Effects of smoking status of the other in a surrogate delay discounting task

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Abstract

Maladaptive behavior and risky decision-making are associated with high rates of delay discounting (DD) (Snider, DeHart, Epstein & Bickel, 2019). There have been many considerations for influences of DD (i.e. biological and environmental manipulations) however, the potential role of observing patterns of impulsive or self-controlled choices in laboratory-based DD measures has not been evaluated. I examined this idea by asking participants (N = 66) to make surrogate DD choices from the perspective of a smoker or a healthy non-smoker. The surrogate discounting rates for the smoker condition were significantly steeper compared to the non-smoker condition. This suggests that participants made differential choices simply from observations of others’ behavior.

*Keywords*: surrogate, delay discounting, temporal discounting,
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Surrogate Delay Discounting

Individuals with a range of addictions show higher levels of impulsivity than their non-addicted counterparts (Bickel, Yi, Kowal, & Gatchalian, 2008; Kofarnus & Bickel, 2014). Impulsivity can be operationalized as the rapid devaluation of delayed reinforcers (Dallery & Locey, 2005; Dallery & Raiff, 2007; Hogarth, Chase & Baess, 2012). This tendency to devalue delayed reinforcers is called delay discounting. Thus, individuals with various addictions show higher rates delay discounting relative to non-addicted individuals.

Delay discounting can be described by Mazur’s (1987) hyperbolic equation:

\[ V = \frac{A}{1 + kD}, \]  

(Equation 1)

where \( V \) is the current subjective value of the delayed reward, \( A \) represents the total amount of the reward, \( k \) is the parameter that indicates the discounting rate, and \( D \) is the delay to the reward. The parameter \( k \) is the measure of delay discounting: higher \( k \)s mean high rates of discounting (impulsivity) and small \( k \)s mean low rates of discounting (greater self-control).

Madden, Petry, Badger and Bickel (1997) assessed rates of delay discounting with opioid-dependent and non-drug using control participants. Participants were asked to make hypothetical choices between an immediate and a delayed amount of money. For example, participants were asked to choose between $990 immediately and $1000 available in 1 month. The immediate amount decreased until the participant switched their preference from the immediate to the larger, later amount. This switch point was called an indifference point, or the point at which the subjective value of the immediate amount was equivalent to the value of the delayed amount. Indifference points were determined for several delayed amounts (e.g., $1000
delayed by 1 month, 1 year, 5 years), and then Equation 1 was fitted to the indifference points and an estimate of $k$ was obtained via least-squares regression. Opioid-dependent individuals showed higher $k$s, or steeper delay discounting, relative to the non-drug using control participants. Similarly, Bickel, Odum and Madden (1999) performed this delay discounting task with smokers, non-smokers, and ex-smokers. Smokers showed higher levels of discounting than non-smokers. Interestingly, ex-smokers showed equivalent rates of discounting to the non-smokers.

The reasons for the differences in delay discounting based on drug use are unclear. Some research suggests that biological mechanisms may be responsible (Mitchell, 2011; MacKillop et al., 2018; Nautiyal et al., 2017; Stein, Pinkston, Brewer, Francisco, & Madden, 2012; Yim et al., 2016). For example, in laboratory animals, several studies have shown that strain-related differences play a role in delay discounting (Anderson & Diller, 2010; Huskinson, Krebs, & Anderson, 2012; Madden, Smith, Brewer, Pinkston, & Johnson, 2008). In contrast, other research posits environmental sources (Dixon, Buono & Belisle, 2016). For example, socioeconomic status (SES) has appears to correlate with delay discounting: lower SES participants show steeper discounting relative to higher SES individuals (Green, Myerson, Lichtman, Rosen, & Fry, 1996; Ishii, 2015; Ishii, Eisen, & Hitokoto, 2017; Lindqvist & Björklund, 2018).

Another possible source of the difference in delay discounting may be an individual’s pre-experimental history of self-observation. Critchfield and Kollins (2001) noted that “most adult subjects will have substantial prior experience with earning and spending money,” and addicted individuals will have prior experience obtaining and using drugs. Thus, the observation of these patterns of choice might influence choice in a typical delay discounting task. As implied
by Critchfield and Kollins, “there is no guarantee that verbal repertoires, as assessed in hypothetical tasks, will correspond to actual choice, but typical preexperimental histories provide the opportunity for ample self-observation of the sort that might inform a self-descriptive verbal repertoire (see Skinner, 1957, e.g., pp. 138–146)”. In a sense, therefore, a delay discounting task may be probing an individual’s self-descriptive repertoire. Speaking loosely, when a participant chooses between $900 now and $1000 in a month, he or she asks, “What have I typically done when confronted with similar choices in my life?”

This notion of self-observation influencing choice in a delay discounting task is also consistent with Bem’s self-perception theory. Bem (1972) derived self-perception theory from the reasoning that individuals label private events based on observation of overt behavior. Individuals determine internal states in part by inference of behavioral observation. As aforementioned, if an individual is confronted with a hypothetical task similar to pre-experimental experience the individual is likely to make choices paralleling that of their prior experience. Testing the hypothesis that self-observation can influence delay discounting is challenging. One possibility would be to experimentally induce particular patterns of impulsive or self-controlled behavior, and then observe effects on delay discounting. Washio et al. (2011) examined discounting following treatment for opioid addiction. They found that discounting decreased for those who completed treatment. Interestingly, they found that discounting was not associated with differences in drug use, which suggests that the decreases in discounting were not the outcome of physiological or neurological changes as function of drug intake. What did occur, however, was completion of a lengthy drug treatment program, which may have provided a new pre-experimental history of self-observation.
Another possibility for testing this hypothesis indirectly would be to assume that the “self” in self-observation is not necessary. That is, it is simply observation of patterns of behavior that influence choices in the laboratory. Thus, if observation of behavior is a key variable, it should not matter whether the observation is of the self (i.e., one’s own behavior) or of another individual’s behavior. If the self or other is a smoker, for example, then discounting should be higher than if the self or other is a non-smoker. We sought to test this hypothesis using a surrogate delay discounting procedure. Specifically, we asked participants to make choices between immediate and delayed amounts of money from the perspective of a hypothetical smoker or a hypothetical non-smoker. In addition, we explored whether the ability to take another’s perspective, as measured by an empathy questionnaire (EQ) (Baron-Cohen & Wheelwright, 2004), was related to the effect of condition on discounting. Similarly, we asked whether social distance to smokers, as measured by the number of smokers known by each participant, was related to the effect of condition on discounting. We hypothesized that empathy and social distance would be significantly correlated with the effects of condition on discounting.

Method

Participants

A sample of 68 participants (46 male, 21 female, 1 gender variant) were recruited from Amazon’s Mechanical Turk (MTurk) crowdsourcing internet platform. Participants deemed “Mechanical Turk Masters” and over the age of 18 participated in the survey. Participants were also instructed that the estimated total completion time was take twenty minutes with a compensation of $2.00 for completion of the survey.

Measures
The delay discounting task was presented via Qualtrics© (Provo, UT). Participants completed the delay discounting tasks first. Participants then completed the EQ (Baron-Cohen & Wheelwright, 2004) following demographic and smoking history questions.

Procedure

Participants entered into the MTurk Human Intelligence Task (HIT) which had the title, “Answer a survey about individuals' choice preference” along with the description of the task, “Choose between different hypothetical amounts of money available immediately or after a delay”. After consenting to participate, participants were presented instructions that stated, “You will now be presented with a series of decision situations relating to money. These are hypothetical, but please choose your answer as if the individual will receive the money in the time frame selected. Please pay close attention to the amount and time frame of each option and choose accordingly. There are no right or wrong answers in this task. Please take your time.”

Next, the participants were instructed to perform the task from the perspective of a non-smoker (“Tony”) or smoker (“Don”). The description given for both hypothetical persons were, “Don is a typical 35-year-old cigarette smoker. Think about what Don would prefer when he is making the following choice” and “Tony is a typical 35-year-old with good health habits. Think about what Tony would prefer when he is making the following choice”. The order of the two tasks were counterbalanced. In this task, participants were asked how much money they would prefer (e.g. $50) immediately or a larger reward after a delay (e.g. $100). The right button choice remained unchanged at $100 but with increasing delays (1 week, 2 weeks, 1 month, 6 months, 5 years, and 25 years) for each subsequent question. The left choice was always the immediate amount with a decreasing monetary value ($100, $99, $97.50, $95, $90, $80, $70, $60, $50, $40,
$30, $20, $10, $7.50, $5, $2.50, and $1) for each succeeding question. All questions were hypothetical in that there was no actual amount of money given to each participant.

Next, the EQ (Baron-Cohen & Wheelwright, 2004) was presented. The EQ questionnaire was used to retrieve their empathy scores (Lawrence, Shaw, Baker, Baron-Cohen, & David, 2004; Allison, Baron-Cohen, Wheelwright, Stone, & Muncer, 2001). Participants were asked to rate how strongly they agreed or disagreed with each question on a four-point Likert scale (see Appendix). Participants were also asked to report on demographics and their smoking history. Thereafter, participants chose “Yes” or “No” to having any family, friends and/or acquaintances that smoke cigarettes. A social distance score was calculated based on the sum of “Yes” responses. Last, participants were asked, “To what extent do you think you made decisions differently between the immediate versus delayed amounts of money depending on whether it was Don (smoker) or Tony (good health habits)?” with five options that ranged from “not at all differently” to “extremely differently”.

Data Analysis

Survey data was collected from a total of 66 participants (45 male, 20 female, 1 gender variant; age: $M = 36.86$, $SD = 8$; household income: $M = $53,901.62, $SD = 41,087.09$). We used Johnson & Bickel’s (2008) criteria to evaluate whether the indifference point data were amenable to quantitative analysis. Data were excluded if one or both of the following criteria were met: 1). when starting at the second delay, an indifference point was greater than 20% of the larger later reward (i.e. $100) from the indifference point before it; and/or 2). if the last indifference point was not less than 10% of the larger later reward (i.e. $100) in relation to the first indifference point. Two out of sixty-eight data sets collected satisfied one or both of the criterion therefore were excluded from analysis.
Equation 1 was fitted to each individual’s indifferences points under the surrogate smoker and non-smoker conditions, and to the median indifference points for each condition. Least-squares regression was performed using Microsoft Excel’s Solver add-in. Residuals were also visually inspected and analyzed for homoscedasticity. K parameters were logged to allow parametric statistical tests. A paired t-test was conducted on the logged ks obtained from each participant for both conditions. Pearson correlation coefficients were obtained for the relation between both empathy and social distance and the difference between the logged ks for each condition. Alpha was set a .05 for all statistical tests.

**Results**

Figure 1 shows fits of Equation 1 to the median indifference points from the smoker and non-smoker conditions. Visual inspection of Figure 1 suggests that individuals discounted $100 more rapidly when they took the perspective of a smoker relative to a healthy non-smoker. The fits were excellent, accounting for 86% and 86% of the variance in the smoker and non-smoker conditions, respectively. A paired-samples t-test was conducted to compare the ks between the smoker and non-smoker conditions. Discounting was higher in the surrogate smoker condition ($k = -2.0, SD=.86$) than in the non-smoker condition ($k = -2.9, SD=.80$); $t(65)=9.14, p = .000$.

Residual analysis suggested that there were no significant departures from homoscedasticity for the fits of Equation 1 to the median data, or for the fits of Equation 1 to the individual data.
Figure 1. Median indifference points shown as a function of delay for surrogate smoker and surrogate non-smoker k-values.

To further illustrate the differences between conditions in DD, k-values were divided by 1 to calculate the amount of time, in days, needed for $100 to decrease to 50% of its original value, also known as the effective delay 50 (ED50) (Yoon & Higgins, 2008). Figure 2 shows a frequency distribution of ED 50 values for all participants. The frequencies of shorter ED50s were higher for smokers relative to non-smokers, and the frequencies of longer ED50s were higher for non-smokers relative to smokers.
A Pearson correlation analysis did not reveal a significant correlation between difference in $k$ value scores across conditions and empathy scores. ($r(66) = .07, p = .59$). Similarly, a Pearson correlation test was did not reveal a significant correlation between the difference in $ks$ and the sum of participants’ “Yes” responses to having any family, friends and/or acquaintances that smoke cigarettes ($r(66) = -.10, p = .43$).

Table 2

*Perceived Difference in Choice Depending on Smoking Status of the Other*

<table>
<thead>
<tr>
<th>Difference</th>
<th>Frequency</th>
<th>Percent</th>
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<tbody>
<tr>
<td>Not at all differently</td>
<td>5</td>
<td>7.6</td>
</tr>
<tr>
<td>Not too differently</td>
<td>19</td>
<td>28.8</td>
</tr>
<tr>
<td>Somewhat differently</td>
<td>30</td>
<td>45.5</td>
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The last survey question participants answered regarded the extent to which they made decisions differently between the immediate versus delayed amounts of money depending on whether it was the smoker or non-smoker condition. As shown in Table 2 the majority of participants reported that they made choices not too differently (29%) and somewhat differently (46%). A Pearson’s correlation between the difference in ks and the participants’ differences in perceived difference in decision making; did not indicate a significant correlation ($r(66) = .10, p = .44$).

**Discussion**

This is the first study to find significant associations between surrogate DD and smoking status of the other. The intended purpose of the study was to evaluate whether participants would exhibit greater discount rates when asked to take the perspective of a smoker vs. a non-smoker. Sixty-six participants were recruited from Amazon MTurk and completed a discounting task from the perspective of a smoker or a non-smoker. Equation 1 was fitted to the indifference points, which also yielded $k$ parameters. Significantly steeper rates of discounting were found in the smoker condition compared to the non-smoker condition. In addition, the frequency distributions of ED50s showed that taking the perspective of a smoker produced smaller ED50s than taking the perspective of a non-smoker. On average, $\$100$ lost half of its value in 659 days for smokers and 2,603 days for non-smokers.
Individuals with a range of addictions show higher levels of impulsivity than their non-addicted counterparts (Amlung, Vedelago, Acker, Balodis & Mackillop, 2017; Bickel et. al., 2019; Bickel, Yi, Kowal, & Gatchalian, 2008). The present results parallel previous findings by Bickel et al. (1999) that revealed higher discounting rates for smokers compared to non-smokers. In particular, current smokers discounted monetary rewards more steeply than participants who never smoked or were ex-smokers (Białaszek, Marcowski & Cox, 2017; Bickel et al., 1999). Thus, the non- and ex-smoking participants may have discounted less steeply based on a history of self-observation of making more self-controlled choices (i.e., not smoking), and the smokers may be discounted steeply based on a history of self-observation of making more impulsive choices (smoking). Similarly, in the present study, those who discounted more steeply from the perspective of a smoker may have done so based on a history of observing smokers make more impulsive choices, and less steeply for non-smokers based on a history of observing healthy individuals make self-controlled choices. This “behavior observation” account does not preclude other biological (e.g., nicotine present or absent) or environmental causes of changes in real-world choice behavior. Rather, it suggests that is not the mere absence of nicotine (for example) that leads to changes in discounting, it is the absence of nicotine the leads to the observation of self-controlled choice that leads to less steep discounting.

I also examined correlations between the differences in k and other variables. First, I examined whether empathy played a role in the participants’ choice differences (O’Connell, Christakou, Haffey & Chakrabarti, 2013) across surrogate smoking conditions. There was a no significance between differences in k values and participant empathy scores. This lack of connection gives more support to the notion that it is in fact observation of patterns of behavior that influence choices in the laboratory rather than “private events” (Moore, 1980).
Second, correlations were tested for differences between $k$ values and the sum of participants’ “Yes” responses to having family, friends and/or acquaintances that smoke cigarettes. This correlational difference was tested between $k$ values and the total amount of family, friends and/or acquaintances that participants reported who smoked cigarettes to see if there was a connection between observation of smoking behavior of others and participants surrogate DD choices. However, results did not show any significant correlation between these two variables.

Third, correlational effects were examined between the differences in $k$ values and the participants’ reported differences in surrogate choices of which no significant correlation was revealed. Although clear differences were made by participants between the immediate versus delayed amounts of money depending on whether it was Don (smoker) or Tony (good health habits), there was no evidence to suggest that the participants discerned their differences in the DD tasks. In other words, the data suggests that participants were unaware of the differences they made between the DD tasks.

There are several limitations to be considered regarding this study. First, some research posits the quality of data retrieved from online contract labor portals (i.e. crowdsourcing) such as Amazon’s MTurk to be poor due to the sole motivation to participate being profit (Asheghi, Sharoff & Markert, 2014) and/or inflated measures due to frequent practice effects such as being deceived by previous studies (Stewart et al., 2015). Second, the description of the smoker and non-smoker conditions as “smoker” and “good health habits” respectively, could have had framing effects such that the negative and/or positive semantics effected the participants perspective of each condition. Studies have shown that the cognitive bias associated with framing does in fact effect the decisions an individual makes (Levin & Gaeth, 1988; Plous, 1993;
Tversky & Kahneman, 1981). Third, the present analyses consisted of data from hypothetical results. That is, participants made choices for hypothetical monetary outcomes. However, some research states no difference in human studies in the degree of DD between real and hypothetical tasks (Johnson & Bickel, 2002; Lagorio & Madden, 2005; Madden, Begotka, Raiff & Kastern, 2003). Fourth, participants may have exhibited steeper discounting rates for the smoker condition because the hypothetical smoker would need money sooner to purchase cigarettes whereas the non-smoker would have no dire need for money short-term.

These findings advocate a few directions for future research. With significant differences in participant choices across surrogate smoker and non-smoker conditions one direction could be to replicate this study with other addictions for the hypothetical other. For example, the other could show problem behavior such as heroin use, alcohol abuse, gambling, and so on. With novel findings that the smoking status of another has effects in a surrogate delay discounting task the foundation is set for other research to examine the reason for making this distinction. Additionally, since participants did not discern the differences they made between DD tasks it would be interesting to replicate the current study with attention checks or test for other reasons participants’ knowledge of difference in choices occurred.

Conclusion

Behavioral economics has aided researchers in understanding the underpinnings of drug dependence with concepts such as DD (Bickel, Mueller, Jones & Christensen, 2010; Koffarnus & Kaplan, 2018). In this study, participants made more impulsive choices for the smoker condition leaving us to question what motivated them to make these differences in choices. These novel findings of differences in discounting rates from surrogate DD tasks adds to the
breadth of research of behavioral patterns found in addicted individuals in that, the smoking status of another has some effect on the choices others make for them.
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Appendix

1. I can easily tell if someone else wants to enter a conversation.  strongly slightly slightly strongly
agreement slightly disagree disagree

2. I find it difficult to explain to others things that I understand easily, when they don't understand it first time.  strongly slightly slightly strongly
agree disagree disagree disagree

3. I really enjoy caring for other people.  strongly slightly slightly strongly
agree disagree disagree disagree

4. I find it hard to know what to do in a social situation.  strongly slightly slightly strongly
agree disagree disagree disagree

5. People often tell me that I went too far in driving my point home in a discussion.  strongly slightly slightly strongly
agree disagree disagree disagree

6. It doesn't bother me too much if I am late meeting a friend.  strongly slightly slightly strongly
agree disagree disagree disagree

7. Friendships and relationships are just too difficult, so I tend not to bother with them.  strongly slightly slightly strongly
agree disagree disagree disagree

8. I often find it difficult to judge if something is rude or polite.  strongly slightly slightly strongly
agree disagree disagree disagree

9. In a conversation, I tend to focus on my own thoughts rather than on what my listener might be thinking.  strongly slightly slightly strongly
agree disagree disagree disagree

10. When I was a child, I enjoyed cutting up worms to see what would happen.  strongly slightly slightly strongly
agree disagree disagree disagree
<p>| | | | | |</p>
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<tr>
<td>11. I can pick up quickly if someone says one thing but means another.</td>
<td>strongly</td>
<td>slightly</td>
<td>slightly</td>
<td>strongly</td>
</tr>
<tr>
<td></td>
<td>agree</td>
<td>agree</td>
<td>disagree</td>
<td>disagree</td>
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<tr>
<td>12. It is hard for me to see why some things upset people so much.</td>
<td>strongly</td>
<td>slightly</td>
<td>slightly</td>
<td>strongly</td>
</tr>
<tr>
<td></td>
<td>agree</td>
<td>agree</td>
<td>disagree</td>
<td>disagree</td>
</tr>
<tr>
<td>13. I find it easy to put myself in somebody else's shoes.</td>
<td>strongly</td>
<td>slightly</td>
<td>slightly</td>
<td>strongly</td>
</tr>
<tr>
<td></td>
<td>agree</td>
<td>agree</td>
<td>disagree</td>
<td>disagree</td>
</tr>
<tr>
<td>14. I am good at predicting how someone will feel.</td>
<td>strongly</td>
<td>slightly</td>
<td>slightly</td>
<td>strongly</td>
</tr>
<tr>
<td></td>
<td>agree</td>
<td>agree</td>
<td>disagree</td>
<td>disagree</td>
</tr>
</tbody>
</table>
15. I am quick to spot when someone in a group is feeling awkward or uncomfortable.  
   | strongly | slightly | slightly | strongly | agree | agree | disagree | disagree |

16. If I say something that someone else is offended by, I think that that's their problem, not mine.  
   | strongly | slightly | slightly | strongly | agree | agree | disagree | disagree |

17. If anyone asked me if I liked their haircut, I would reply truthfully, even if I didn't like it.  
   | strongly | slightly | slightly | strongly | agree | agree | disagree | disagree |

18. I can't always see why someone should have felt offended by a remark.  
   | strongly | slightly | slightly | strongly | agree | agree | disagree | disagree |

19. Seeing people cry doesn't really upset me.  
   | strongly | slightly | slightly | strongly | agree | agree | disagree | disagree |

20. I am very blunt, which some people take to be rudeness, even though this is unintentional.  
   | strongly | slightly | slightly | strongly | agree | agree | disagree | disagree |

21. I don’t tend to find social situations confusing.  
   | strongly | slightly | slightly | strongly | agree | agree | disagree | disagree |

22. Other people tell me I am good at understanding how they are feeling and what they are thinking.  
   | strongly | slightly | slightly | strongly | agree | agree | disagree | disagree |

23. When I talk to people, I tend to talk about their experiences rather than my own.  
   | strongly | slightly | slightly | strongly | agree | agree | disagree | disagree |

24. It upsets me to see an animal in pain.  
   | strongly | slightly | slightly | strongly | agree | agree | disagree | disagree |
25. I am able to make decisions without being influenced by people's feelings. | strongly | slightly | slightly | strongly |
|agree | agree | disagree | disagree |

26. I can easily tell if someone else is interested or bored with what I am saying. | strongly | slightly | slightly | strongly |
|agree | agree | disagree | disagree |

27. I get upset if I see people suffering on news programmes. | strongly | slightly | slightly | strongly |
|agree | agree | disagree | disagree |

28. Friends usually talk to me about their problems as they say that I am very understanding. | strongly | slightly | slightly | strongly |
|agree | agree | disagree | disagree |

29. I can sense if I am intruding, even if the other person doesn't tell me. | strongly | slightly | slightly | strongly |
|agree | agree | disagree | disagree |

30. People sometimes tell me that I have gone too far with teasing. | strongly | slightly | slightly | strongly |
|agree | agree | disagree | disagree |

31. Other people often say that I am insensitive, though I don’t always see why. | strongly | slightly | slightly | strongly |
|agree | agree | disagree | disagree |

32. If I see a stranger in a group, I think that it is up to them to make an effort to join in. | strongly | slightly | slightly | strongly |
|agree | agree | disagree | disagree |

33. I usually stay emotionally detached when watching a film. | strongly | slightly | slightly | strongly |
|agree | agree | disagree | disagree |

34. I can tune into how someone else feels rapidly and intuitively. | strongly | slightly | slightly | strongly |
|agree | agree | disagree | disagree |
35. I can easily work out what another person might want to talk about. | strongly | slightly | slightly | strongly | agree | agree | disagree | disagree |
36. I can tell if someone is masking their true emotion. | strongly | slightly | slightly | strongly | agree | agree | disagree | disagree |
37. I don't consciously work out the rules of social situations. | strongly | slightly | slightly | strongly | agree | agree | disagree | disagree |
38. I am good at predicting what someone will do. | strongly | slightly | slightly | strongly | agree | agree | disagree | disagree |
39. I tend to get emotionally involved with a friend's problems. | strongly | slightly | slightly | strongly | agree | agree | disagree | disagree |
40. I can usually appreciate the other person's viewpoint, even if I don't agree with it. | strongly | slightly | slightly | strongly | agree | agree | disagree | disagree |