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04/30/2007

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A growing body of research has distinguished implicit from explicit attitudes. Yet, very little research has been conducted on the implicit attitudes of children; and no research has examined the implicit environmental attitudes of children. The purpose of the current study was two-fold. First, children’s implicit and explicit environmental attitudes were examined using a sample of 52 fourth and fifth graders. Second, the psychometric properties of a new game version of the Implicit Association Test (IAT), known as FlexiTwins, were examined and its appropriateness for use with children was assessed. Implicitly, approximately 75% of the participants showed some form of connectedness with nature, with only 6% of children showing a connectedness with built. Explicitly, 58.4% of children stated that they were partially connected to nature. Results showed evidence for reliability of FlexiTwins. Test-retest correlation showed that FlexiTwins is a relatively stable measure. In addition, two subscales of the game were correlated and provided evidence of good internal reliability of the game. No significant correlations with explicit environmental measures were found. Although the validity of the new measure is not yet fully known, the reported results suggest that FlexiTwins is a useful measure of implicit social cognition and can easily be used to measure a variety of constructs. This study serves as phase I of an accelerated longitudinal study of connections with nature in order to better understand how environmental attitudes develop in children.

Keywords: Children; Connectedness with Nature; Environmental Attitudes; FlexiTwins; Implicit Association Test; Implicit Social Cognition.
Using the Implicit Association Test to Explore Environmental Preferences in Children

In the past ten years, implicit social cognition has emerged as an alternative to self-report measures and several new tools have been developed to measure a variety of implicit associations (De Houwer, 2003; Greenwald, McGhee, & Schwartz, 1998; Nosek & Banaji, 2001). These measures have been used to study attitudes in adults relating to topics such as politics (e.g., Karpinski, Steinman, & Hilton, 2005), ethnic and gender stereotypes (e.g., Greenwald et al., 1998; Ottaway, Hayden & Oakes, 2001; Phelps et al., 2000; Rowatt & Franklin, 2004), consumer attitudes (e.g., Brunel, Tietje, & Greenwald, 2004; Maison, Greenwald, & Bruin, 2001; Maison, Greenwald, & Bruin, 2004), and environmental attitudes (e.g., Schultz, Shriver, Tabanico, & Khazian, 2004; Schultz & Tabanico, in press). Yet very little research has been conducted on the implicit attitudes of children (Baron & Banaji, 2006; Sinclair, Dunn & Lowery, 2004; Skowronski & Lawrence, 2001; Rutland, Cameron, Milne, & McGeorge, 2005) and no research has yet examined the implicit environmental attitudes of children.

The purpose of the current study was two-fold. First, children’s implicit and explicit environmental attitudes were examined. Second, the psychometric properties of a new game version of the Implicit Association Test (IAT), known as FlexiTwins, were examined and its appropriateness for use with children was assessed.

Overview of Implicit Association Tests (IAT)

"Attitudes are favorable or unfavorable dispositions toward social objects,
such as people, places, and policies” (Greenwald & Banaji, 1995, p. 7).

Psychological studies of attitudes have distinguished between implicit and explicit attitudes. Explicit attitudes are attitudes that are readily available for recall. They can be thought of as a controlled process. According to Andrade and May (2004), controlled processes are slow, attention-demanding, and they usually lead to explicit memory. Implicit attitudes, on the other hand, are attitudes that are not readily available for recall. Their recall can be thought of as automatic processes, which according to Andrade and May, are fast and efficient and they usually lead to implicit memory.

Whereas explicit attitudes are measured using self-report, implicit attitudes are measured using response latency or accuracy. Measures of implicit attitudes include the Implicit Association Test (IAT; Greenwald et al., 1998), the Go-No-Go Association Test (GNAT; Nosek & Banaji, 2001) and the Extrinsic Affective Simon Task (EAST; De Houwer, 2003). In these tests, participants are presented with a stimulus and are asked to assign the stimulus to a particular category. Reaction time data are collected using a computer, showing how quickly participants can correctly categorize the stimulus.

In the IAT (Greenwald et al., 1998), participants are presented with seven blocks of trials, within which category pairs are presented (two target discrimination categories and two attribute categories). Target discrimination categories are the “social objects” of interest. For instance, some popular target discriminate categories are Black versus White, insect versus flower, or nature versus built (Greenwald et al.,
Attribute categories are the associations we make with the target discrimination categories. Commonly used attribute categories are *good* versus *bad*, *pleasant* versus *unpleasant*, or *self* versus *other* (Greenwald et al., 1998; Schultz et al., 2004). Once the categories have been established, participants are presented with a stimulus and asked to decide to which category it belongs. Classifications are made by pressing a computer key (usually “k” or “d”). Reaction time data are collected for the milliseconds required to correctly categorize each stimulus. The mean reaction time of a block is then compared to the mean reaction time of other blocks, allowing the researcher to establish which blocks of associations are stronger.

The primary outcome measure produced by these tests is known as the IAT effect. The IAT effect is produced by subtracting the mean reaction time of the compatible trials (categories that are easily associated) from the mean reaction time of the incompatible trials (categories that are not easily associated). Compatible and incompatible trials are thought of in terms of their ease within which they are categorized together. To clarify, when looking at the discriminate categories *flower* and *insect* when paired with the attribute categories *good* and *bad*, we can see that the compatible trial would be pairing the category *flower* with *good* and *insect* with *bad* because these associations are easily made. The incompatible trial would then be pairing the category *flower* with *bad* and *insect* with *good* because these associations are not easily made. Laboratory data using these measures has found good evidence for reliability and validity of the IAT effect (Banaji, 2001; Cunningham, Preacher, &
Using the Implicit Banaji, 2001; Greenwald et al., 1998; Greenwald, Nosek, & Banaji, 2002; Nosek, 2005; Nosek, Banaji, & Greenwald, 2002; Phelps, et al., 2000; Poehlman, Ulmann, Greenwald, & Banaji, 2005).

**IAT Measures.** The IAT uses reaction times to evaluate associations between given categories. To analyze these reaction times, calculations of the mean and standard deviations of key blocks are taken. In order to better understand these means and standard deviations, the D-score (IAT effect) and percent correct are used. Each measure will be described briefly.

Originally, Greenwald et al. (1998) suggested that the reaction time data produced by the IAT should be analyzed with a log-transformed latency procedure. However, since the publication of that first article, several modifications have been made to the original scoring algorithm proposed by Greenwald et al., and the D-score has been accepted as the best outcome measure produced by the IAT (Cai et al., 2004; Greenwald et al., 2003). In the discussion of the D-score, the algorithm as presented in Greenwald et al. (2003) will be used.

**D-score.** The D-score, as outlined by Greenwald et al. (2003), is calculated by comparing reaction times, in milliseconds, of compatible trials to incompatible trials. In order to obtain a D-score, time difference between the compatible and incompatible practice trials (D1) is calculated by subtracting the compatible practice trial from the incompatible practice trial. In addition, the time difference between the compatible and incompatible test trials (D2) is calculated by subtracting the compatible test trial from the incompatible test trial. A standard deviation is
calculated for practice blocks and for test blocks. Finally, the time difference score for the practice blocks (D1) is divided by the standard deviation of the practice blocks and added to the time difference score for the test blocks (D2) divided by the standard deviation of the test blocks. The resulting sum is divided by two, yielding the D-score. All calculations are made using data that encompass the total time a stimulus is present until a correct response, regardless of whether it was preceded by an incorrect response. The typical D-score ranges from -2.0 to 2.0, with only a few scores that fall above or below this range.

The present study is designed to examine a new IAT measure (FlexiTwins) to examine childrens' connectedness to nature. In several studies using the IAT to measure connectedness to nature presented by Schultz and Tabanico (in press), the IAT D-scores ranged from -.44 to 1.13 and -.91 to 1.44. The means from the IAT D-score ranged from .23 to .53.

The D-score measures preference for one category relative to another category. Consequently, when the D-score is equal or close to zero it means that participants have no preference for either category association. When the score is in the positive direction, the preference is for the compatible category. When the score is in the negative direction, the preference is for the incompatible category. The D-score is also capable of showing the strength of preference for one category relevant to another, not just the direction of the preference. For instance, a D-score of .2 or -.2 shows a slight preference, .4 or -.4 shows a moderate preference, and .6 or -.6 shows a large or strong preference.
Cai, Sriram, Greenwald, and McFarland (2004) suggest that the D-score has several advantages over other measures used to analyze reaction time data (such as the log-transformed latencies proposed by Greenwald et al., 1998). In a re-analysis of the data presented by McFarland and Crouch (2002), Cai et al. (2004) found that the D-score decreased the individual variability commonly found with reaction time data, more so than other measures used to analyze reaction time data. In addition, Cai et al. found that the D-score allowed researchers to better understand individual differences in the actual magnitude of the preferences of target discriminate categories. Further, they suggested that the D-score helped in minimizing order effects and effects due to prior exposure to the IAT. Finally, Cai et al. suggested that the D-score eliminates the problems found in response speed by accounting for the individual variance within the blocks. Moreover, this scoring procedure allows for an examination of internal reliability by correlating the two D-scores (D1 and D2).

**Outliers and errors.** The original algorithm proposed by Greenwald et al. (1998) accounted for outliers and errors by examining each response time per stimulus. If the response time was lower than 300 milliseconds (ms) it was recoded to 300 ms. If the response time was higher than 3000 ms it was recoded to 3000 ms. However, Greenwald et al. (2003) suggested that this is not the most beneficial way of handling these outliers. They suggested that participants could not possibly respond to a stimulus before 400 ms, and if they did, they were guessing. In order to account for this, Greenwald et al. (2003) suggested that response times lower than 400 ms be deleted from the data. In addition, Greenwald et al. (2003) suggested that
participants should not take longer than 10,000 ms to respond to a stimulus, and if they did, they were not attending to their task; therefore, these responses over 10,000 ms should be deleted from the data. These modifications of the data allow the researcher to control for participants being very fast or very slow and to control for error.

**Percent correct.** In addition to deleting outliers from the data, the percentage of correct responses for each block is calculated in order to account for participants with high error rates. Correct responses are responses wherein the participant correctly categorizes the stimulus (i.e. placing a nature word in the nature category). To calculate percent correct scores, the number of correct responses in a given block is divided by the number of stimuli presented within that block (Schultz & Tabanico, in press). Participants with percent correct scores less than 70% correct on all blocks used to calculate the D-score are eliminated from analysis.

**Reliability of the IAT**

In one of the first studies of IAT reliability, Cunningham et al. (2001) examined the extent to which the IAT is internally reliable using inter-item consistency. In a study on implicit attitudes, 99 participants completed measures of implicit attitudes, including the traditional IAT and the IAT with mandated response-window times included. In order to establish inter-item consistency, Cronbach’s alpha was calculated for the IAT. In this study, the Cronbach’s alpha for the IAT was .78 and for the IAT with mandated response-time windows Cronbach’s alpha was .64. This suggests that the IAT is more internally reliable in its original form; the addition
of the mandated response-time window decreases the internal consistency, at least in terms of the consistency of the items within the IAT.

In the same study, Cunningham et al. (2001) also suggested that the IAT is relatively stable over time. Measures of implicit and explicit attitudes were completed once at four different research sessions. In order to demonstrate the stability of the IAT over time, Cunningham et al. computed an estimate of stability for each IAT. In doing this, the error was removed from the variance within each IAT (using Structural Equation Modeling), producing an error-free estimate of the relationship over time. In examining the test-retest reliability of the IAT, Cunningham et al. found that the IAT was relatively stable, with a test-retest phi correlation of .46. The IAT is more stable over time when the IAT does not include mandated response-window times ($r = .46$ for traditional IAT versus $r = .36$ for mandated response window time IAT).

Other authors have shown similar results when examining the reliability of the IAT. For instance, Egloff, Schwertferger, and Schmuckle (2005) reported the reliability of an IAT used to measure anxiety. In their study, 65 participants completed the IAT-Anxiety twice. Egloff et al. (2005) found that the internal reliability of the D-score, calculated using Spearman-Brown adjusted split-half correlations, was .85 for the first IAT and .79 for the second IAT. They further investigated the reliability of the IATs by examining the inter-item internal reliability. These results showed that the first IAT received a Cronbach’s alpha score of .82 and the second IAT received a Cronbach’s alpha score of .79. Egloff et al. also reported
the test-retest reliability of these two IATs by correlating the D-scores produced by both tests. These IATs were found to be significantly correlated at .55. Egloff et al. further examined the stability of the IAT over time by having participants complete the IAT-Anxiety twice over the duration of one week, one month, or one year, with correlations of .58, .62, and .47, respectively. From these findings we can see that the IAT can be a significantly stable measure over time.

Similar results were reported by Asendorpf, Banse, and Mucke. (2002), who found the internal reliability of two shyness IATs using Cronbach’s alpha. The first shyness IAT had a score of .89 and the second shyness IAT had a score of .82. Asendorpf et al. also examined the test-retest reliability by correlating the D-score of these two IATs, resulting in a significant correlation of .62.

Finally, Banse et al. (2001) examined the reliability of an IAT used to measure attitudes towards homosexuality by giving two IATs to 101 heterosexual and homosexual participants. Internal reliability was calculated using Cronbach’s alpha and produced an average Cronbach’s alpha of .82 for combined tests. In addition, Banse et al. examined the test-retest reliability of the IATs measuring attitudes towards homosexuals, producing a significant correlation of .52 between tests.

Schultz, Shriver, Tabanico, and Khazian (2004) examined the stability of the IAT in measuring connectedness with nature. They had 100 college students complete explicit measures of environmental concern and the environmental IAT twice, either immediately, or at 1 or 4 weeks. Results showed that the IAT showed reasonable and significant levels of test–retest reliability (immediate: $r = .45$; one-
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week: $r = .46$, and 4-weeks: $r = .40$).

From these findings, we can see that the IAT is a moderately reliable assessment of associations. This reliability is less than we see when looking at explicit measures of the same associations, but it is higher than other forms of implicit association (Cunningham et al., 2001; Bosson, Swann, & Pennebaker, 2000). For instance, Cunningham et al (2001) showed that the IAT had a mean alpha of .78 compared to a response window IAT, which had an alpha of .63 and a response window evaluative priming task, which had an alpha of .64. Bosson, Swann, and Pennebaker (2000) also showed that the IAT had a higher alpha than the other implicit measures used. For example, the IAT had an alpha of .88 compared to an alpha of .49 for a subliminal attitude prime task and -.38 for a Stroop task.

Validity of the IAT

Banaji (2001) suggests that there are two problems with assessing the validity of the IAT. The first of these problems resides in predictive validity. Predictive validity refers to the attempt to make predictions about an individual’s behavior based on the results of a psychological measure (Rosenthal & Rosnow, 1991). Banaji warns that finding predictive validity will be hard to achieve because of the nature of the IAT. Because the IAT measures implicit associations that are not subject to conscious control, predicting intentioned or consciously controlled behavior can be difficult. Despite this warning, the predictive validity using the IAT seems to be relatively good across many different measures. For instance, Nosek et al. (2002) demonstrated the predictive validity of the IAT in a study on the gender differences in
preference for math versus the arts. To do this, Nosek et al. examined the stereotype that men like math and women do not, using implicit attitudes. The results from this study demonstrated that both men and women had negative implicit attitudes towards math. However, in line with the stereotype, these implicit attitudes in women were much more negative than the implicit attitudes in men. In addition, women who were in math intensive college majors still had more negative implicit attitudes towards math than their fellow male college students.

Hummert et al. (2002) suggested that the IAT was a valid predictor of age biases (preferring one age group over the other). In their study, participants completed age bias IATs in order to understand age biases in people of various ages. They found that, implicitly, old participants preferred the young age more than the young participants preferred the young age. In contrast, when looking at explicit measures of age bias, the young participants indicated they preferred the old age; however, the old participants indicated that they preferred the young age. Hummert et al. suggested that the age bias IAT is a good predictor of age stereotyping.

In another study, Poehlman et al. (2005) conducted a meta-analysis of predictive validity of the IAT. Three independent raters examined the extent to which 86 independent IATs predicted criterion measures. These 86 independent IATs were separated into 10 categories (e.g., achievement, food choices, political preferences, self-esteem, stereotyping/prejudice). It was found that the IAT was a significant predictor of criteria measures, receiving a low, but significant correlation between all criterions analyzed in their meta-analysis.
The second validity problem addressed by Banaji (2001) involves the face validity of the IAT. A measure has face validity when it appears to be a legitimate assessment of the construct. Banaji suggested that the results from the IAT may not “feel” like a valid measure to participants. However, Banaji suggests that the absence of face validity is almost the point of the IAT. Because implicit associations are not readily available for recall, they may feel invalid to a person, when in fact they are actually a valid measure of implicit rather than explicit associations.

Convergent validity is the “validity supported by substantial correlation between conceptually similar measures” (Rosenthal & Rosnow, 1991, p. 616). Cunningham et al. (2001) examined the convergent validity of implicit attitudes using a race IAT (preference for group depending on ethnic identities). They compared Black and White faces on the evaluation of good and bad using three measures of implicit attitudes and one measure of explicit attitude. Cunningham et al. found that the IAT correlated significantly with two other measures of implicit attitudes (evaluative priming: \( r = .55 \); the IAT with mandated response-time windows: \( r = .77 \)) and also correlated significantly with a measure of explicit attitudes (Modern Racism Scale: \( r = .45 \)). These findings suggest that the IAT demonstrates strong convergent validity.

Construct validity addresses whether the test adequately samples the relevant material it purports to cover (Rosenthal & Rosnow, 1991). In a replication of the Greenwald et al. (1998) article, Ottaway et al. (2001) established the construct validity of the IAT by demonstrating that the IAT is sensitive to implicit racial biases.
by administering race IATs (preference for Black versus White and Hispanic versus White) to examine the implicit attitudes of race in 33 Caucasian female students. In examining these IATs, Ottaway et al. found that White names were preferred over both Black and Hispanic names.

In a set of studies, Schultz et al. (2004) found that the IAT could be used to measure the extent to which an individual had an implicit connection with nature. In the first study, Schultz et al. had 160 college students complete several measures of explicit environmental concern as well as an IAT to measure connectedness with nature (preference for Nature versus Built). Results from their study showed that the IAT was significantly correlated with explicit measures of environmental concern (biospheric concern: $r = 0.21$; and egoistic concern: $r = -0.16$). In the second study, Schultz et al. had 100 college students complete explicit measures of environmental concern and the IAT. Results showed that the IAT was again significantly correlated with explicit measures of environmental concern (biospheric concern: $r = 0.27$; egoistic concern: $r = -0.22$), and it was also significantly correlated with Schultz’ (2002) Inclusion of Nature in Self (INS) measure ($r = 0.26$).

**FlexiTwins.** Several modifications of the IAT have been proposed in recent years (Baron & Banaji, 2006; Bruni, Schultz, & Bowlin, 2006; Bruni, Schultz, Ports, & Mueller, 2005; Vande Kamp, 2003). One of these modifications, FlexiTwins, is a video-game version of the IAT. Bruni et al. (2006) created FlexiTwins to be a fun and enjoyable measure of implicit social cognition appropriate for both adults and children. FlexiTwins includes the basic concepts behind the traditional IAT;
however, FlexiTwins has a colorful interface with frogs that eat the stimulus, electrified tongues when incorrect responses occur, and feedback sounds. See Figure 1 for screen shots of FlexiTwins.

Several studies were conducted in the development of FlexiTwins, examining both reliability and validity. In the first study, Bruni et al. (2006) had 50 university students complete several measures of implicit connectedness with nature (e.g., IAT, FlexiTwins). In addition, participants were asked to play FlexiTwins twice. D-score correlations between time 1 ($M = -.04, SD = .31$) and time 2 ($M = .11, SD = .23$) suggested that FlexiTwins scores were relatively stable over time ($r = .52$). In addition, after computing a mean FlexiTwins D-score, the new FlexiTwins measure was significantly correlated with the traditional IAT ($r = .49$). Finally, correlations were examined between FlexiTwins and explicit measures of environmental attitudes. However, no significant correlations were found between these measures.

In a second study, 90 university students completed several measures of implicit social cognition (e.g., IAT, an IAT game, and FlexiTwins) to measure environmental attitudes (Bowlin, Bruni, Mouw, & Schultz, 2006). Regarding internal reliability, the two subscales generated by the game were significantly correlated ($r = .38$). The stability of FlexiTwins was also examined. It was found that D-score time 1 was significantly correlated with FlexiTwins D-score time 2 ($r = .60$). Finally, the validity of FlexiTwins was examined by comparing FlexiTwins D-score to other implicit measures of environmental concern revealing that the D-score was significantly correlated with the traditional GNAT ($r = .23$). In addition, D-score time
It was significantly correlated with the INS ($r = .23$), with the environmental concern question (Dunlap, Gallup, & Gallup, 1992; 1993: $r = .19$), and was marginally correlated with the *biospheric concern* subscale of the Environmental Motives Scale (Schultz, 2000: $r = .19$).

*IAT used with Children*

While the studies reported above provide good evidence for the reliability and validity of the IAT with adults, very little research has been conducted on the IAT using children. In fact, only four studies have tested children using an IAT procedure. Moreover, these studies only assessed two types of associations: race bias (Baron & Banaji, 2006; Rutland et al., 2005; Sinclair et al., 2005) and gender bias (Skowronski & Lawrence, 2001).

Skowronski and Lawrence (2001) assessed gender bias using the IAT in both children and college students. Using 59 fifth grade children and 85 college students, it was found that only college-aged participants showed gender bias, responding faster to compatible trials (*female/pleasant* and *male/unpleasant*) than incompatible trials (*female/unpleasant* and *male/pleasant*). Children, on the other hand, showed no preference for compatible or incompatible trials. The only significant finding for fifth graders was that they had higher mean square error scores than college students. Because of the large mean square error rates for children, Skowronski and Lawrence suggested that error rate data may be a more reliable measure to use with children, as it is more sensitive to implicit attitudes among fifth graders. Skowronski and Lawrence used a cross-sectional design for their study; however, they suggest that a
Using the Implicit longitudinal design would be useful in understanding when attitudes of gender bias change between childhood and adulthood.

In a study of the implicit and explicit attitudes of 155 White British children between the ages of 6 and 16, Rutland et al. (2005) examined the extent to which these children held racial biases. Implicit attitudes were assessed using a race IAT (preference for Black versus White). Stimuli for this IAT were presented in pictures of Black and White faces with neutral expressions. Children were asked to categorize these faces and their reaction times to each stimulus were recorded. In addition, the children were asked to complete two forms of explicit measures (i.e., personal normative belief measure, and the inter-group bias measure). Findings from this study suggested that children over the age of ten show implicit inter-group biases, but not explicit inter-group bias and not out-group prejudice. These results suggest that there is an age at which children learn to suppress their inter-group external bias.

In another study on racial biases in children, Baron and Banaji (2006) used the IAT to examine these attitudes in children ages six and ten and adults. Seventy-nine participants completed two IATs. Pictures were used to represent the discriminate target categories: flower, insect, Black, and White. In contrast, words were used to represent the target attribute categories: good and bad. In this study, Baron and Banaji demonstrate that children, at age six, are capable of successfully completing an IAT. In addition, six-year-olds responded faster to compatible trials (flower good/insect bad and White good/Black bad) than incompatible trials (flower bad/insect good and White bad/Black good). In explicit measures of racial biases, the
preference for *White* over *Black* is also present in children at age six.

Baron and Banaji (2006) also found that children at age 10 showed a similar implicit pattern of response within the IAT. Ten year olds respond faster to compatible trials (*flower good/insect bad* and *White good/Black bad*) than incompatible trials (*flower bad/insect good* and *White bad/Black good*). In their response to explicit measures of racial bias, 10-year-olds also show preference for their own group (*White* when compared to *Black*); however, this response is significantly less than that found for the six-year-olds.

Finally, Baron and Banaji (2006) found that adults, like children, respond faster to compatible (*flower good/insect bad* and *White good/Black bad*) trials than incompatible trials (*flower bad/insect good* and *White bad/Black good*). However, in the explicit measures of racial bias, adults show no preference for either *White* or *Black*.

Finally, Sinclair et al. (2004) examined the relationship between racial bias in parents’ explicit attitudes and children’s implicit and explicit attitudes. Intergenerational attitudes were found to be similar for both children and their parents, with both responding faster to compatible trials (*White/good* and *Black/bad*) than to incompatible trials (*White/bad* and *Black/good*). Sinclair et al. also demonstrated that parental attitudes may influence the attitudes of their children, but only when the children highly identify with their parents.

To date, no IATs have been used with children in order to examine implicit connections with nature.
The Formation of Environmental Attitudes

Environmental attitudes refer to the “collection of beliefs, affect, and behavioral intentions a person holds regarding environmentally related activities or issues” (Schultz, Gouveia, Cameron, Tankha, Schmuck, & Franek, 2005, p. 458). Of particular interest in this present study are the variables that influence the formation of environmental attitudes in children. Several variables have been identified that correlate with explicit environmental attitudes in adults and may play a role in the development of environmental attitudes. These factors include: education, (Johnson, Bowker, & Cordell, 2004; Oskamp & Schultz, 2005; Sherburn & Devlin, 2004; Tikka, Kuitunen, & Tynys, 2000), age (Johnson, et al., 2004; Oskamp & Schultz, 2005), ethnicity (Hunter, 2000; Johnson, et al., 2004; Jones & Rainey, 2006; Mohai & Bryant, 1998; Parker & McDonough, 1999; Oskamp & Schultz, 2005; Schultz, Unipan, & Gamba, 2000), gender (Blocker & Eckberg, 1997; Dietz, Kalof, & Stern, 2002; Hunter, Hatch, & Johnson, 2004; Johnson, et al., 2004; Olli, Grendstad, & Wollebaek, 2001; Oskamp & Schultz, 2005; Zelelzny, Chua, & Aldrich, 2000), income (Oskamp & Schultz, 2005), religion (Biel & Nilsson, 2005; Eckberg & Blocker, 1989; Greely, 1993; Hunter & Toney, 2005; Kanagy & Willits, 1993; Oskamp & Schultz, 2005; Schultz, et al., 2000), place of residency (Berenguer, Corraliz, & Martin, 2005) and political affiliation (Johnson, et al., 2004; Oskamp & Schultz, 2005).

In a review of these variables, Oskamp and Schultz (2005) suggested that education was the best predictor of environmental concern, with those with more
formal education having more concern for the environment than those with less formal education. Younger people, women, wealthier people, those with no formal religious affiliations, and Democrats tend to express more concern for the environment than do older people, men, poor people, Catholics, and Republicans. Likewise, in a study to validate the New Ecological Paradigm scale (NEP), Johnson et al. (2004) found that age, education level, ethnicity, gender, nature-based recreation, place of residency, and political ideology were related to environmental behavior. In their study, women were had higher environmental concern than men, read more environmental/conservative literature, recycled more, and were more likely to participate in nature-based recreation. They also found that age was related to environmental behaviors. For instance, older participants were more likely to read environment or conservative literature and recycle, and less likely to join an environmental or conservative group and participate in nature-based recreation than younger participants.

In a study of 533 adult participants’ childhood experiences with nature, Ewert, Place, and Sibthorp (2005) administered a modification of the NEP and asked questions regarding the participants’ childhood experience with nature, their education level, and their exposure to the environment through the media. Results indicated that early childhood outdoor consumptive experiences or an experience that takes something away from nature (e.g., shell collecting) were negatively related to environmental concern and that early childhood outdoor appreciative experiences or an experience that has little impact on the natural environment (e.g., bird-watching,
star-gazing) were positively related to environmental concern. In addition, Ewert et al. found that exposure to environmental media and negative environmental events also affected the environmental attitudes of these adults. These findings suggest that early childhood outdoor experiences, both through real-life experiences and media coverage, may play a role in the formation of environmental attitudes. Kahn (2006) also examined the factors associated with conservation behavior. The factors he identified included stated intentions, lifestyle choices, informational techniques, positive motivational techniques, environmental attitudes, values, and intrinsic satisfactions.

In order to determine the sources of environmental commitment in a group of environmentalists, Chawla (1999) asked 56 environmentalists what they thought was the foundation of their relationship with the environment. Experiences with natural areas, family influences, organizations, negative experiences, and education were the most frequently mentioned foundations listed by the environmentalists. Interestingly, most environmentalists described childhood as the foundation of their relationship with the environment. See also Palmer (1993) and Degenhardt (2002).

The factors identified thus far in the development of environmental attitudes have come from these studies conducted retrospectively with adults. Kahn (2006) suggested that these factors are only weakly related to conservation behavior and more research is needed with children, examining what factors are associated with the development of conservation behavior. Yet very few studies have examined the factors associated with the development of children’s environmental attitudes (e.g.,
Cohen & Horm-Wingerd, 1993; Eagles & Denmare, 1999), and most of those that have examined children's environmental attitudes were concerned with examining the effects of environmental education and nature-based programs, rather than children's environmental attitudes. For instance, in a study of 72 sixth grade children, Eagles and Denmare found that environmental attitudes were positively correlated with talking about the environment at home, watching nature films, and reading about the environment. They also found a gender difference in moralistic environmental attitudes, with girls having higher moralistic attitudes than boys. In contrast, Cohen and Horm-Wingerd (1993) found that there were no gender differences in ecological awareness in a sample of preschool children. In addition, Cohen and Horm-Wingerd found no differences in ecological awareness between children living in either rural or urban areas.

Another important aspect of the present study is the idea of connectedness with nature. According to Schultz et al. (2004), the extent to which we are connected with nature influences our environmental attitudes and actions. Thus, connectedness with nature refers to how much a person believes that he or she is part of the natural environment. On one end of the continuum, a person can believe that he or she is separate from nature (different than animals or plants and is not governed by the same laws of nature as animals and plants); on the other end of the continuum, a person can believe that he or she is nature (the same as animals and plants and governed by the same laws of nature as animals and plants).

Several measures have been used to examine connectedness with nature. The
first measure is the Inclusion of Nature in Self (INS). This measure contains a series of seven overlapping circles labeled ‘Self’ and ‘Nature’ and asks respondents to “Please circle the picture below that best describes your relationship with the natural environment. How interconnected are you with nature?” The circle chosen by the respondents demonstrates their explicit connectedness with nature. Schultz et al. (2004) also measured implicit connectedness with nature using an IAT. In this IAT, the categories ‘Self’ and ‘Other’ are paired with the categories ‘Nature’ and ‘Built’ to determine the extent to which the participant implicitly identifies with the natural environment.

Conclusion

In conclusion, little is known about the development of environmental attitudes from childhood to adulthood. Rather, the information available about environmental attitudes comes retrospectively from adults looking back at their childhood or from evaluating an educational program for use with children (Cohen & Horm-Wingerd, 1993; Eagles & Denmare, 1999). In addition, the field of implicit social cognition has just recently begun to examine the implicit attitudes of children (Baron & Banaji, 2006; Rutland, Cameron et al., 2005; Sinclair et al., 2005; Skowronski & Lawrence, 2001), and to date, children’s implicit connections with nature have not been studied. The IAT, and more specifically FlexiTwins, offers a unique opportunity to study the environmental attitudes of children implicitly, broadening the understanding of how environmental attitudes are developed and contributing to the limited literature on children’s implicit attitudes.
Pilot Studies

As preliminary data for this thesis, two pilot studies were conducted. In the first study, 51 children from the Chicago, IL area between the ages of 7 and 10 years of age completed a card sorting task in order to understand the ways in which children conceptualize “nature.” Children were presented with pictures of various nature and built objects and were asked to put them into categories, either nature, built, or other. In the nature category, 7 of the 20 objects were correctly categorized by more than 80% of the participants. The top five correctly categorized objects were flower (94.1%), tree (94.1%), mountain (92.2%), waterfall (92.2%), and butterfly (86.3%). Of the built objects, 11 of the 20 objects were accurately categorized by more than 80% of the participants. The top five correctly categorized objects were church (92.2%), car (86.3%), truck (86.3%), chair (86.3%), and boat (84.3%). There were some objects that less than 60% of the children were able to correctly categorize. In the nature category, 3 of the 20 objects were correctly categorized by less than 60% of the participants. These objects were banana (45.1%), shell (52.9%), and pumpkin (56.9%). In the built category, 7 of the 20 objects were correctly categorized by less than 60% of the participants. These objects were candle (52.9%), doll (58.8%), kite (54.9%), money (33.3%), ring (51.0%), teddy bear (52.9%), and soccer ball (51.0%).

In a second pilot study, the extent to which children were able to play FlexiTwins using either pictures or words was examined. Thirty children from the fifth grade classes at San Pasqual Union School District, Escondido, CA completed
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FlexiTwins twice. These children were randomly assigned to play FlexiTwins using either pictures or words. In the words version of FlexiTwins, the child's name was used in the 'Me' category and names of other people were used in the 'Not me' category. This method of describing self versus other for the children was used because we thought that they would be able to more accurately categorize themselves and others by name, rather than using pronouns. In the picture version of FlexiTwins, the child's picture was imported into the game through a webcam. The picture of the child was used in the 'Me' category and pictures of other children were used in the 'Not me' category. We used this method of describing self versus other for the children because we thought that they would be able to more accurately categorize themselves and others by picture, rather than using pronouns. Results suggested that there was no significant difference in FlexiTwins' D-score when using pictures (M = .83, SD = .33) or words (M = .66, SD = .38), t(28) = 1.29, p = .21.

Although no differences were seen when examining the D-scores produced by FlexiTwins with pictures or words, there were differences in the reliability and validity of the two versions. In looking at the internal reliability of FlexiTwins with pictures, the subscores D1 and D2 were not significantly related, r = .25, p = .41; however, the subscores D1 and D2 of FlexiTwins with words were marginally related, r = .43, p = .09. In addition, when looking at the test-retest of FlexiTwins with pictures generated a D-score at time 1 that was not significantly related to the D-score of time 2, r = .44, p = .13. However, the test-retest of FlexiTwins with words produced a D-score at time 1 that was significantly related to the D-score at time 2, r
Neither version showed strong evidence of validity. FlexiTwins with pictures was not significantly related to external measures of environmental concern (INS: $M = 4.31, SD = 1.97, r = -0.09, p = .77$; the environmental concern question: $M = 5.77, SD = 1.17, r = .24, p = .42$; and the environmental actions question: $M = 5.38, SD = 2.66, r = .12, p = .70$). FlexiTwins with words was not significantly related to external measures of environmental concern (INS: $M = 4.65, SD = 1.32, r = .09, p = .72$; the environmental concern question: $M = 5.29, SD = 1.65, r = -.09, p = .72$; and the environmental actions question: $M = 4.53, SD = 3.11, r = .07, p = .78$).

**Hypothesis/Research Questions**

The purpose of the study was two-fold. First, children’s implicit and explicit environmental attitudes were examined. Exploratory analyses of the implicit and explicit measures were conducted in order to begin to understand the environmental attitudes of children and how they develop.

Second, the psychometric properties of FlexiTwins using both implicit and explicit measures of environmental concern were examined. It was hypothesized that FlexiTwins would be a reliable and valid measure of environmental attitudes. FlexiTwins was expected to be internally reliable and stable over time. Past research using college students has suggested that FlexiTwins is internally reliable and stable over time (Bowlin et al., 2006; and Bruni et al., 2006). However, as mentioned, FlexiTwins has not been used with children. It may be that FlexiTwins is not a reliable and stable measure of environmental attitudes in children and may only be suitable for use with adults.
It was also hypothesized that FlexiTwins would be a valid measure of connections with nature, correlating with explicit measures of environmental concern. Past research using college students has suggested that implicit and explicit measures of environmental attitudes are significantly correlated (Bowlin et al., 2006; Bruni et al., 2006); however, most of these correlations are small, in the .2 to .5 level. Because of these past findings, small to medium correlations between the implicit and explicit environmental attitudes in children were expected.

Methods

Participants

Participants were 52 students from San Pasqual Union School District (33 fourth and 19 fifth grade children). The age of the children ranged from 9 to 11 (M = 9.69, SD = .67). There were 28 boys and 24 girls. These children were predominately White, with a few Hispanic and Asian students. San Pasqual Union School District is located in the suburbs of San Diego County, CA, in the hills of Escondido. This school is both an elementary and secondary school, with grades from kindergarten through eighth grade. Informed consent was obtained from the participant’s parent or legal guardian and informed assent was received from the child prior to participation in this study.

Materials

In order to measure the environmental attitudes of these fourth and fifth grade children and to validate FlexiTwins as a reliable and valid measure of implicit social cognition for use with children, several implicit and explicit measures of
environmental attitudes were administered. Explicit measures were examined using a questionnaire and a face-to-face interview. Implicit attitudes were assessed using an IAT game (FlexiTwins).

**Questionnaire:** A questionnaire was developed to measure the explicit environmental attitudes of children and their demographic variables. Measures of explicit attitudes included: (1) the Environmental Motives Scale (Schultz, 2000), (2) a set of circles with varying degrees of overlap, known as the Inclusion of Nature in Self (INS) measure (Schultz, 2002), and (3) the environmental concern question taken from the Gallup poll (Dunlap, Gallup, & Gallup, 1992, 1993). See Appendix A for a full description of each measure used on this questionnaire. In addition, the questionnaire can be viewed at: www.csusm.edu/environment.

All explicit measures mentioned above rely on self-report. The implicit attitudes of these children were measured using a modified version of the IAT, known as FlexiTwins (Bowlin et al., 2006; Bruni et al., 2006).

**FlexiTwins.** FlexiTwins is based on the traditional IAT presented by Greenwald et al. (1998). However, several modifications have been made to make it more child-friendly. First, FlexiTwins differs from the traditional IAT in that it is a colorful, animated game. In this computerized game version, two frogs are shown on lily pads, one on the left and one on the right side of the screen. Background graphics show scenes from nature and can be turned on or off.

FlexiTwins is similar to the traditional IAT in that stimuli are presented one at a time; however, unlike the traditional IAT wherein the stimuli are presented directly
in the middle of the screen, the stimuli in FlexiTwins fall from the top to the bottom of the screen. FlexiTwins also uses sounds, which present feedback and give FlexiTwins a game-like feel that is not present in the traditional IAT. Moreover, built-in feedback reminders pop up on the screen, reminding participants to catch as quickly and accurately as possible. The game version was developed to be fun, attractive, and easily used with a wide range of ages.

In FlexiTwins, participants are presented with four categories: two target discriminate categories and two attribute categories. Target discriminate categories are the categories used in examining to understand the participants’ preference. For example, target discrimination categories used to measure connectedness to nature would be ‘Nature’ or ‘Built.’ Attribute categories are the categories used to differentially associate the two target discrimination categories. For example, the attribute categories examining connectedness to nature are ‘Me’ or ‘Not me.’ Once the categories have been established, participants are presented with a stimulus and asked to decide to which category the stimulus belongs. If the stimulus belongs to one of the categories on the right, the participant presses a button (k). If the stimulus belongs to one of the categories on the left, the participant presses a different button (d). Stimuli used in the ‘Nature’ and ‘Built’ categories were taken from pilot data, mentioned above. The ‘Nature’ category is represented by the words flower, tree, mountain, waterfall, and butterfly. The ‘Built’ category is represented by the words church, car, truck, chair, and boat.

Like the traditional IAT, FlexiTwins has seven blocks. In the first block,
participants are presented with the target discrimination categories, one on the left
and one on the right. In the second block, participants are presented with the attribute
discrimination categories, one on the left and one on the right. In block three, target
discrimination and attribute categories are paired, with one pair presented on the left
and one pair presented on the right. Block three is a practice block. Block four is
identical to block three; however, it is a test block and the data are used to calculate
the IAT effect. Block five is the reverse of block one, with the target discriminate
categories presented on opposite sides of the screen. Block six and seven are the
reverse of blocks three and four, with the target discriminate categories on the
opposite side of the screen. Each block is either a practice trial or a test trial. Practice
trials consist of 24 random stimuli. Test trials consist of 36 random stimuli.

Participants begin each block with an introduction screen, orienting the
participant to the correct category and stimuli list. Once a participant begins a block,
a stimulus is presented on the screen until the participant correctly categorizes the
stimulus on either the right or the left. This process is completed throughout the
duration of the blocks, until all blocks, trials, and stimuli have been presented.

Reaction time data are collected to evaluate associations between given
categories. This is done by measuring the amount of time it takes a participant to
correctly categorize a stimulus. To analyze these reaction times, calculation of means
and standard deviations of key blocks are taken. In order to better understand these
means and standard deviations, the D-score and percent correct are used, which
allows the researcher to establish which blocks of associations are preferred (i.e.,
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more strongly associated). An online version of FlexiTwins is available at www.conservationpsychology.org/game.

FlexiTwins was administered on laptop computers running Microsoft Windows XP, with 384 MB of RAM and a Pentium III microprocessor. FlexiTwins was run with the following settings. Stimulus fall duration refers to the amount of time it takes a stimulus to fall from the top of the screen to the bottom of the screen. It was set at four seconds. Gravitational acceleration refers to the hanging of the stimulus at the top of the screen before falling to the ground. Gravitational acceleration is slow at the top and fast at the bottom. It was turned off for this study; thus the stimulus will steadily fall from top to bottom in 4000ms. There are three background choices in FlexiTwins. Two of the backgrounds are of natural settings (i.e., pond and forest). However, in this study the background image was turned off, presenting a green background behind the frogs. Sound effects were turned on to auditorially remind the children to be accurate and give FlexiTwins a more game-like feel. Sound effects include introduction and instruction screen music, beeps for incorrect responses, and dings for correct responses. The high score display was turned on, allowing the children to see a score produced by the game and encourage accuracy and speed from the children. Finally, FlexiTwins was administered using words, as pilot data presented previously suggested is the more reliable and valid form of FlexiTwins for use with children.

Procedure

After collecting informed consent from the parents and assent from the
children, the children individually completed an online questionnaire regarding their environmental attitudes. In order to obtain accurate data, the children were asked to play FlexiTwins until they had completed the game twice with a percent correct score greater than 70%. Upon completion of the games, the children were debriefed and thanked.

Results

Complete data were obtained from 52 participants. No participants were removed from the data set. Using descriptive statistics, the implicit and explicit attitudes of the participants were assessed. To start, FlexiTwins provided an implicit measure of connections with nature. To obtain FlexiTwins percent correct scores greater than or equal to 70% correct, nine fourth graders and five fifth graders had to play FlexiTwins more than twice. These fourth and fifth grade students that had to play FlexiTwins more than twice played FlexiTwins an average of four times before they obtained percent correct scores greater than or equal to 70% correct. Scores on FlexiTwins D-score time 1 ranged from -.63 to 1.33 ($M = .48, SD = .40$). However, when looking at the frequency of scores, approximately 10% of participants’ scores were in the negative direction, with only about 6% showing preference for built environments. On the other hand, 75% of participants showed preference for natural environments. Scores on FlexiTwins D-score time 2 ranged from -.61 to 1.40 ($M = .35, SD = .37$). When looking at the frequency of scores, 15% of participants’ scores were in the negative direction, with only about 8% showing preference for built environments. In contrast, 73% showed preference for nature environments. Figure
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2 shows a histogram of the distribution of these scores.

Next, the explicit attitudes of participants were examined. Table 1 shows descriptive statistics for all explicit measures. Results from the Inclusion of Nature in Self (INS) measure suggest that children have a range of explicit interconnectedness with nature. However, 58.4% ($N = 31$) of children report that they are partially connected to nature. Only a few children reported not being connected at all (7.5%; $N = 4$) or being completely connected (9.4%; $N = 5$).

The psychometric properties of the Environmental Motives Scale were also examined. The 12 items from this scale were factor analyzed using a principal component analysis, with an oblimin rotation. Using a three-factor structure, 71.3% of the total variance was explained. The results are presented in Table 2. The three factors represent the subscales of the Environmental Motives Scale (egoistic, altruistic, and biospheric concern). The following items clearly loaded onto the egoistic concern subscale: my life, my future, and future generations. The following items clearly loaded onto the altruistic concern subscale: my family, and humanity. And, the following items clearly loaded onto the biospheric concern subscale: trees, birds, plants, and animals. However, the following items were cross-loaded on both the egoistic and altruistic subscale: me, my health, and children.

In order to further evaluate the Environmental Motives Scale, subscales were created, in line with past research (Schultz, 2000), by taking the mean score for each of the items used in each of the subscales (egoistic concern items: me, my future, my lifestyle, and my health; altruistic concern items: future generations, humanity, my
family, and children; biospheric concern items: animals, plants, trees, and birds).

Mean scores on the egoistic concern subscale ranged from 1.5 to 7, on the altruistic concern subscale they ranged from 2 to 7, and on the biospheric concern subscale they ranged from 2.5 to 7. Cronbach’s alpha reliabilities for each of the Environmental Motives subscales were also calculated (egoistic concern: $\alpha = .86$; altruistic concern: $\alpha = .79$; biospheric concern: $\alpha = .77$). When looking at the percentage of scores greater than six (or showing great concern) on the subscales, 47.1% showed great egoistic concern, 56.6% showed great altruistic concern, and 32% showed great biospheric concern. When looking at the percentage of scores less than two (or showing little concern) on the subscales, only 3.8% showed little egoistic concern, 1.9% showed little altruistic concern, and no participants showed little biospheric concern.

Finally, when asked how concerned they were personally about environmental problems using the environmental concern question, 54.7% of participants had moderate concern ($N = 29$). Only one child reported not being concerned about environmental problems and eight children (15.1%) reported having extreme concern about environmental problems.

The hypothesis that FlexiTwins would be internally reliable was tested by examining the correlation of the two subscales (D1 and D2) generated by the game. Using a one-tailed Pearson’s correlation, results showed that FlexiTwins time 1 D1 ($M = .48$, $SD = .40$) was significantly correlated to FlexiTwins time 1 D2 ($M = .35$, $SD = .37$; $r = .45$, $p < .01$). FlexiTwins time 2 D1 ($M = .42$, $SD = .49$) was also
significantly correlated to FlexiTwins time 2 D2 ($M = .29$, $SD = .45$, $r = .25$, $p < .05$). This analysis was also conducted excluding participants who had to play FlexiTwins more than twice to obtain percent correct scores greater than or equal to 70% correct ($N = 39$). Using a one-tailed Pearson’s correlation, results showed that FlexiTwins time 1 D1 ($M = .53$, $SD = .59$) was significantly correlated to FlexiTwins time 1 D2 ($M = .45$, $SD = .43$; $r = .49$, $p < .01$). FlexiTwins time 2 D1 ($M = .44$, $SD = .46$) was also significantly correlated to FlexiTwins time 2 D2 ($M = .24$, $SD = .44$, $r = .38$, $p < .01$).

The hypothesis that FlexiTwins would be a stable measure of implicit connections with nature over time was examined next by correlating the D-scores from FlexiTwins played at time 1 and time 2. Using a one-tailed Pearson’s correlation, FlexiTwins D-score time 1 was found to be significantly correlated with FlexiTwins D-score time 2 ($r = .45$, $p < .01$). This analysis was also conducted excluding participants who had to play FlexiTwins more than twice to obtain percent correct scores greater than or equal to 70% correct ($N = 39$). Using a one-tailed Pearson’s correlation, FlexiTwins D-score time 1 ($M = .34$, $SD = .38$) was found to be significantly correlated with FlexiTwins D-score time 2 ($M = .49$, $SD = .44$; $r = .45$, $p < .01$).

It was hypothesized that FlexiTwins would correlate with explicit measures of environmental concern. To assess the validity of FlexiTwins, correlations between implicit and explicit measures of environmental concern were conducted. It was found that FlexiTwins time 1 D-score was not significantly correlated with the
environmental concern question \((M = 5.00, SD = 1.41; r = .02, p = .44)\), INS \((M = 4.12, SD = 1.69, r = .13, p = .17)\), nor with any of the subscales of the Environmental Motives Scale \((egoistic concern: M = 5.56, SD = 1.47, r = -.03, p = .83; altruistic concern: M = 5.90, SD = 1.24, r = -.09, p = .56; and biospheric concern: M = 5.39, SD = 1.21, r = -.06, p = .67)\). In addition, FlexiTwins D-score time 2 was not significantly correlated with the environmental concern question \((M = 5.00, SD = 1.41; r = .02, p = .87)\), INS \((M = 4.12, SD = 1.69; r = -.03, p = .42)\), or with any of the subscales of Environmental Motives Scale \((egoistic concern: M = 5.56, SD = 1.47, r = .05, p = .73; altruistic concern: M = 5.90, SD = 1.24, r = -.21, p = .13; and biospheric concern: M = 5.40, SD = 1.21, r = -.22, p = .12)\).

The correlations between explicit and implicit measures was also conducted excluding participants who had to play FlexiTwins more than twice to obtain percent correct scores greater than or equal to 70\% correct \((N = 39)\). It was found that FlexiTwins time 1 D-score was not significantly correlated with the environmental concern question \((M = 5.15, SD = 1.25; r = .07, p = .68)\), INS \((M = 4.21, SD = 1.72, r = .21, p = .21)\), nor with any of the subscales of the Environmental Motives Scale \((egoistic concern: M = 5.61, SD = 1.27, r = -.05, p = .75; altruistic concern: M = 5.98, SD = 1.06, r = -.15, p = .35; and biospheric concern: M = 5.51, SD = 1.13, r = -.05, p = .78)\). In addition, FlexiTwins D-score time 2 was not significantly correlated with the environmental concern question \((M = 5.15, SD = 1.25; r = .03, p = .87)\), INS \((M = 4.12, SD = 1.72; r = .03, p = .87)\), or with any of the subscales of Environmental Motives Scale \((egoistic concern: M = 5.61, SD = 1.27, r = -.05, p = .75; altruistic concern: M = 5.98, SD = 1.06, r = -.15, p = .35; and biospheric concern: M = 5.51, SD = 1.13, r = -.05, p = .78)\).
Using the Implicit concern: $M = 5.98, SD = 1.06, r = -.15, p = .35$; and biospheric concern: $M = 5.51, SD = 1.13, r = -.05, p = .78$). Table 3 highlights all relevant correlations between implicit and explicit measures.

Next, the relationship between implicit connection with nature and the demographics of the participants was explored. Gender differences were examined first. Using an independent samples $t$-test, no significant differences were found in the FlexiTwins D-score time 1 between males ($M = .40, SD = .44$) and females ($M = .35, SD = .07$), $t(50) = -1.48, p = .15$. In addition, no significant differences were found in the FlexiTwins D-score time 2 between males ($M = .34, SD = .39$) and females ($M = .37, SD = .36$), $t(50) = -.29, p = .77$.

Age differences in FlexiTwins D-scores were also examined. Using a one-way ANOVA, no significant differences were found between the FlexiTwins D-score time 1 of participants who were age 9 ($M = .45, SD = .42$), age 10 ($M = .49, SD = .43$), or age 11 ($M = .52, SD = .29$) years old, $F(2, 49) = .09, p = .92, \eta^2 = .00$. However, when looking at FlexiTwins D-score time 2, there was a significant difference found between the FlexiTwins D-score time 2 and the age of the participants, $F(2, 49) = 3.55, p < .05, \eta^2 = .13$. Post-hoc comparisons suggest that there is a significant difference in FlexiTwins D-scores when participants play FlexiTwins a second time for participants who were 9 years old ($M = .24, SE = .08$) compared to those who were 10 years old ($M = .50, SE = .07$), $t(49) = -.26, p < .05$. There was also a marginally significant difference between the FlexiTwins D-scores of participants who were 10 years old compared to those who were 11 years old ($M =
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.20, $SE = .15$), $t(49) = .29, p = .08$. In order to further understand these differences, paired samples $t$-tests were conducted by age. From these analyses it was found that the D-scores of 9-year-olds at time 1 ($M = .45, SD = .42$) were significantly different from their D-scores at time 2 ($M = .24, SD = .39$), $t(21) = 2.63, p < .05$. This was also true for 11-year-olds. The D-scores of 11-year-olds at time 1 ($M = .52, SD = .29$) were significantly different from their D-scores at time 2 ($M = .20, SD = .40$), $t(5) = 3.33, p < .05$). In contrast, the D-scores of 10-year-olds at time 1 ($M = .49, SD = .43$) were not significantly different from their D-scores at time 2 ($M = .49, SD = .32$), $t(23) = -.07, p = .95$.

Because students were recruited from two different grades at San Pasqual Union School District, differences between the FlexiTwins D-score time 1 of participants in the fourth grade as compared to those participants in the fifth grade were examined. Using an independent samples $t$-test, no significant difference were found in the FlexiTwins D-score time 1 of participants in the fourth grade ($M = .46, SD = .43$) when compared with participants in the fifth grade ($M = .51, SD = .37$), $t(50) = -.46, p = .65$. In addition, no significant differences were found in the FlexiTwins D-score time 2 of participants in the fourth grade ($M = .36, SD = .40$) when compared with participants in the fifth grade ($M = .35, SD = .33$), $t(50) = .07, p = .95$.

Discussion

In this study, the environmental attitudes of children were examined both implicitly and explicitly. Exploratory analysis of the data suggested that, explicitly,
the majority of participants reported a moderate concern about environmental problems and connectedness with nature. Implicitly, the majority of participants reported a positive connection with nature. In addition, the psychometric properties of a new measure of implicit connections with nature were examined. The hypothesis that FlexiTwins would be a reliable measure of implicit connections with nature was supported. FlexiTwins was found to be both internally reliable and stable over time. However, it was also hypothesized the FlexiTwins would be a valid measure of connections with nature and this hypothesis was not supported.

In this study, it was found that FlexiTwins was both internally reliable and stable over time. This is in line with past research using college students (Bowlin et al., 2006; Bruni et al., 2006), who also found FlexiTwins to be internally reliable and stable. This finding is promising, suggesting that even though FlexiTwins is a game, the basic concepts of the IAT are still present in this measure, allowing researchers a more flexible tool for measuring the implicit attitude of both children and adults.

It was also hypothesized that FlexiTwins would be a valid measure of connections with nature in that it would correlate with explicit measures of environmental concern. Surprisingly, this was not the case. In this study, the FlexiTwins D-scores at time 1 and time 2 were not correlated with any explicit measures of environmental concern. This is not congruent with past research, which found that the implicit and explicit measures of environmental attitudes were significantly correlated when looking at a sample of college students (Bowlin et al., 2006; Bruni et al., 2006).
Although the validity of FlexiTwins was not supported in this study, there are several possibilities for this finding. To start, the most plausible explanation for this lack of findings is that there is a fundamental difference between implicit and explicit attitudes, suggesting that the implicit and explicit attitudes expressed by the children are truly not related. As discussed above, implicitly children showed a connection with nature; yet explicitly children only showed a partial connection with nature. The reported explicit environment concerns of participants were only moderate; whereas, the implicit environmental attitudes of these children were relatively high. Rutland et al. (2005) suggest that around the age of 10 the implicit and explicit attitudes of children begin to differ. Perhaps this is the reason for the lack of a significant relationship between the implicit and explicit measures of environmental concern in this sample of fourth and fifth grade children. In addition, past research has found that implicit and explicit attitudes are related but distinct constructs (Lane, Banaji, Nosek & Greenwald, 2007; Nosek, 2007; Nosek & Smyth, 2007). Moreover, Nosek (2007) suggests that implicit and explicit measures have little in common, procedurally. These findings suggest that implicit and explicit measures may or may not correlate significantly. In fact, the research on the validity of the IAT has not identified the processes that accounts for the differences between implicit and explicit attitudes (Nosek & Smyth, 2007); and thus, the validity of such measures may not be able to be identified using the traditional validation process of correlating established measures (in this case explicit measures of environmental concern) with one’s new measure in question (in this case implicit connectedness with nature measured using
Another reason there may be a lack of a significant relationship between these implicit and explicit measures could be the nature of the explicit measures. All of the explicit measures used in the present study were designed for use with adults and have not been tested for use with children. The present study is the first study to examine the properties of the Environmental Motives scale when used with children and found that some items did not load onto the same factors as had previously been used with adults. Moreover, most of the explicit measures are focused on environmental concern whereas FlexiTwins measures the child’s self-association for nature versus built environments or connectedness with nature. The differences in these measures could account for the lack of a significant relationship between these measures. Future research should further examine the validity of both the implicit and explicit measures used to examine environmental concern in children in order to better understand the reason for the lack of findings in this present study.

Interestingly, in this study it was found that boys and girls do not differ in their connectedness with nature, as measured by FlexiTwins. Past research has found that women tend to score higher than men on measures of implicit connectedness with nature (Schultz & Tabanico, in press). This suggests that at some point in time, something changes between the viewpoints of boys and girls, causing women to have more connectedness with nature. Future research should examine the differences between men and women as they mature to see when and why this difference occurs.

Although no age differences were found when looking at the D-scores of
participants on their first time playing the game, age differences were found in the FlexiTwins D-score when the participants played FlexiTwins the second time. Nine-year-olds had lower D-scores (less connection with nature) than participants who were ten years old. And, ten-year-olds had marginally higher D-scores than participants who were eleven years old. Interestingly, this pattern was also seen when looking at the paired-samples $t$ tests by age. The time 1 D-scores of participants who were 9 years old and 11 years old were significantly different from their D-score at time 2; whereas, the time 1 D-scores of participants who were 10 years old were not significantly different from their D-scores at time 2. These patterns may allow us to examine the development of implicit connections with nature. However, at this time the patterns are unclear. Future research should further examine these patterns as well as the variables associated with these patterns in order to better understand the implicit connectedness with nature in children.

In order to begin to understand the development of environmental attitudes and connectedness with nature in children, the present study explored the implicit and explicit attitudes of children. Generally speaking, children show at least moderate concern about the environment. And, very few children show little or no concern for the environment. However, descriptive analyses suggest that the implicit and explicit attitudes of children differ in regards to their connectedness with nature, with implicit attitudes showing moderate to high interconnectedness and explicit measures showing only moderate interconnectedness. These findings are promising and suggest that environmental attitudes are already beginning to form by the age of nine in this
sample of fourth and fifth grade students. So, what causes these attitudes to change? Why do some people go on to become environmentalists and some people have no care about their environment? More research is needed in order to understand how these attitudes form and what variable play a key role in the formation of these attitudes.

In conclusion, children possess moderate levels of explicit environmental concern and connectedness with nature. In addition, children show a strong implicit self-association with the natural environment. In the present study, FlexiTwins was shown to be a reliable measure of connectedness with nature. Although the validity of the measure is not yet known, FlexiTwins is a useful measure of implicit social cognition and could be used with a variety of constructs, from racial bias to preference for soda type. This study serves as phase I of an accelerated longitudinal study of connections with nature in order to better understand how environmental attitudes develop in children. However, FlexiTwins should not be limited to the study of connections with nature. It is a useful tool for work with children, in that it is fun and attractive, has built in feedback, and offers a more game-like feel than the traditional IAT.
References


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33-39.


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Jones, R. E., & Rainey, S. A. (2006). Examining linkages between race, environmental concern, health, and justice in a highly polluted community of


Sherburn, M., & Devlin, A. S. (2004). Academic major, environmental concern, and


Table 1. Descriptive statistics of explicit environmental measures

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Motives</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>egoistic concern</em></td>
<td>5.56</td>
<td>1.47</td>
</tr>
<tr>
<td><em>altruistic concern</em></td>
<td>5.90</td>
<td>1.24</td>
</tr>
<tr>
<td><em>biospheric concern</em></td>
<td>5.40</td>
<td>1.21</td>
</tr>
<tr>
<td>Inclusion of Nature in Self (INS)</td>
<td>4.12</td>
<td>1.69</td>
</tr>
<tr>
<td>Environmental concern question</td>
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<td>1.41</td>
</tr>
</tbody>
</table>

Note: Range of possible item response for Environmental Motives Scale = 1 to 7; Inclusion of Nature in Self Scale = 1 to 7; and Environmental concern question = 0 to 10.
Table 2. Factor loadings from the Environmental Motives Scale

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor 1 (egoistic)</th>
<th>Factor 2 (biospheric)</th>
<th>Factor 3 (altruistic)</th>
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<tbody>
<tr>
<td>Animals</td>
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<td></td>
</tr>
<tr>
<td>Birds</td>
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<td>Plants</td>
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<td>Trees</td>
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<td></td>
</tr>
<tr>
<td>Children</td>
<td>.66</td>
<td>.76</td>
<td></td>
</tr>
<tr>
<td>Humanity</td>
<td></td>
<td>.75</td>
<td></td>
</tr>
<tr>
<td>My Family</td>
<td></td>
<td>.82</td>
<td></td>
</tr>
<tr>
<td>Future Generations</td>
<td>.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Me</td>
<td>.72</td>
<td>.82</td>
<td></td>
</tr>
<tr>
<td>My Future</td>
<td>.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>My Health</td>
<td>.77</td>
<td>.50</td>
<td>.64</td>
</tr>
<tr>
<td>My Life</td>
<td>.78</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Factor loadings smaller than 0.5 are not shown.
### Table 3. Relevant correlations between implicit and explicit environmental measures

<table>
<thead>
<tr>
<th></th>
<th>$D_{T1}$</th>
<th>$D_{T2}$</th>
<th>$D_{T1m}$</th>
<th>$D_{T2m}$</th>
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<tr>
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<td>Egoistic</td>
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<tr>
<td>Biospheric</td>
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<td>-.22</td>
<td>-.05</td>
<td>-.08</td>
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<tr>
<td>Inclusion of Nature in Self</td>
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<td>.21</td>
<td>.03</td>
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<tr>
<td>Environmental concern</td>
<td>.02</td>
<td>.02</td>
<td>.07</td>
<td>.14</td>
</tr>
</tbody>
</table>

* significant at the .05 level; **significant at the .01 level

(D $T_1$ = FlexiTwins D-score time 1; D $T_2$ = FlexiTwins D-score time 2; D $T_{1m}$ = FlexiTwins D-score time 1 limited; D $T_{2m}$ = FlexiTwins D-score time 2 limited)
Figure Caption

*Figure 1.* Screen Shots from FlexiTwins

*Figure 2.* Histogram of distribution of FlexiTwins D-score
Figure 1.
Figure 2

Flexi Twins Time 1 D-score
Flexi Twins Time 2 D-score
Using the Implicit

Appendices
Appendix A

*Environmental Concern Question:* This question is taken from Dunlap, Gallup, and Gallup’s (1992, 1993) Gallup poll. This poll was used in the 1993 Health of the Planet study, which obtained samples from 24 countries world wide. It has also been used sporadically in United States samples, and elsewhere in the world. This question measures a person’s explicit account of their personal concern for environmental issues. Below is a copy of this item:

How concerned are you personally about environmental problems? Would you say…

1  2  3  4  5  6  7

Not at all concerned     Extremely concerned

*Environmental Motives Scale:* This scale provides a measure of an individual’s concern about environmental problems because of the consequences that result from harming nature. Concern for environmental issues is divided into three categories: *egoistic, altruistic,* and *biospheric.* Participants rated 12 items from 1 (not important) to 7 (supreme importance). *Egoistic* items were: me, my future, my lifestyle, and my health. *Altruistic* items were: future generations, humanity, my family, and children. *Biospheric* items were: animals, plants, trees, and birds. See Schultz (2000, 2001, 2002). Below is a copy of the measure used:

Kids around the world are generally concerned about environmental problems because of the consequences that result from polluting the environment.

However, kids differ in the problems that concern them the most. *Please rate*
Using the Implicit 64

each of the following items from 1 (not important) to 7 (very important) in response to the question:

I am concerned about pollution because of the consequences for:

_____ Plants   _____ Trees   _____ My family
_____ Me       _____ My lifestyle  _____ Humanity
_____ My future  _____ My health   _____ Birds
_____ Future generations  _____ Children   _____ Animals

*Inclusion of Nature in Self Scale:* This single item graphical scale was an adaptation of Aron, Aron, and Smollan’s (1992) Inclusion of Other in Self (IOS) scale. This measure was used to measure the extent to which an individual includes nature within his or her cognitive representation of self. The modified scale contains a series of seven overlapping circles labeled “self”, and “nature” and the item asks respondents to “Please circle the picture below that best describes your relationship with the natural environment. How interconnected are you with nature?” Results from previous studies have found these responses to be positively correlated with self-reported environmental behavior, and correlated with other measures of general environmental attitudes. Below is a copy of the measure used:

Please circle the picture below which best describes your relationship with the natural environment. How interconnected are you with nature?