A BETTING DICE TEST TO STUDY THE INTERACTIVE STYLE OF RISK-TAKING BEHAVIOR

ISABEL AREND, JUAN BOTELLA, MARÍA JOSÉ CONTRERAS, JOSÉ MANUEL HERNÁNDEZ, and JOSÉ SANTACREU
Universidad Autónoma de Madrid

The purpose of this research was to assess the consistency and stability of risk-behavior within the interactive style perspective through a betting dice test (Ribes & Sánchez, 1992). We used two different versions of the betting dice test (BDT), in which some parametric values were changed in order to verify the interactive style configuration. When BDT version 1 was used (Study 1) we found that, even though the response options had the same expected value, subjects presented a conservative strategy, and that the behavior remained stable after 2 hr. The second BDT version (Study 2) allowed us to verify two aspects of the risk-taking behavior: (a) Subjects' risk behavior remains stable after 1 yr; and (b) the assumed risk varies between the two versions of the BDT. These results are discussed within the interactive style framework.

Risk-taking behavior has been studied from different perspectives in psychology. From decision theory it has been considered as a part of the decision-making process (Jacoby & Kaplan, 1972; Kahneman & Tversky, 1979; León & Lópes, 1988; Yates, 1992). Classical theories of personality have studied risk-taking behavior using the trait concept to explain why subjects show different risk behaviors when they face the same situation (Cattell, 1965; Costa & McCrae, 1995; Eysenck, 1967). Zuckerman (1971, 1994) also studied risk-taking behavior as a part of the personality trait he described as “sensation seeking.” The theoretical framework for the study of individual differences developed by Ribes and Sánchez (1992) has been considered as an alternative in explaining how personality issues can be studied by giving priority to subjects’ interactions with specific situations.

Dixon, Hayes, and Aban (2000; Dixon, Hayes, & Ebbs, 1998) investigated risk-taking behavior in the context of gambling. Their research focused on the effects of reinforcement histories on subsequent gambling and the role of inaccurate, accurate, or no instructions on

This research was supported by the project AENA-UAM/785001. Correspondence may be addressed to Isabel Cristina Arend, Dep. de Psicología Biológica y de la Salud, Facultad de Psicología, Universidad Autónoma de Madrid- Cantoblanco, 28049 – Madrid- España. (E-mail: isabel.arend@uam.es).
gambling; they also studied the correlation between historical measures of risk and risk performance. They found that subjects sometimes follow instructions received after prolonged exposure to contingencies. Their main conclusion was that subjects exposed to inaccurate rules yield more risk levels and make larger bets than subjects exposed to accurate and no-rule conditions.

Subject individuality and the idiosyncratic characteristics of behavior are key concepts in Ribes and Sánchez’s formulations, as are the interactions between the subject and the parametric values of a situation. Therefore, risk-taking behavior can be studied from this perspective whenever the situation involves two or more alternatives and there is an inverse relation between the probability of obtaining a reward and its magnitude. Some studies have been carried out to verify the interactive style of risk-taking behaviors (Doval, 1995; Ribes & Sánchez, 1992; Santé & Santacreu, 2001). Within the interactive style perspective researchers have used tasks that are functionally identical but morphologically different to assess the degree of consistency in subjects’ behavior. An example would be using two games situations, roulette and a dice game. These situations can be characterized as morphologically different in the sense that they are different types of betting games, and functionally equivalent because they have the same expected value associated with each response alternative.

The term interactive style refers to a stable form of behavior particular to each person, and which can be observed when there is an interaction between the subject and a specific situation. Situations are defined, according to this perspective, by the contingency relations between the parametric values of the variables operating in them. Thus, the interactive style makes the behavior more likely to occur when certain contingencies are present. The concept of interactive style also implies that the subject’s behavior is historically shaped. An interactive style should be assessed and measured in situations in which subjects can not learn the correct response to obtain a positive consequence. An open contingency situation can be described as one in which the behavior is independent of the consequence (Doval, Viladrich, & Riba, 1998; Harzem, 1984; Ribes & Sánchez, 1992; Viladrich & Doval, 1998). In the context of risk behavior the person is asked to choose among response alternatives with the same expected value. Subjects are not informed of the number of trials, which means that the tendency to opt for a specific alternative is not biased by the equivalence of the mathematical outcome.

Ribes and Sánchez (1992) point out that personality characteristics can be seen as the way behavior is organized according to the contingencies. This theory does not provide a global description of risk behavior; rather, it states that it is the functional relations established between the parametric values of the variables that define the situation as risky.

Some empirical studies have been carried out in order to explore how interactive styles are shaped. We shall briefly describe three of these studies in order to clarify the nature of our predictions about risk behavior,
and also to present the methodological basis for the study of risk behavior from an interbehavioral perspective.

Ribes and Sánchez (1992) used a horse-race game to pursue four goals: (a) to identify individual differences in subjects' behavior in the same experimental task, (b) to verify the consistency of subjects' behavior, (c) to verify the temporal stability of the behavior with a 1-year delay between measurements, and (d) to verify the role of open and closed contingencies in an experimental situation. The hypothesis here was that the behavior would be homogeneous with closed contingencies, whereas in open contingencies wider variability would be observed.

Subjects showed differences when the experimental conditions were characterized by open contingencies. Such differences were not observed when closed contingencies were established using a criterion of effectiveness. Thus, an open contingencies design is seen to be powerful when individual differences are expected to be found.

In the study by Doval (1995) the goals were (a) to design assessment tools to evaluate interactive styles, (b) to identify the consistency and stability in open contingency situations, (c) to identify the effect of closing the contingencies in the modulation of individual differences, (d) to identify the interaction between subjects' behavior and the different parameters of the risk-taking situations (number of trials, number of points, number of trials that subjects won and the number of trials they lost, and (e) to verify in closed-contingencies situations the modulator effect of the interactive style of risk-taking behavior of each subject in terms of its precision, speed, and opportunity.

Three assessment tasks were used. The first involved betting on a horse-race and was similar to that used by Ribes and Sánchez (1992). The second was a task in the context of the stock market (morphologically different). The companies on the left-hand side had a solidly established tendency in the investment market, with a higher probability of "winning." The companies on the right side of the screen did not have a stable market tendency. However, the expected value for obtaining each point on either side of the screen was the same (open contingencies). The third task was similar to the first one, but in this case one of the options, choosing the right or the left race, was associated with a higher expected value. To study temporal stability, subjects were evaluated with the first task at two points, separated by an interval of 1 month.

Doval (1995) found, through individualized analysis with 10 subjects, that the first and the second instruments were appropriate for assessing interactive style, because they fulfilled the theoretical requirements for evaluating such styles previously described. With regard to interactions of behavior with different situational parameters, Doval found the following results: (a) The number of trials did not relate to the amount of risk subjects assumed, (b) there was a tendency to assume more risk when the number of trials without winning was higher, and (c) the number of points subjects won did not relate to the assumed risk.
Of the subjects, 80% had stable behavior across the time interval and across the situational conditions. The main contribution of Doval's research is that the idiosyncrasy of subjects' behavior can be observed, and that the subjects' interactions are stable in time and consistent in a variety of functionally similar situations. Doval's results can be considered as evidence in favor of the interactive style as a construct capable of discriminating the individuality of risk-taking behavior.

The third study we report here was designed by Santacreu, Froján, and Hernández (1991) to assess risk-taking behavior through the Betting Dice Test (BDT). The goals of the study were: (a) to evaluate the Betting Dice Test as an alternative for assessing risk-taking behavior, (b) to compare two different methodologies for evaluating risk with the BDT, and (c) to identify the variables that can interfere in the experimental situation (number of points, number of hits, previously assumed risk), and that allow us to predict the subject's interactive style in a specific situation.

The task consisted in asking subjects to bet, using two dice, on one of three possible alternatives: even/odd, higher than or equal to 10, and equal to 12. The associated probabilities were even/odd = 1/2; equal to 10 = 1/6; equal to 12 = 1/36. Modalities of the bets implied different risk values, and the points subjects could win for each of the response options had the same expected value.

In Phase 1 subjects were asked to record on paper their preferences for 10 bets, without receiving feedback on the results (phase for identification of the interactive style). During the second phase subjects received feedback, that is, they received information about the results of each bet. During this phase they had an opportunity to reconfigure the interactive style according to their results. In the third phase, without receiving feedback, they had to indicate their preferences. In contrast to previous studies, each one of the phases in this study had 10 trials.

Results indicated that subjects were consistent across the different study phases. Considering the distribution of the risk variable during the first study phase, the group showed a tendency to present conservative responses, even though the three response options had the same expected value. The use of feedback in the second phase reduced the risk level. The effect of giving feedback is the closing of contingencies, in the sense that a specific choice is reinforced or punished by the consequences of the bet, causing subjects to change their behavior according to the result of the feedback. Thus, it seems that the use of conservative strategies was caused by the closing of contingencies produced by the feedback, a result the authors interpreted as supporting the position of Ribes & Sánchez. These results were also found in studies by Santé (1999) and Santé and Santacreu (2001), which used a similar betting dice test.

Following the studies described above, the present research explores risk-taking behavior from the interactive styles perspective. The purposes of our research were (a) to verify consistency of behavior in a betting dice test with the same associated value for each betting alternative, and (b)
to verify the stability of behavior of the interactive style of risk-taking behavior between assessments at different points in time.

In contrast to the studies described previously, we did not include feedback in the evaluation sessions, so that we could verify whether subjects' behavior was consistent and stable when the open contingency situation was used. In a first study we attempted to assess risk-taking behavior through a computerized Betting Dice Test developed by Rubio and Santacreu (1998) and to verify the consistency of subjects' behavior, by using the same task twice with a 2-hr interval. In a second study we report the results obtained using a second version of the BDT, and temporal stability assessed by means of test-retest with a 1-yr interval. We also present data from a study designed to verify subjects' behavior stability and the relationship between task features and risk-taking behavior for the same sample.

**Study 1**

**Method**

**Participants.** The sample consisted of 809 candidates for entry to a course for the position of air traffic controller. There were 437 females with a mean age of 27 (SD = 4, age range 20 to 44) and 372 males with a mean age of 28 (SD = 5, age range 20 to 43). All were university graduates.

**Materials.** The tasks were administered in a large room with individual workplaces appropriately separated. They were administered on PC with Philips 107-s, 17" monitors.

**Instrument.** The Betting Dice Test (BDT) used to asses the risk-taking behavior was designed by Santacreu et al. (1991) to measure subjects' tendency to select response options that represent different risk values. A value is considered risky if it is associated with a low reinforcement probability, but a large reward. The basic criterion for deciding whether a response is more or less risky is as follows: the lower the probability of obtaining reinforcement and the greater the reward associated with a given option, the greater the risk assumed in choosing that option.

Rubio and Santacreu (1998) designed the computerized version of the Betting Dice Test (BDTv1) to assess subjects' tendency to select risky alternatives. In this version the subject was asked to choose between three possible betting modalities. The bets were made using two dice. Subjects had to estimate the result of the sum of the two dice. They were told to choose the option even/odd if they thought the sum was going to be even or odd; to choose the option of a number higher than or equal to 10; or to choose the option in which the sum of the two dice would be 12. (See Figure 1). The subject was told that a hit in Option 1 scores 2 points, a hit in Option 2 scores 6 points and a hit in Option 3 scores 36 points (see Table 1). The subject who assumed most risk would prefer the third option, whereas the less risk-oriented subject would opt more frequently for the first option. Subjects had 10 trials to make their bets, but they were not informed of this in the instructions.
There are a certain number of opportunities to throw the dice. Your aim is
TO GET THE HIGHEST POSSIBLE SCORE. For each throw, you can wager in one
of the categories. If you are right, you will get the score assigned to that category. If
you are wrong, you do not score.

Category of wager: EVEN or ODD
2 points
Category of wager: From 10 Upwards
6 points
Category of wager: Equaling 12
36 points

Figure 1. Parametric values of the Betting Dice Test Version 1.

Table 1

Neperian Logarithms for the Inverse of the Probability (Study 1)

<table>
<thead>
<tr>
<th>Response Options*</th>
<th>Associated Reward</th>
<th>Inverse of the probability</th>
<th>Ln</th>
</tr>
</thead>
<tbody>
<tr>
<td>Even/odd</td>
<td>2</td>
<td>2/1 = 2</td>
<td>0.69</td>
</tr>
<tr>
<td>Equal or higher than 10</td>
<td>6</td>
<td>6/1 = 6</td>
<td>1.79</td>
</tr>
<tr>
<td>Equal 12</td>
<td>36</td>
<td>36/1 = 36</td>
<td>3.58</td>
</tr>
</tbody>
</table>

*The subject must estimate the result of the sum of the two dice.

Procedure. The Betting Dice Test was administered with other
personality and ability measures during the selection process. The
BDTv1 was administered twice, first at the beginning of the session
(BDTV1a), as the 5th test, and subsequently at the end of the session, as
the 16th test (BDTv1b). The assessment session took 3 hr, and
participants had a 15-min rest interval in the middle of the session.

Results
The risk value in each response selection is defined as the inverse of
the probability of hits in that alternative, as is usual in the study of risk-
taking behavior. In the present study the inverse of the probability of
winning is as follows: 2, 6, 36. The risk value was defined by calculating
the neperian logarithm for the inverse of the probability (ln). This method
gives a closer index of the risk behavior subjects assume when they are asked to opt for each alternative. Calculating the neperian logarithm of the inverse of the probability has the advantage of making the mean of risk value assumed by subjects in the test equal to the sum of the numbers of times subjects opt for each response alternative. Table 1 shows the inverse of the probability of each response option and the neperian logarithm corresponding to each one.

For each subject we calculated the risk value; that is, the average of bets in the 10 trials. Subjects assumed the same risk values at the two assessment points (see Figures 2 and 3), so that the difference between the means is not statistically significant, \( t(810) = -0.073; p = 0.942 \). Given the large size of our sample, our analyses were carried out assuming an alpha level of .01. With regard to scores distribution, we observed that subjects preferred to play on the first two options, indicating a conservative tendency. Figure 3 shows the scores distribution when the test was reapplied after 2 hr. We calculated the correlation between subjects’ scores in the first application (BDTv1a) and the second application (BDTv1b). Pearson’s correlation coefficient was found to be statistically significant (.59, \( p < .01 \)).

![Histogram showing assumed risk values (BDTv1a)](image)

**Figure 2.** Distribution of the risk values (see text) BDTv1a.

The test was consistent across the trials. We obtained high Cronbach’s alpha coefficients in both applications, .77 and .85, respectively. A split-half correlation showed that reliability was also statistically significant, in both the first (.69, \( p < .01 \)) and second applications (.77, \( p < .01 \)).
Figure 3. Distribution of the risk values BDTv1b.

Discussion
As already pointed out, interactive style can be seen as a stable way of behaving that results from the interactions between the parametric values and the variables operating in each situation. According to Ribes and Sánchez (1992), an interactive style will be configured when open contingencies tasks are used, and the motives and abilities for emitting a response are not determined by response expectations, thus allowing the interactive style to manifest itself. In our study, even though the three options had the same expected value, subjects preferred to bet on the first two alternatives, which correspond to a conservative bias. Working with the same expected value allowed us to verify subjects’ assumed risk. Thus, the betting dice test showed itself to be useful for assessing risk-taking behavior as an interactive style. It may be the case that the three-response format used in this version leads subjects to prefer more conservative options, since Options 1 and 2 implied almost the same risk values, encouraging them to avoid the third one, which is more risky.

With regard to the results from the two different assessment time points, subjects’ behavior was seen to remain consistent across the interval. Consistency in subjects’ behavior was also reported in other studies using similar tasks (Doval, 1995; Ribes & Sánchez, 1992) and was interpreted as reflecting stability in subjects’ behavior. However, it may be that the 2-hr interval between the two applications was too short, allowing the retrieval of the strategy used on the first occasion.

In order to better differentiate subjects’ risk-taking behavior in a betting task, we decided to change the task configuration by giving the subjects four response options. Taking into account that in the first study Options 1 and 2 had approximate values (see Table 1), Study 1 subjects may have been biased to choose a more conservative option. By
changing to four options we would be opening the contingencies more, so
that the assumed risk value would be better distributed. We also included
a 1-yr assessment interval to evaluate the stability of their risk-taking
behavior. Furthermore, we included a message in each trial reminding
subjects to try to obtain as many points as possible. Our goals in this
second study were (a) to check whether the new version of the betting
dice test discriminates subjects' risk-taking behavior and (b) to check
whether there is temporal stability in the tendency to assume risk after 1 yr.

Study 2

Method

Participants. 427 of those that participated in the selection process
for entry to a course for the position of air traffic controller, as in Study 1,
but one and two years later. The sample was made up of 203 females
with an average age of 28 (SD = 4, a range from 21 to 40) and 224 males
with an average age of 29 (SD = 5, a range from 22 to 44). All were
university graduates.

Materials. These were the same as for the previous study.

Instrument. The Betting Dice Test (Version 2: BDTv2) measures the
level of risk when the subject tries to obtain a reward by means of four
response options. This test is a modification of Version 1. In order to
better discriminate between subjects' risk-taking behavior, we decided to

![Figure 4. Parametric values of the Betting Dice Test Version 2.](image-url)
incorporate the following changes: (a) to give four response options and (b) to emphasize the goal of obtaining as many points as possible, through the inclusion of a message after each trial. The test includes 10 trials with four response options each: (a) obtain, with the sum of two dice, more than 4 points, (b) obtain more than 7 points, (c) obtain more than 9 points, and (d) obtain 12 points. The first bet allows the subject to obtain 1 point, the second 2 points, the third 5 points, and the final one 30 points (Figure 4). The probability of obtaining points is reduced as the possibility of obtaining more points increases. In this way, the first bet implies the least risk, and the final one the most risk.

Table 2

<table>
<thead>
<tr>
<th>Response Options</th>
<th>Associated Reward</th>
<th>Inverse of the probability</th>
<th>Ln</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 4</td>
<td>1</td>
<td>36/30 = 1.2</td>
<td>0.18</td>
</tr>
<tr>
<td>&gt; 7</td>
<td>2</td>
<td>36/15 = 2.4</td>
<td>0.87</td>
</tr>
<tr>
<td>&gt; 9</td>
<td>5</td>
<td>36/6 = 6</td>
<td>1.79</td>
</tr>
<tr>
<td>= 12</td>
<td>30</td>
<td>36/1 = 36</td>
<td>3.58</td>
</tr>
</tbody>
</table>

Procedure. The BDTv2 was used in the same selection process as the BDTv1, but 1 and 2 years later. In the first-year sample it occupied seventh place in the order of tests in the assessment session; in the second-year sample it occupied eighth place. Other personality and cognitive ability measures were once again used to select participants for taking the course. The session took 3 hr, and participants had a 15-min rest interval in the middle of the session. In order to study behavior stability across the two versions of the Betting Dice Test we also analyzed the performance of 46 subjects who participated in 1998 (BDTv1), 1999 and 2000 (BDTv2).

Results

As in the first study, assumed risk was calculated as the neperian logarithm for the inverse of the probability of obtaining a reward with each response alternative. In this study the inverse of the probability was different from the associated values given for each alternative. Therefore, the neperian logarithms were calculated for the values resulting from the inverse of the probability for each response alternative: for example, the results of the inverse of the probability of getting the first option is 36/30 = 1.2, and the neperian logarithm of 1.2 is 0.18, which is the amount of risk associated with this first option. Table 2 shows the inverse of the probability for each response alternative and the neperian logarithm of each one.

Average scores across subjects for the BDTv2a and the BDTv2b are presented in Figures 5 and 6. Once again, and as expected, average scores were similar for the two applications, with no significance differences between them, t(1, 426) = 2.32, p = .020. We can observe that the four-response format changes the subjects' bets in each trial. Scores are organized around the mean value.
Figure 5. Distribution of risk values the BDTv2 in 1999.

Figure 6. Distributions of risk values the BDTv2 in 2000.

With regard to the consistency in the test, Cronbach’s alphas were .82 and .87 for the BDTv2a and b, respectively.

In order to verify whether subjects’ risk-taking behavior remained stable across the interval between the two assessment points, we calculated the correlation between subjects’ risk scores in the first application (BDTv2a) and those in the second application (BDTv2b). As expected, the correlation was statistically significant, .43 ($p < .01$).
Thus, because interactive style is a result of the interaction between the subject's behavior and the parametric values implied in each task, we would expect to find differences in subjects' behavior when the parametric values of the betting dice test were changed. In order to verify this hypothesis, we selected evaluated performances in the BDTv1 and the BDTv2 for the 46 subjects who participated in the three selection processes. Descriptive results for the BDTv1 (a and b) and for the BDTv2 (a and b) are shown in Table 3. Means for the two applications of the BDTv1 reveal similar behavior patterns despite the 2-hr interval.

Correlations were calculated for the BDTv1 (a and b) and for the BDTv2 (a and b) (see Table 4). As expected, there was a significant correlation between the two measures of the BDTv1, .41 (p < .05).

| Descriptive Results of the BDTv1 (a and b) and BDTv2 (a and b) |
|--------------------|----------------|----------------|--------|
| Mean (N = 46)      | Min             | Max            | SD     |
| BDTv1a             | 1.48            | .69            | 3.58   | .70   |
| BDTv1b             | 1.45            | .69            | 3.58   | .65   |
| BDTv2a             | 1.14            | .18            | 3.58   | .70   |
| BDTv2b             | 1.01            | .18            | 3.58   | .67   |

Table 4

| Correlation Between the Two versions of the Betting Dice Test |
|-------------------|----------------|---------------|--------|
| BDTv1a             | BDTv1b         | BDTv2a        | BDTv2b |
| BDTv1a             | .41**          | .03           | .14    |
| BDTv1b             | .09            | .19           |        |
| BDTv2a             |                | .45**         |        |

** p < .001

With regard to the descriptive results for the BDTv2, a similar average of assumed risk was obtained for the two measures (see Table 3). Thus, subjects showed a high level of behavior stability after 1 yr. Correlation between the two measures was .45 (p < .001) (see Table 4).

As mentioned above, we were also interested in verifying whether subjects' risk-taking behavior would depend on the features of the task. Thus, we calculated the correlation between the assumed risk values obtained in Version 1 and the global indices obtained in Version 2. No significant correlation was found (see Table 4).

Taken together, these results indicate that (a) subjects show temporal stability within the same risk-taking behavior measure and (b) there is no relationship between the scores obtained in two different tasks supposedly designed to assess the same risk-taking behavior; that is, risk-taking behavior as an interactive style is sensitive to the specific task features selected for designing the test.

Discussion

The results indicate that (a) the BDTv2 provides better discrimination
of subjects’ risk-taking behavior; and (b) the test allows the risk-taking behavior to be configured, indicating that an open-contingency design is a powerful tool for assessing the interactive style of risk-taking behavior.

Through this second study we were able to answer a question that could not be answered by using a 2-hr assessment interval. The correlation found for the two assessment points indicates that the subjects’ behavior remained stable over a 1-yr interval. As we had found in our first study, when the BDTv1 was used with a short interval (2 hr), open-contingency designs permitted configuration of the interactive style, and more importantly, constituted sensitive measures for identifying subjects’ style when the parametric values of each situation were the same. Again, even though the alternatives had the same expected value, subjects presented the same risk scores at the two assessment points.

This conclusion is convergent with findings from other studies in which an open-contingencies design was used and the interactive style was successfully configured (Doval et al., 1998; Santacreu & Garcia-Leal, 2000; Viladrich & Doval, 1998).

General Discussion

These studies underline the fact that the use of open-contingency designs allows the assessment of risk-taking behavior as an interactive style, and that the amount of risk subjects assume depends on the task configuration.

We demonstrated in our studies that an open-contingency design allows the assessment of the interactive style risk-taking behavior, because subjects presented their tendency by choosing one of the alternatives with the same expected value. However, changes in the features of the task permitted subjects to configure a different interactive style. These results follow the contributions made by Ribes and Sánchez (1992) with regard to the methodological requirements for assessing interactive style. They also found in their studies that the behavior configuration depends on task structure. As commented in Study 1, the BDTv1 may lead to a conservative bias because the two response options represent similar risk values, not allowing the subjects to choose the third one, which is more risky. As our main goal was to present the BDT as an alternative for assessing risk-taking behavior, we believe that the methodological requirements set by Ribes and Sánchez (1992) should be explored by changing the task morphology.

Ribes and Sánchez’s (1992) approach to the study of individual differences represents a challenging alternative for the assessment of personality issues. The temporal stability observed in our studies, when task configuration was the same, leads us to conclude that the tendency to behave in a specific way is task-specific, showing that behavior will be configured when the parametric values of the situations are the same (this was also observed in Doval’s studies).

The consistency shown by the scores in our study represents reliable evidence that the computerized tasks used here can be considered to constitute a useful assessment strategy for evaluating risk-taking behavior as an interactive style.
References


