedule contingencies were temporarily discontinued and the disk was not dimmed. After 30 sec had passed the schedule contingencies were reinstated with the inner disk dimmed under the same random schedule. Each segment was terminated after a correct response, an incorrect response or 15 sec, whichever came first. The next EOG recording segment began immediately. Each session consisted of 4 identical blocks of trials separated by a timeout.

Prior to drug test sessions, 0.25 g/kg ethanol was administered intragastrically. Thirty min later the first block of test trials began. After completion of this block, 0.25 g/kg ethanol (cumulative dose of 0.5 g/kg) was administered to the monkey as before and the 2nd block of test trials was conducted in the same manner. Prior to the 3rd and 4th blocks of test trials, 0.5 g/kg (cumulative dose of 1 g/kg) and 1 g/kg (cumulative dose of 2 g/kg) ethanol were administered in the same manner. The interval between successive drug administrations was 48 min. At least 2 days prior to each test session, control test sessions were conducted. Control test sessions were identical to ethanol test sessions except that tap water was given to the monkey instead of ethanol before each block of the test trials. Between ethanol or control test sessions, the training sessions continued.

Data analysis. The number of completed trials, observing

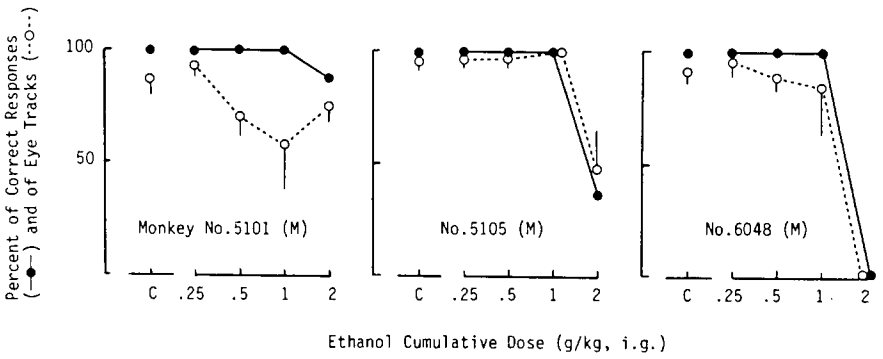

FIG. 1. The effects of ethanol on lever pressing behavior (percent of correct responses) and on pursuit eye movements (percent of eye tracks) in rhesus monkeys. The absicissa shows doses on a log scale that were administered during a session using a cumulative dose procedure. Data points at C are means (S.D.) averaged over the four blocks of test trials during a control test session when water instead of ethanol was administered. The percent of eye tracks is the average from the 5 segments of electrooculogram recordings at each cumulative dose.

responses, correct responses, and incorrect responses in each test block were recorded as well as the number of times that the inner disk was dimmed. The percent of correct responses was computed as the ratio of total number of correct responses (reinforced responses) to total number of inner disk dimmings. Cumulative latency, the duration from the onset of dimming of the inner disk to a correct response was also recorded. If there was no correct response, then 0.6 sec was added to the cumulative latency. The average response latency was defined as the cumulative latency divided by the total number of inner disk dimmings. If there were no correct responses in a test block, the average response latency was the maximum value of 0.6 sec.

The EOG records were visually inspected to count the number of eye tracking cycles during each 30 sec segment for each EOG recording component. An eye tracking cycle was defined as a sinusoid with a peak and a trough corresponding to the peak and trough of the stimulus signal cycle regardless of whether the eye position tracing was smooth. The percent of eye tracks was computed from the ratio of the number of eye tracking cycles to the number of signal cycles. Means and standard deviations of this percentage were calculated across the five 30 sec segments in each EOG component of each block of test trials.

Ethanol administration. Eighty-proof vodka (Stolichnaya) was used undiluted. The volume of vodka administered before the 1st, 2nd 3rd, and 4th test blocks was 0.78 ml/kg, 0.78 ml/kg, 1.56 ml/kg, and 3.12 ml/kg, respectively. Each volume was delivered into the stomach through an infant feeding tube by syringe over a 5 min period. During control test sessions, the same volume of tap water was given in the same manner before each test block.

Blood ethanol level determination. The blood ethanol levels were determined 25 min after each ethanol administration. At this time, 20 μl of blood was collected in capillary tubes by piercing the great saphenous vein of the right foot. The blood was emptied from the capillary tube into a 25-ml Erlenmeyer flask containing 0.5 ml of distilled water, and the flask was immediately sealed. The blood was kept at −80°C in a freezer until measured. One ml of the gas volume from the flask was injected into the port of a gas chromatograph (Model No. 560, Tracor Instruments, Austin, TX) equipped with a flame ionization detector. The ethanol was chromatographed in Porapak Q (Walters Associates Inc.), packed in a glass column (6 ft × 4 mm) and quantified against standards which were prepared by adding known amounts of ethanol to 0.5 ml of water at appropriate concentrations and then submitting them to the same chromatography.

Experiment 2. Ethanol Effects in Human Subjects

Six healthy subjects, 3 males and 3 females between the ages of 23 and 52 and weighing between 54 and 86 kg, served as volunteers. All were either graduate students or employees of The University of Chicago and were social drinkers. Prior to participation in the experiment, the subjects read and signed a consent form which outlined the study and possible side effects of the ethanol they might be given. Each subject participated in 3 sessions. Session 1 was a training session and sessions 2 and 3 were a control and ethanol test session. Each subject agreed not to take alcoholic beverages at least 18 hr before and after both sessions. The subjects were not informed which day was a control and which an ethanol test session. The subjects were asked to consume a light lunch 3 hr before the start of both test sessions.

Apparatus. The experiment was conducted with each subject seated in a chair placed inside the same wooden enclosure as used in Experiment 1. The subject held a microswitch that could be activated by a force of approximately 500 g. A subject placed his or her chin on a chin rest to prevent head movement. The conditions of the stimulus projected on the white screen were the same as in Experiment 1. Electrodes were placed at the outer canthus of each eye and at the center of the forehead of each subject for the duration of test sessions. Other conditions were the same as in Experiment 1 except that the rotating sound of a motor was used as the signal for a correct response.

Procedure. The subject was seated in a totally darkened enclosure during the experimental sessions. The procedure was the same as in Experiment 1. Trials were signalled by the onset of a tone, a single response on the microswitch terminated the tone, and the oscillating disk was then projected on the screen. The inner disk was dimmed under the same random time schedule. Pressing the microswitch during the 0.5 sec period when the inner disk was dimmed or within 0.1 sec afterward resulted in presentation of the rotat-

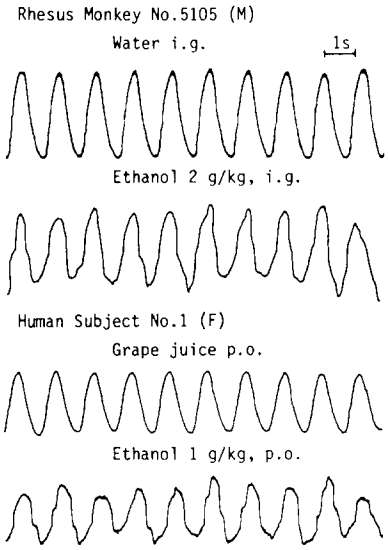

FIG. 2. The effects of ethanol on pursuit eye movements in a rhesus monkey and in a human subject shown by electrooculogram (EOG) recording. Subjects followed with their eyes the projection on a screen of a disk that oscillated sinusoidally in the horizontal plane at a frequency of 0.8 Hz. Doses are expressed as cumulative doses.

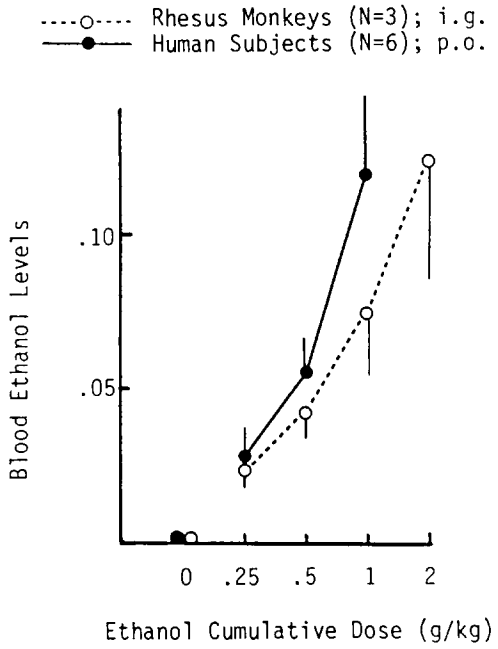

FIG. 3. Blood ethanol levels in rhesus monkeys and human subjects measured by gas chromatography and expressed as g/100 ml. Blood samples were collected 25 min after each ethanol administration during ethanol test sessions. The levels are expressed as means± S.D.'s over subjects.

ing sound of the motor for 5 sec. A trial was terminated upon either the delivery of the sound or an incorrect response (i.e., a response that did not occur within the 0.6 sec period). In the training session, each subject was instructed to follow the disk by moving the eyes only and to press the microswitch when the inner disk was dimmed. He or she was also told that the rotating sound of the motor indicated that the response was correct. During the training session, electrodes were not attached to the subject and the training session was terminated after 50 correct responses. In the ethanol test session, each subject initially drank grape juice in a volume of 0.78 ml/kg. Thirty min after finishing the grape juice, the first block of test trials was given in the same manner as in Experiment 1. After the completion of this block, the subject drank a solution containing 0.25 g/kg ethanol. Thirty min later, the 2nd block of test trials was given as above. The remainder of the session had two more blocks of test trials. Thirty min before block 3, a solution containing 0.25 g/kg ethanol (cumulative dose of 0.5 g/kg) was administered and 30 min before the 4th block, 0.5 g/kg ethanol (cumulative dose of 1 g/kg) was consumed. Between blocks of test trials, the subject was seated on a chair in an illuminated room adjacent to the experimental room. The control test session was given at least 3 days before the ethanol test session. The procedure was identical except that each subject drank grape juice before each block of test trials.

Data analysis. Same as Experiment 1.

Ethanol administration. The same 80-proof vodka as in Experiment 1 was used. For each ethanol drink, the vodka was diluted with grape juice at a concentration of 50%. The volume of the grape juice was 0.78 ml/kg for the first drink, and the volumes of the diluted vodka in the 2nd, the 3rd, and 4th drinks were 1.56, 1.56 and 3.12 ml/kg, respectively. In the control test session, each subject drank the same volume of grape juice as in the corresponding block of test trials during the ethanol test session. Each drink was consumed within 5 min.

Blood ethanol determination. Blood ethanol levels were determined 25 min after each drink in the test sessions. At this time, 20 μl of blood was collected in a capillary tube by piercing one finger tip. The other details were the same as Experiment 1. In addition, a breathlyzer (Model No. 900, Stephenson Co., Red Bank, NJ) was used to estimate the blood ethanol level from the subject's breath at 20 min after each drink.

Subjective effects. Each subject filled out a shortened version of the Addiction Research Center Inventory (ARCI) 10 min after each drink during both test sessions. The ARCI consists of 49 true/false statements describing momentary subjective state changes. The statements are classified in 3 categories: the morphine-benzedrine group scale (MBG) which is thought to measure drug-induced euphoria; the LSD scale, which measures psychotomimetic effects; and the pentobarbital-chlorpromazine-alcohol group scale (PCAG), which measures those subjective effects produced by tranquilizers, sedatives and alcohol. Subscales scores were averaged across subjects after each drink and the mean differences on the two test sessions were statistically tested by a paired t-test.

RESULTS

Experiment 1. Ethanol Effects in Rhesus Monkeys

In training sessions, all three monkeys responded appropriately under the terminal contingencies and all 99 reinforcers were delivered within 40 min. The percent of correct

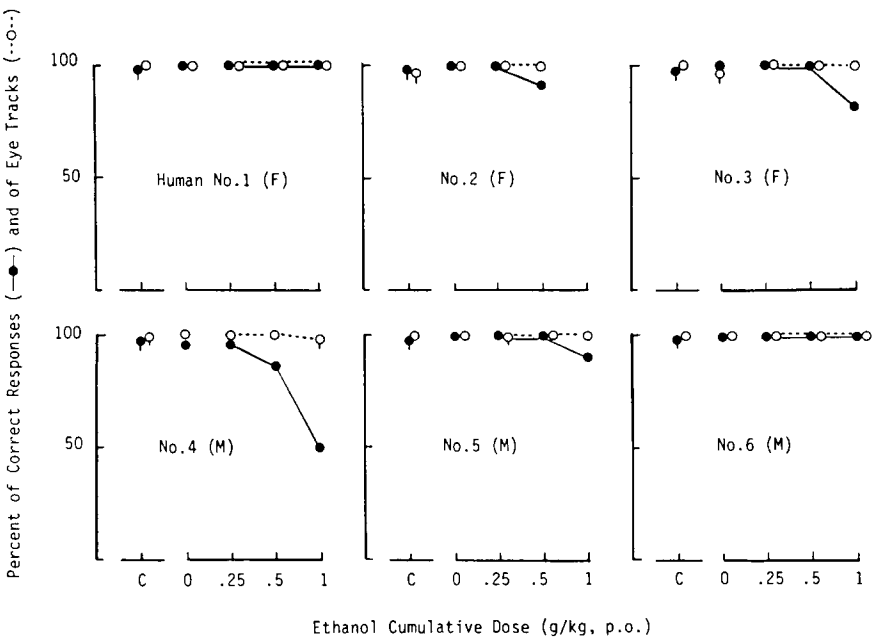

FIG. 4. The effects of ethanol on switch pressing behavior (percent of correct responses) and on pursuit eye movements (percent of eye tracks) in human subjects. The abscissa shows doses on a log scale that were administered during a session using a cumulative dose response procedure. Data points at C are means (S.D.) averaged over the four blocks of test trials during a control test session when grape juice instead of ethanol was administered. The percent of eye tracks is the average from the 5 segments of electrooculogram recordings at each cumulative dose.

responses in training sessions across the 3 monkeys ranged between 97 and 100% averaged over 5 consecutive training sessions occurring immediately prior to the first test session. From direct observation of the monkeys, it appeared that their eye movements were synchronized with the movements of the disk, that is, moved sinusoidally, which was confirmed by the EOG tracing. In control test sessions, lever pressing behavior was unaffected by intragastric water administration during any of the 4 blocks of test trials. The mean percent (±S.D.) of correct responses averaged across blocks was 100±0% for 3 monkeys (solid circles at C in Fig. 1). The mean response latency (in sec) averaged over all 4 blocks of trials was 0.37±0.01 in monkey 5101, 0.43±0.02 in monkey 5105, and 0.44±0.01 in monkey 6048 during control test sessions. Smooth pursuit eye movements were observed in EOG recording components for each monkey (top row in Fig. 2). The mean percent of eye tracks over the 4 blocks was 86.9±7.9% in monkey 5101, 97.6±1.1% in monkey 5105, and 90.7±2.9% in monkey 6048 (open circles at C in Fig. 1).

As shown in Fig. 1, 0.25 to 1 g/kg ethanol did not decrease the percent of correct responses in any of the monkeys. However, average response latency increased in a dose dependent manner up to a maximum of 16% greater than control values. A dose of 2.0 g/kg ethanol decreased the percent of correct responses slightly in monkey 5101 and markedly in monkeys 5105 and 6048. The average response latency at this dose was 0.48 sec in monkey 5101, 0.53 sec in monkey 5105, and 0.6 sec in monkey 6048. Compared to changes in correct responses, the percent of eye tracks was decreased more by ethanol in monkey 5101 but there were no differential effects on these 2 measures in the other two monkeys (Fig. 1). Based on visual inspection of the EOG recordings, the number of episodes of saccadic non-pursuit eye movements increased at 0.5–2 g/kg ethanol in monkey 5101, at 2 g/kg in monkey 5105, and at 1 and 2 g/kg in monkey 6048. Saccadic pursuit eye movements were observed episodically at 2 g/kg in monkey 5101 (2nd row in Fig. 2).

As shown in Fig. 3, blood ethanol levels increased in dose dependent manner and exceeded 0.1 g/100 ml after the administration of 2 g/kg.

Experiment 2. Ethanol Effects in Human Subjects

In the training session, all subjects responded appropriately under the terminal contingencies. All 50 reinforcers (the rotating sound of the motor) were presented and the training session was approximately 18 min in duration. The percent of correct responses in this training session ranged between 98 and 100% across subjects. In the control test session, stable switch pressing behavior observed during each of the blocks of trials was unaffected by grape juice. The mean percent (±S.D.) of correct responses over the 4 blocks was 100±0% in 4 subjects (1, 3, 5 and 6), 96.8±3.7% in subject 2, and 99.6±0.5% in subject 4 (solid circles at C in Fig. 4). The mean of the average response latency (in sec) over the 4 blocks in the control test session ranged between 0.32 and 0.38 sec across subjects. Smooth pursuit eye movements were observed in EOG recording components for each subject (3rd row in Fig. 2). The mean of the percent of eye tracks over the 4 blocks of the control session ranged between 96.8 and 100% across subjects (open circles at C in Fig. 4).

As shown in Fig. 4, ethanol decreased the percent of correct responses in a dose dependent manner in subject 4,

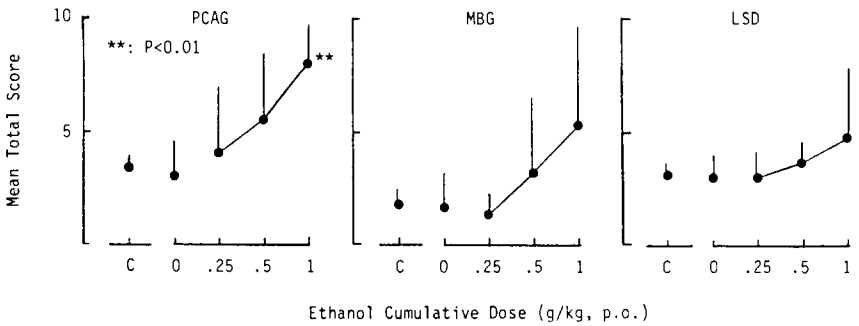

FIG. 5. The subjective effects of ethanol in human subjects produced on three scales of the ARCI (Addiction Research Center Inventory). PCAG: Pentobarbital-Chlorpromazine-Alcohol group scale; MBG: Morphine-Benzedrine group scale; LSD: LSD scale. Scores on each scale were averaged over 6 subjects and means with S.D.'s are indicated. Data points at C are means with S.D.'s obtained during the control test session.

decreased it slightly at 0.5 or 1 g/kg in subjects 2, 3 and 5, and did not decrease this measure in the dose range tested in subjects 1 and 6. Because subject 2 vomited in the middle of the last block of test trials following the administration of the cumulative dose of 1 g/kg, the experiment was discontinued and no data during the last block were obtained. Ethanol increased the average response latency in a dose dependent manner in all subjects. The average response latency increased up to 30% of control values at 1 g/kg in subjects 1 and 6 whose percent correct responses did not decrease across the dose range tested. The average response latency at 1 g/kg ranged between 0.36 and 0.54 sec across subjects, excluding subject 2. The percent of eye tracks did not decrease and smooth pursuit eye movements continued at the doses tested in all subjects. Saccadic pursuit eye movements, however, were observed at 1 g/kg in subjects 1, 3, 4 and 5 (bottom row in Fig. 2). Subject 6 continued to show smooth pursuit eye movements even at 1 g/kg. Saccadic non-pursuit eye movements were rarely observed during the EOG recording components across the dose range tested.

Blood ethanol levels increased in a dose dependent manner as shown in Fig. 3. The correlation between blood ethanol levels and estimated blood ethanol levels from subject's breath was very high (correlation coefficients ranged between 0.96 and 1.00 across subjects).

On the ARCI, the scores on each of the 3 scales increased in a dose-dependent manner after ethanol administration (Fig. 5), but only the score on the PCAG at 1 g/kg ethanol was significantly increased in comparison with the control session value.

DISCUSSION

The purpose of the present experiment was to compare the effects of ethanol on eye tracking performance in monkeys and humans. To facilitate this comparison, the experimental methods used with both species were matched as closely as possible. The apparatus and procedures used with both species were basically similar. In particular, the doses used and the interval between ethanol administrations were identical. Despite this attempt to evaluate similar doses, the blood ethanol levels were higher in humans than in monkeys. Although the reason for this higher level is unknown, differences in absorption rates and metabolism in both species are possible explanations. In addition, they may have been due to differences in ethanol concentration and fasting time. In the human subjects vodka diluted with grape juice (20% ethanol concentration) was given in order to avoid irritiation and damage to the gastric mucosa [3,9]. The degree of food deprivation also differed in the two species which could have affected the magnitude or time course of ethanol's effects since the presence of food in the stomach delays ethanol absorption [6]. Although the fasting time for monkeys was sufficiently long (approximately 22 hr) to insure an empty stomach, in humans only 3 hours of food deprivation was feasible. Since 3 to 4 hr are required for stomach emptying in humans, it is unlikely that the stomachs of the humans were totally empty at the time of drinking the first ethanol solution. However, it is likely that complete stomach emptying occurred as the session proceeded.

Another important difference in experimental procedure was the fact that pursuit eye movements in monkeys were maintained in an indirect manner by reinforcing lever pressing behavior with water. That is, pursuit eye movements were not essential for the monkeys to obtain water reinforcer although it would have been difficult to perform the task without pursuing the target. On the other hand, smooth pursuit eye movements as well as switch pressing behavior in humans were maintained by the experimenter's verbal instruction to follow the moving disk with their eyes and to press a microswitch when the center of the disk dimmed. These differences in factors maintaining pursuit eye movements and lever or microswitch pressing behavior might have produced the differences observed in the effects of ethanol. In monkeys, lever pressing behavior was less sensitive to the effects of ethanol than pursuit eye movements in 2 monkeys while switch pressing behavior was more sensitive to the effects of ethanol than pursuit eye movements in 4 human subjects. Furthermore, the lowest dose producing appreciable effects was 2 g/kg in monkeys and 1 g/kg in humans. Although this difference in sensitivity may have been due to pharmacokinetic factors, as discussed above, differences in procedure could have also contributed. However, many of the effects of ethanol such as the production of saccadic pursuit eye movements which have been reported by other investigators [5], disruption of responding, and an increase in average response latency were similar in both species. Thus, eye tracking experiments using rhesus monkeys may be useful for predicting drug effects on this function in humans. On the other hand, experiments in humans

can contribute information difficult to obtain in non-verbal species. For instance, in the present experiments, doses which produced alterations in performance also produced changes in mood as evaluated by a paper and pencil questionnaire. Thus, such reported changes in subjective state can be used to indicate the possibility of concurrent performance decrements.

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