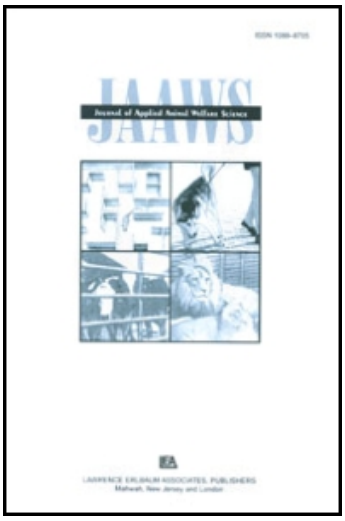

**Journal of Applied Animal Welfare Science**
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t775648083

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Online Publication Date: 01 October 2008

**To cite this Article** Powell, David M. and Svoke, Joseph T.(2008)'Novel Environmental Enrichment May Provide a Tool for Rapid Assessment of Animal Personality: A Case Study With Giant Pandas (Ailuropoda melanoleuca)',Journal of Applied Animal Welfare Science,11:4,301 — 318
**To link to this Article: DOI:** 10.1080/10888700802329673
**URL:** http://dx.doi.org/10.1080/10888700802329673

JOURNAL OF APPLIED ANIMAL WELFARE SCIENCE, *11*:301–318, 2008

ISSN: 1088-8705 print/1532-7604 online
DOI: 10.1080/10888700802329673



ARTICLES

# Novel Environmental Enrichment May Provide a Tool for Rapid Assessment of Animal Personality: A Case Study With Giant Pandas (*Ailuropoda melanoleuca*)

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Historically, the assessment of nonhuman animal personality has included a variety of methods—from direct behavioral observations in a variety of test situations to assessments provided by animal caretakers or trainers. Careful observation of how animals in zoos interact with novel enrichment may provide reliable insight into their personality. This study sought to describe a process for evaluating whether different methods of assessing personality result in similar conclusions. The study exposed 4 giant pandas at the Smithsonian National Zoological Park and Zoo Atlanta to 10 novel enrichment items and recorded their behavior. Keepers also rated each panda on 23 behavioral characteristics on a survey. The study obtained individual behavior profiles for each panda. Significant differences across individuals in both the novel enrichment trials and keeper surveys formed the basis for the profiles. These methods also provided some insight into differences between the sexes that—based on the natural history of giant pandas—are qualitatively similar to what would be expected. The study found some consistency between assessment methods. However, there is a need for further study to validate these measures in a larger sample of giant pandas.

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People involved in the day-to-day care and management of nonhuman animals often believe that different individuals have differing personalities (Feaver, Mendl, & Bateson, 1986). Though most personality research has been conducted on humans, there is a growing recognition that studies of animals can also be helpful in understanding personality (Gosling, 2001). In the last 10 to 15 years, there has also been a growing field of work on the implications of individual differences in behavior for captive management and breeding of animals in zoos and production settings (Carlstead, Fraser, Bennett, & Kleiman, 1999; Carlstead, Mellen, & Kleiman, 1999; Gold & Maple, 1994; Mendl, Zanella, & Broom, 1992; Powell et al., 2008). For example, male black rhinoceros, who were scored as being more dominant to conspecifics by their keepers, had lower reproductive success (Carlstead, Mellen, et al., 1999). In a multi-institutional study of giant pandas in China, Powell et al. found that female pandas, who were more shy, were more likely to be aggressive to males during breeding introductions and show less sociosexual behavior overall. Shyness tended to be higher in giant pandas living in enclosures with only one den site, suggesting that changes in enclosure features might have a positive impact on personality and improve reproductive success. Wielebnowski (1999) found that nonbreeding cheetahs were rated by their keepers as being significantly more tense or fearful than breeding cheetahs.

Behavioral ecologists in the field have also shown a renewed interest in suites of correlated behavioral characteristics in animals. For example, individuals who could be characterized as bold or aggressive in interactions with conspecifics (during feeding or courtship) are also sometimes bold or aggressive in interactions with predators (Bell, 2005). These groups of behavioral characteristics that are correlated across different situations or contexts have been termed "behavioral syndromes" by evolutionary biologists; Sih, Bell, & Johnson (2004) provide an overview.

A variety of behavioral assays are used to identify personality characteristics or behavioral syndromes; Manteca & Deag (1993) provide a review. Some tests simply involve observation of animals in a home enclosure and/or their interactions with familiar conspecifics. More often, the assays rely on measuring animal responses to some form of novelty (exposure to novel environments, stimuli, conspecifics, humans) or to stimuli that are known to be stressful. In recent years, there has been an effort to try to validate keeper or caretaker assessments of personality (Carlstead, Mellen, et al., 1999; Momozawa et al., 2003; Wielebnowski, 1999). In most studies, human evaluations of animal personality are reliably correlated with at least some behavioral characteristics of animals (but see Seaman, Davidson, & Waran, 2002).

The reliability of a human's assessment of animal personality likely increases over time as the human has more experience with the animal and observes his or her responses to a greater variety of stimuli or situations. In some

cases, it may be many months before a caretaker could make a reliable and accurate assessment of an individual animal's personality. However, managers in production settings or in propagation programs often need information more quickly. In commercial mink (*Mustela vison*) farms, the stick test—a rapid evaluation tool—has been validated and put into widespread use for selection of mink behavioral characteristics (Hansen & Moller, 2001). In this article, we describe a process for determining whether a personality assessment method that relies on significant experience with an animal (a keeper survey) produces similar results to an objective test that can be done quickly (a novel object test). Our prediction was that careful observation of how zoo animals respond to completely novel enrichment items would provide an easy and reliable method for rapidly assessing animal personality. The hypothesis was tested by comparing behavioral responses of four giant pandas (*Ailuropoda melanoleuca*) to novel enrichment items with keeper assessments of the pandas' personalities.

Giant pandas are bamboo specialists who inhabit subalpine temperate forests in three provinces of China. Depending on the mountain range and time of year, males and females are more or less territorial, with male ranges overlapping those of females. The mating system is promiscuous, with females having only one estrus per year. Females give birth to one or two infants but only raise one in the wild. Cubs remain with their mothers for an average of 18 months—Lindburg and Baragona (2004) and Schaller, Hu, Pan, and Zhu (1985) provide reviews.

Historically, giant pandas have not reproduced well in captivity (Lindburg, Huang, & Huang, 1998; Zhang, Swaisgood, & Zhang, 2004). Many males demonstrated a lack of interest in females or were aggressive to females during mating introductions; females too were sometimes aggressive or uninterested in mates and would sometimes exhibit a weak or silent estrus. Fortunately, this trend has changed dramatically in the last 5 to 10 years with greatly improved husbandry and behavioral management. Now, the majority of animals breed naturally (Zhang et al., 2004).



## METHODS

### Subjects

The subjects of this study were 4 adult giant pandas. Male TT was born in 1997 and female MX was born in 1998. Both animals were captive-born at the China Research & Conservation Center for the Giant Panda in the Wolong Nature Reserve, Sichuan province, China. The pandas were transported to the Smithsonian National Zoological Park (NZP) in Washington, DC, in December 2000. Male YY and female LL were born in 1997 at the Chengdu Research

Base of Giant Panda Breeding, Sichuan province, China. This pair of pandas was transported to Zoo Atlanta (ZA) in Atlanta, Georgia, in November 1999.

## Housing

At NZP, the pandas had daily access to two large outdoor enclosures (803 $m^2$ and 970 $m^2$). Each yard contained shade trees, dead trees for climbing, a pool of water, and an artificially cooled cave (caves were cooled only during summer months). The pandas were housed together during the day and were separated at night into large night rooms that included waterfalls, climbing structures, and dens.

During this study at ZA, each panda was housed in an indoor enclosure or outdoor enclosure on view to zoo visitors from 0800 to 1700 daily. Each indoor exhibit room (63 $m^2$) contained a climbing structure, natural substrate, and an automatic drinker. Each outdoor enclosure (325 $m^2$ and 232 $m^2$) contained climbing structures, a water pool, shade trees, shrubs, cave, natural substrate, and an automatic drinker. From 1700–0800 the pandas were housed in two to three indoor dens that were not on view to zoo visitors. The pandas were housed separately from each other throughout the study.

## Novel Enrichment Trials

A total of 10 novel enrichment trials were conducted for each panda; some of the enrichments involved food items presented in challenging ways (see Appendix). The pandas were observed continuously, and the following variables were measured:

1. Latency to touch object,
2. Total contact time with object,
3. Number of visits to the object (separated by >5 s),
4. Number of visits to the door to indoor quarters (separated by >5 s),
5. Total time sitting at the shift door,
6. Scent marks, and
7. Stereotypic behaviors.

We also calculated the mean amount of time spent with the novel object per visit. All observations were conducted by a single individual at each institution. Reliability between observers was assessed using a videotaped test scenario and a calculation of percentage agreement between observers (Lehner, 1996). Reliability between observers was 92%. Each novel enrichment trial contributed one data point per variable for each animal. Data from all enrichment trials were pooled because the goal was to characterize general responses to novelty rather than reaction to specific objects.

At NZP, novel enrichment trials were conducted throughout the year in 2001 as keepers developed new enrichment ideas for the pandas. Most trials took place in the first half of the year. Novel enrichment trials were always conducted in the afternoon (1300–1500). During a trial, identical enrichments were placed in the two outdoor exhibit enclosures in locations where they would be immediately visible when the pandas were released. Pandas were separated from one another and put into one enclosure for 1 hr. Each panda was tested in the same enclosure for all trials. No food aside from what was used in the enrichment items was provided during the trials.

At ZA, the novel enrichment trials were conducted throughout July 2006 for LL and August 2006 for YY. All new enrichment devices were designed and constructed (if needed) prior to the start of data collection. Novel enrichment trials were always conducted in the afternoon between 1330 and 1530. All trials were conducted in the same indoor exhibit room. For each trial, one novel object was placed within the enclosure in a location where it would be visible to the subject as soon as the subject entered the room. Each trial was 1 hr in duration and occurred in the same room throughout all observations. As at NZP, no food aside from what was used in the enrichment items was provided during the trials. This represented a change from the normal husbandry for the ZA pandas, who were accustomed to having bamboo available at all times.

Data were analyzed using a one-way, repeated measures analysis of variance (ANOVA) for each dependent variable recorded. Each panda was considered a separate treatment, and each trial was the repeated measure. When data could not be transformed to meet the assumption of normality (number of scent marks performed, number of stereotypic behaviors performed), a repeated measures ANOVA on ranks was used. Significant differences between treatments were identified using the Holm-Sidak method (Holm, 1979; Sidak, 1967). All analyses were performed using Sigmastat 2.03 and significance was assessed when $p < .05$.



## Personality Survey

In 2005, a personality questionnaire was developed based on surveys previously used by Wielebnowski (1999) for cheetah and by Ellis et al. (2004) for giant pandas. The survey included 23 behavioral characteristics and their definitions (Table 1). Beside each characteristic, a 10 cm line was drawn and keepers were asked to place a mark along the line that indicated how strongly they felt each panda demonstrated that characteristic (Feaver et al., 1986). Keepers were asked to consider how each animal was "in general" with regard to each characteristic as opposed to relying on anecdotes and rare occurrences. Asked for their individual opinion, the keepers were instructed not to share their responses with others. The distance from the left side of the line to their mark was

TABLE 1
Characteristics of Personality and Their Definitions Used in the Survey of Giant Panda Caretakers

| | |
|---|---|
| Alert | Pays attention to surroundings and changes in surroundings |
| Active | Moves a lot (e.g., pacing, playing, climbing, walking) |
| Aggressive to panda | Reacts in a hostile way or attacks frequently |
| Aggressive to people | Reacts in a hostile way or attempts to attack/threaten people |
| Calm | Not easily disturbed by changes in the environment |
| Curious | Readily approaches and explores changes in the environment |
| Eccentric | Shows unusual or stereotypic behavior |
| Excitable | Overreacts to changes in the environment |
| Friendly to panda | Social, initiates and seems to seek proximity |
| Friendly to people | Initiates proximity, reacts socially to people |
| Fearful of panda | Retreats readily from other pandas |
| Fearful of people | Retreats readily from people |
| Anxious/Insecure | Seems scared easily, "jumpy," fearful in general |
| Playful | Initiates and participates in play with other pandas or objects |
| Secure/Self-Assured | Moves in a seemingly confident, well-coordinated, and relaxed manner |
| Smart | Learns quickly to associate certain events and seems to remember for a long time |
| Innovative | Problem solver, creates new behaviors |
| Solitary | Spends time alone, avoids company |
| Tense | Shows restraint in movement and posture |
| Vocal | Frequently and readily vocalizes |
| Irritable | Reacts excessively to events and situations |
| Oblivious | Unresponsive to and seemingly unaware of significant events/situations |
| Shy | Reluctant to engage in social situations |



measured and divided by the total length of the line to produce a score for each characteristic.

Six individuals at NZP and four individuals at ZA were asked to complete the survey. These individuals had worked with giant pandas from 6 months to 4 years. At NZP, only two of the six individuals surveyed had worked with the giant pandas during the novel object tests, and the behavioral differences recorded during the tests were never shared with the animal care staff prior to receiving the survey 4 years later. At ZA, surveys were completed just prior to beginning novel object trials in July 2006.

To examine whether personality characteristics were rated reliably across observers, we calculated Kendall's coefficient of concordance (Siegel & Castellan, 1988) for each panda. All coefficients were highly significant ($p < .001$). We then calculated coefficients of variation (CVs) for each behavioral characteristic for each panda separately so that we could compare the variability in ratings across different characteristics while controlling for the mean (Carlstead &

Brown, 2005). Characteristics with a CV of 0.5 or greater in either pair of pandas were discarded from further analysis. These characteristics were as follows:

1. Aggressive to panda,
2. Aggressive to people,
3. Fearful of panda,
4. Fearful of people,
5. Insecure,
6. Irritable, and
7. Oblivious.

We compared scores for each remaining characteristic between males and females overall and within institution. We also compared NZP with ZA animals. We made comparisons using randomization tests (design 6a; Todman & Dugard, 2001). We could not use repeated measures ANOVA for these data because the number of raters at each institution was different, producing a different number of observations for each animal. Personality characteristics likely represent general responses or trends in behavior rather than absolute responses; therefore, differences in personality scores were considered significant when $p < .10$. We also report estimates of effect size, Cohen's $d$ (Sheskin, 2004), when significant differences were found either between sexes or between institutions.



### Comparing Personality With Novel Object Trials

We tried to relate personality scores to behavior during novel object trials using correlational analyses from all pandas; however, with only 4 animals, we had very little power to detect significant differences. Here we report relationships between variables with correlation coefficients >0.8 and $p < .15$. These results should be viewed conservatively at this point; more conclusive relationships should be identified using a larger sample of animals.

## RESULTS

### Novel Object Trials

There was a significant difference (Figure 1) in latency to touch the novel object across pandas ($F_{3,27} = 7.27$, $p < .001$,) with female MX having a significantly longer latency to touch novel objects (X = 171.4 s) than female LL (X = 78.4 s, $p = .01$), male TT (X = 66.7 s, $p = .01$), and male YY (X = 38.8 s, $p = .01$).

The difference in time spent interacting with novel objects approached significance ($F_{3,27} = 2.66$, $p = .07$). There were significant differences (Figure 2) in

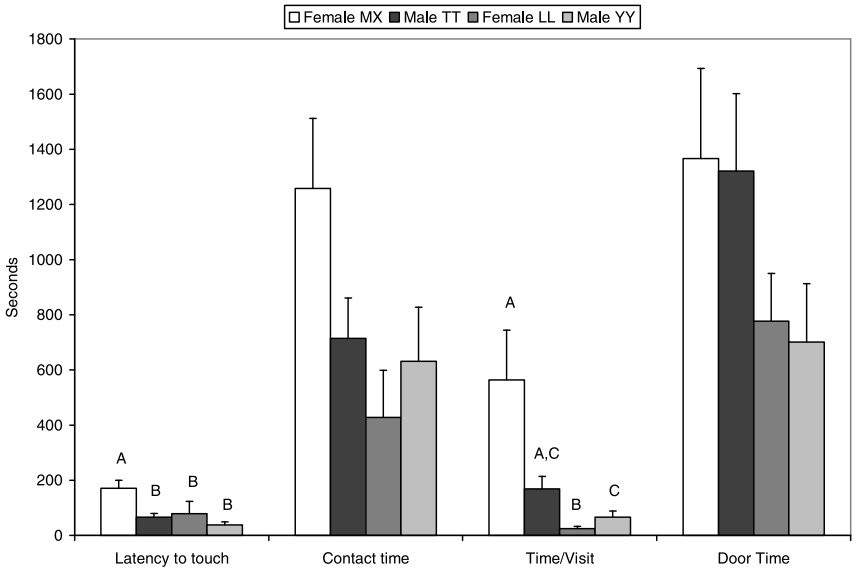


FIGURE 1 Continuous variables measured during novel enrichment trials. Bars sharing a letter within a variable are not significantly different.

the number of times pandas visited the novel objects ($F_{3,27} = 10.73$, $p < .001$). Female LL made significantly more visits (X = 13.8) to novel objects than did female MX (X = 2.9, $p = .01$) and male TT (X = 4.7, i = 0.01). Male YY also made significantly more visits (X = 10.1) to novel objects than did male TT ($p = .02$) and female MX ($p = .01$). There were also significant differences in the mean amount of time spent with the object per visit across pandas ($F_{3,27} = 12.20$, $p < .001$, Figure 1). Female MX spent significantly more time per visit (X = 564.2 s) than Female LL (X = 24.3 s, $p = .01$) and male YY (X = 66.8 s, $p = .01$). Male TT spent significantly more time per visit (X = 168.5 s) than did female LL ($p = .01$). Male YY spent significantly more time per visit than did female LL ($p = .02$).

There were no significant differences across pandas in time spent at the shift door to the exhibit ($F_{3,27} = 1.70$, $p = .19$, Figure 1), but there were significant differences in the number of visits the pandas made to the shift door ($F_{3,27} = 8.14$, $p < .001$, Figure 2). Female LL made significantly more visits to the shift door (X = 27.9) than female MX (X = 4.2, $p = .01$), male YY (X = 13.5, $p = .01$), and male TT (X = 9.5, $p = .01$).

There were no significant differences in the number of scent marks deposited by the pandas during the trials ($X^2 = 6.97$, 3 *df*, $p = .07$, Figure 2); there was a significant difference in the number of stereotypic behaviors performed ($X^2 =$

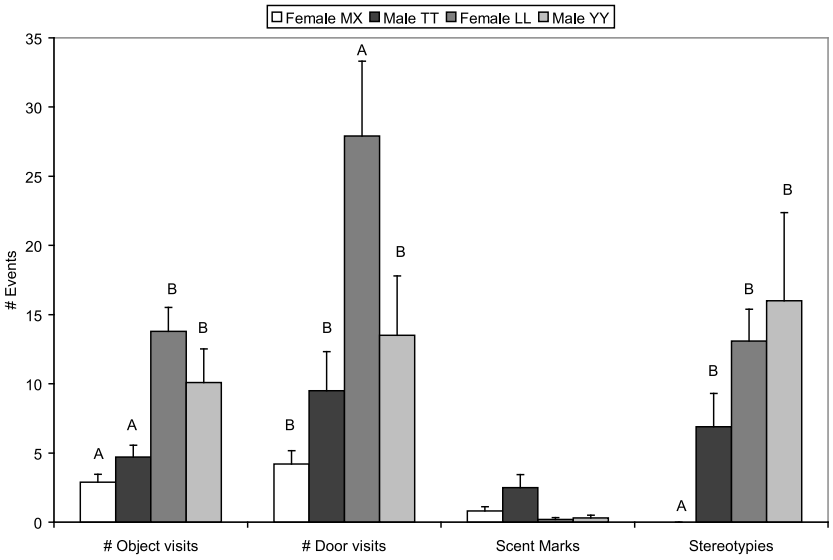


FIGURE 2 Frequencies of behaviors measured during novel enrichment trials. Bars sharing a letter within a variable are not significantly different.

15.07, 3 *df*, $p = .02$, Figure 2). Female LL (X = 13.1 behaviors, $p < .05$), male YY (X = 16.0 behaviors, $p < .05$), and male TT (X = 6.9 behaviors, $p < .05$) all exhibited more stereotypic behaviors than female MX (X = 0 behaviors).

Stereotypy was observed only in the male panda at NZP, and his stereotypy consisted entirely of pirouettes. In a pirouette, the panda stands up on hind limbs, rotates the body, and then returns to a quadrupedal position. Stereotypy was observed in both LL and YY at Zoo Atlanta. LL's consisted of head bobs, chest sucking, and tongue flicks. YY's consisted of either head bobs or somersaults. Head bobbing consisted of lifting the head upward with an immediate partial or full drop or in a circular motion. It is more often associated with the panda sitting or standing at a door. Tongue flicks comprised three or more repetitive exposures of the tongue, often in a licking motion not associated with feeding or grooming. For chest sucking, the mouth is used to suck on fur in the chest area. A somersault is a headfirst roll onto the ground; most often, this occurs during a bout of locomotion.

## Personality Characteristics

First, we found that scores for NZP pandas were significantly different from scores for the ZA pandas on all but 3 of the 16 characteristics in the survey

(Table 2). There were no significant differences between institutions on Calm ($p = .13$), Tense ($p = 1.0$), and Shy ($p = .37$). ZA pandas were rated significantly higher than NZP pandas on Alert ($p < .001$, Cohen's $d = 0.13$), Excitable ($p = .07$, Cohen's $d = 0.03$), and Innovative ($p = .01$, Cohen's $d = 0.20$). NZP pandas were rated significantly (all $p < .001$) higher on Active (Cohen's $d = 0.84$), Curious (Cohen's $d = 0.13$), Eccentric (Cohen's $d = 0.24$), Friendly to panda (Cohen's $d = 1.82$), Friendly to people (Cohen's $d = 1.38$), Playful (Cohen's $d = 2.62$), Self-Assured (Cohen's $d = 1.31$), Smart (Cohen's $d = 0.08$), Solitary (Cohen's $d = 0.15$), and Vocal (Cohen's $d = 0.97$).

There were significant differences between males and females in personality scores (Table 2). Males were rated as significantly more Active ($p < .001$, Cohen's $d = 1.27$), Eccentric ($p < .001$, Cohen's $d = 1.31$), and Self-Assured ($p = .01$, Cohen's $d = 0.95$). Females were rated as more Alert ($p < .001$, Cohen's $d = 0.88$), Excitable ($p = .01$, Cohen's $d = 0.97$), Innovative ($p < .001$, Cohen's $d = 1.17$), Solitary ($p < .001$, Cohen's $d = 1.06$), and Tense ($p < .001$, Cohen's $d = 1.10$).

There were also differences between individuals within institutions, though there were more differences at NZP than at ZA (Table 2). At ZA, male YY was rated significantly more Friendly to panda ($p < .001$) and Vocal ($p < .001$) than female LL, who was rated significantly more Solitary ($p < .001$). The NZP male TT was rated significantly more Active ($p < .001$), Eccentric ($p < .001$), and Self-Assured ($p < .001$) than the female whereas female MX was rated significantly more Alert ($p < .001$), Excitable ($p < .001$), Innovative ($p < .001$), Tense ($p < .001$), and Vocal ($p < .001$) than the male.

## Comparing Personality With Novel Object Trials

We found a number of personality and novel object test variables that were associated according to our criteria (Table 3). Active and Self-Assured animals tended to scent mark more frequently during novel trials. Self-Assured pandas also made fewer visits to the object and shift door. Shy animals made more visits to both the novel object and the shift door. Solitary animals tended to take longer to touch the novel object. Playful pandas spent more time at the shift door but made fewer visits to it, made fewer visits to the novel object, and performed less stereotypic behavior. Vocal pandas and those scored more Friendly to people spent more time in contact with the novel object. Vocal pandas also made fewer visits to the shift door. Pandas rated as being more Friendly to pandas and people made fewer visits to the object and the shift door. Calm pandas spent less time in contact with novel objects and less time with the object per visit; they also touched the object more quickly.

TABLE 2
Mean (±*SE*) Personality Scores for Individual Giant Pandas, National Zoo Pandas, Zoo Atlanta Pandas, Males and Females

| *Characteristic* | *MX* | *TT* | *LL* | *YY* | *NZP* | *ZA* | *Males* | *Females* |
|---|---|---|---|---|---|---|---|---|
| Alert | 0.76 ± .10 | 0.51 ± .08 | 0.69 ± .06 | 0.64 ± .07 | 0.64 ± .07 | 0.66 ± .04 | 0.56 ± .06 | 0.73 ± .06 |
| Active | 0.63 ± .03 | 0.87 ± .03 | 0.63 ± .09 | 0.66 ± .02 | 0.75 ± .04 | 0.64 ± .04 | 0.79 ± .04 | 0.63 ± .04 |
| Calm | 0.48 ± .11 | 0.65 ± .10 | 0.64 ± .12 | 0.59 ± .14 | 0.57 ± .08 | 0.62 ± .08 | 0.63 ± .08 | 0.55 ± .08 |
| Curious | 0.65 ± .08 | 0.76 ± .04 | 0.72 ± .09 | 0.64 ± .14 | 0.70 ± .05 | 0.68 ± .08 | 0.71 ± .06 | 0.67 ± .06 |
| Eccentric | 0.13 ± .03 | 0.75 ± .04 | 0.46 ± .08 | 0.29 ± .08 | 0.44 ± .10 | 0.37 ± .06 | 0.56 ± .08 | 0.23 ± .06 |
| Excitable | 0.45 ± .07 | 0.17 ± .07 | 0.31 ± .06 | 0.32 ± .08 | 0.31 ± .06 | 0.31 ± .05 | 0.23 ± .05 | 0.39 ± .05 |
| Friendly to panda | 0.87 ± .05 | 0.88 ± .04 | 0.42 ± .12 | 0.67 ± .08 | 0.87 ± .03 | 0.54 ± .08 | 0.79 ± .05 | 0.68 ± .09 |
| Friendly to people | 0.89 ± .04 | 0.87 ± .03 | 0.67 ± .07 | 0.78 ± .07 | 0.88 ± .02 | 0.72 ± .05 | 0.83 ± .03 | 0.80 ± .05 |
| Playful | 0.89 ± .03 | 0.91 ± .02 | 0.55 ± .09 | 0.63 ± .07 | 0.90 ± .02 | 0.59 ± .06 | 0.80 ± .05 | 0.75 ± .07 |
| Self-Assured | 0.84 ± .02 | 0.93 ± .01 | 0.69 ± .08 | 0.81 ± .03 | 0.89 ± .02 | 0.75 ± .05 | 0.88 ± .02 | 0.78 ± .04 |
| Smart | 0.85 ± .05 | 0.76 ± .07 | 0.78 ± .01 | 0.80 ± .05 | 0.80 ± .04 | 0.79 ± .03 | 0.78 ± .05 | 0.82 ± .09 |
| Innovative | 0.73 ± .09 | 0.45 ± .09 | 0.73 ± .07 | 0.54 ± .13 | 0.59 ± .08 | 0.64 ± .08 | 0.49 ± .07 | 0.73 ± .06 |
| Solitary | 0.45 ± .05 | 0.27 ± .09 | 0.42 ± .19 | 0.24 ± .03 | 0.36 ± .06 | 0.33 ± .07 | 0.26 ± .05 | 0.44 ± .06 |
| Tense | 0.20 ± .03 | 0.09 ± .02 | 0.29 ± .11 | 0.14 ± .01 | 0.14 ± .03 | 0.22 ± .06 | 0.11 ± .01 | 0.24 ± .05 |
| Vocal | 0.82 ± .05 | 0.55 ± .10 | 0.23 ± .07 | 0.67 ± .05 | 0.68 ± .07 | 0.45 ± .09 | 0.59 ± .06 | 0.59 ± .10 |
| Shy | 0.07 ± .01 | 0.07 ± .02 | 0.17 ± .04 | 0.11 ± .05 | 0.07 ± .01 | 0.14 ± .03 | 0.09 ± .02 | 0.11 ± .02 |

TABLE 3
Pairs of Personality and Novel Object Test Variables Whose Correlation Coefficient Was $r > .85$ and $p < .15$

| *Variables Positively Correlated* | |
|---|---|
| Friendly to people | Contact time |
| Vocal | Contact time |
| Playful | Door time |
| Shy | Door visits, object visits |
| Solitary | Latency to touch |
| Active | Scent mark |
| Self-Assured | Scent mark |
| *Variables Negatively Correlated* | |
| Calm | Contact time, time/visit, latency to touch object |
| Friendly to people | Door visits, object visits |
| Friendly to panda | Door visits, object visits |
| Playful | Door visits, object visits, stereotypic behavior |
| Self-Assured | Door visits, object visits |
| Vocal | Door visits |



## DISCUSSION

Our primary objective in this study was to determine whether different methods of assessing personality (novel object tests versus keeper assessments) provided consistent information. Previous studies using multi-institutional approaches have found that reliable assessments of personality can be obtained from animal keepers (Carlstead, Mellen, et al., 1999) and novel object tests (Carlstead, Mellen, et al., 1999; Powell et al., 2008) and that these assessments correlate with behavior and reproductive success. In a study of domestic horses, Visser et al. (2003) found that riders' assessment of personality was correlated with the horses' scores during a handling test but not a novel object test. If giving animals novel enrichment items and observing their responses produces similar insights into personality as keeper assessments, which require months to years of experience with an animal, then perhaps novel enrichment tests could be used to provide rapid, reliable data on an individual's personality (the stick test; Hansen & Moller, 2001). In the present study, both the novel object trials and the personality surveys were able to distinguish individual pandas on a number of characteristics, and they allowed us to create behavioral profiles of individuals. The personality surveys indicated a greater number of sex and institutional differences among pandas.

At the individual level, we found some qualitatively similar results between the novel object trials and the keeper surveys in terms of distinguishing one

panda from the other. At NZP, the male panda approached novel objects more quickly and performed more stereotypic behavior than the female. The male was also rated as being more Self-Assured and Eccentric, whereas the female was rated as more Excitable and Tense. In a previous analysis involving only the NZP pandas, Powell (2005) found a number of qualitatively similar results between novel object test results and keepers' impressions of the pandas' personalities. The ZA pandas differed from one another in very few characteristics according to the surveys (Friendly to panda, Vocal, Solitary) making it more difficult to find meaningful similarities between survey and novel object test results.

Given the small sample size, we were unable to test for main effects of sex and institution on novel object responses. Qualitatively, we were able to find some parallel relationships based on sex from the survey and novel object test data. For example, females are rated as significantly more Alert, Excitable, and Tense than males. Female pandas at these institutions showed a trend of taking longer to touch the novel objects and spending more time at the door to the exhibits. Females were rated as significantly less Eccentric but more Innovative than males. Both females showed less stereotypic behavior than their male counterparts. Males were rated significantly more Self-Assured than females and scent marked their enclosures more than did the female counterparts.

The sex differences observed in the survey data are interesting in that they are what would be expected based on the natural history of giant pandas. Males occupy territories or home ranges that overlap those of several females who do not have overlapping home ranges (Schaller et al., 1985). Males compete with one another for breeding opportunities and provide no parental care. Previous research with captive pandas in China suggests that bold males and those that respond positively to novelty perform better during sexual interactions with females (Powell et al., 2008). We therefore would expect that males might be scored as more Active because they patrol larger areas and more Self-Assured because they compete with one another for access to mates.

The kinds of stereotypic behavior observed in pandas in captivity have not been observed in pandas in the wild; therefore, it is not clear whether there is an evolutionary basis for male pandas to be scored as more Eccentric, which reflected the propensity to engage in unusual or stereotypic behavior in this survey. Because female giant pandas in the wild live alone and provide all the care and protection of offspring, it is not surprising that they are rated more highly on Alert, Excitable, Solitary, and Tense. Females may be more Innovative because they are the sole playmates for their offspring. Play takes a variety of forms and thus may necessitate the development of new behaviors. Giant panda cubs engage in higher rates of some play behaviors when playing with a mother than when playing with another cub (Wilson et al., in press). Wilson et al. suggested that giant panda mothers modify their play behavior (by reclining during play) to allow cubs to perform some behaviors more frequently.

This may be an example of an innovative behavior that mothers use during cub rearing.

With only 4 giant pandas, it was difficult to establish statistically significant correlations between novel object test variables and aspects of personality in our sample; the relationships we highlight here certainly deserve further study before conclusions can be drawn about how well these two methods of assessment are correlated. For example, it is not clear why pandas who vocalize more frequently would spend more time with novel objects or visit shift doors more frequently. We also found relationships between variables that do not share a similar context. For example, Shy animals made more visits to the novel object and the shift door. In this study, Shy referred only to how the animal behaved in social situations with other pandas. Other relationships were more compelling. Calm was defined as being not easily disturbed by changes in the environment; therefore, it is not surprising that Calm pandas approached the novel objects more quickly but spent less time interacting with them. Self-Assured animals are confident in their surroundings, thus they might be expected to claim and advertise their "territories" more by scent marking and devote less effort to relatively new stimuli in their environment and show less interest in doors leading to other parts of the holding facility.

It was particularly interesting to observe the alternative solutions that the pandas had for dealing with enrichment items involving food items. In some cases, the solutions appeared to be sex specific. Males and females at both institutions demonstrated similar alternative solutions to obtain food from enrichment items. For example, when presented with tubs of water containing floating food items, females at both institutions systematically fished each piece of food out, whereas both males turned the tub over. Both females opened cardboard boxes by attempting to open up the flaps of the box, whereas the males immediately tried to crush and tear apart the boxes. A PVC tube feeder with capped ends is frequently used to give the pandas their leaf-eater biscuits at NZP. A small slot is cut out of the tube to allow the biscuits to fall. From the beginning, the pandas have interacted with this feeder in completely different ways. The male rolls the feeder on the ground until all of the biscuits have passively fallen out, whereas the female lies on her back, holds the feeder between her front paws, and shakes it with the slot facing down.

One new enrichment item used for this study at ZA, a "bell feeder," also elicited different reactions from the sexes. The feeder is made from a 16.5 cm diameter piece of PVC. A series of shelves are attached inside, and biscuits are placed on the top shelf. The feeder is hung and has a piece of rope attached to the bottom for the pandas to use to shake the biscuits down the shelves to be dispensed from the bottom. Both pandas used the rope as a support to stand bipedally and then hit the PVC with their other paw. The female would strike it a couple of times, releasing a few biscuits, then sit down to eat the biscuits, and then go back to the feeder again. The male, on the other hand,

continued to hit it until nearly all the biscuits had fallen out before eating them. Many of these differences are consistent across items and over time and undoubtedly contribute to the keepers' assessments of the pandas' personalities. These differences in style of interaction only became apparent during successive trials, and the dependent variables we measured during the trials did not enable us to capture these effectively. It seems likely that a more detailed analysis of the actual interaction with the objects would allow for identification of sex differences and perhaps institutional differences.

There was only one variable (number of visits to novel object) for which there was a significant difference between the two institutions. ZA pandas made more visits to the novel object whereas, in general, NZP pandas tended to spend more time per visit with the novel object. Though a visit was recorded only when the animal touched the novel object, it is possible that ZA pandas were scored as visiting their novel objects more because the enclosure in which they were tested was significantly smaller and simpler than the enclosures in which the NZP animals were tested. The ZA animals were tested in their indoor dayrooms because the trials took place during the summer and there were temperature restrictions on when the pandas would be exhibited outside. The ZA indoor dayrooms had a wood mulch substrate and logs for climbing. The NZP animals were tested in their outdoor yards, which contained grass, sand, stone, water, and concrete substrates, natural vegetation, logs, and trees for climbing. Alternatively, the ZA pandas may have made more visits to the novel object in their search for food. Not having food in the form of bamboo constantly available during the trials may have caused the ZA animals to revisit the objects more frequently in hopes of obtaining more food from the enrichment items that were food based.

Although the NZP pandas were scored higher on a number of characteristics than ZA pandas on the survey, the pattern of characteristics does not suggest a clear, consistent institutional effect. For example, one institution's animals did not score more highly than the other on Excitable, Shy, and Tense, characteristics that taken together might suggest a suboptimal environment. Instead, the differences lie in characteristics that may reflect multiple aspects of the same dimension of personality. For example, in this survey, being innovative (ZA pandas scored higher) reflected the ability to solve problems and develop new behaviors, whereas being smart (NZP pandas scored higher) related more to association and memory.

## ANIMAL WELFARE IMPLICATIONS

The sample size in this study is limited and precluded a rigorous statistical comparison of survey and novel object test measures; however, the results found here suggest that careful observation of interaction with novel objects could provide insight into a panda's personality that is consistent with human assess-

ments based on months to years of experience with the animals. Further study is needed to more clearly establish relationships between behavioral measures and characteristics of personality in giant pandas. However, previous work has demonstrated that reliable insight into the animal's personality can be gained very quickly if time is taken to carefully observe interaction with novel objects (Hansen & Moller, 2001).

Knowledge of individual personality is often very helpful in planning introductions of unfamiliar individuals for breeding or exhibit. Observing responses to novel stimuli may also help predict how an animal will respond when moved to a new enclosure. For giant pandas, differences in personality are correlated with the success of breeding introductions (Powell et al., 2008); so, to the extent that personality can be shaped by the environment, it seems possible that personality could be manipulated by changes in the environment or husbandry routine to benefit breeding efforts. Work with swift foxes (*Vulpes velox*) has shown that captive-born individuals, who were classified as "bold" according to a number of behavioral measures, were more likely to die within 6 months of release to the wild (Bremner-Harrison, Prodohl, & Elwood, 2004). Thus, the application of personality data can be of use in selecting the most appropriate individuals for reintroduction as well.



## CONCLUSION

Environmental enrichment should already be part of the husbandry routine in most places, so this is an easy behavioral assay to do. It might be more helpful, though, to include exposure to nonfood novel objects early on as well; thus, interactions with the objects are less guided by the underlying physiological condition of the animal.

## ACKNOWLEDGMENTS

Funding for the study was provided by the Friends of the National Zoo's Giant Panda Conservation Fund and Zoo Atlanta. The China Wildlife Conservation Association is a cooperative partner in the Smithsonian National Zoological Park's research and conservation program for giant pandas. The Chinese Association of Zoological Gardens is a cooperative partner in Zoo Atlanta's research and conservation program for giant pandas. This research was approved by the Institutional Animal Care and Use Committees at the Smithsonian National Zoological Park and Zoo Atlanta.

We thank the giant panda keepers at the Smithsonian National Zoological Park and Zoo Atlanta for their assistance with enrichment trials and surveys. Nell Ball, Lorie Tarou, and Kathy Carlstead provided assistance with the study.

## REFERENCES


Bell, A. M. (2005). Behavioural differences between individuals and two populations of stickleback (*Gasterosteus aculeatus*). *Journal of Evolutionary Biology, 18,* 464–473.

Bremner-Harrison, S., Prodohl, P. A., & Elwood, R. W. (2004). Behavioural trait assessment as a release criterion: Boldness predicts early death in a reintroduction programme of captive-bred swift fox (*Vulpes velox*). *Animal Conservation, 7,* 313–320.

Carlstead, K., & Brown, J. L. (2005). Relationships between patterns of fecal corticoid excretion and behavior, reproduction, and environmental factors in captive black (*Diceros bicornis*) and white (*Ceratotherium simum*) rhinoceros. *Zoo Biology, 24,* 215–232.

Carlstead, K., Fraser, J., Bennett, C., & Kleiman, D. G. (1999). Black rhinoceros (*Diceros bicornis*) in U.S. zoos: II. Behavior, breeding success, and mortality in relation to housing facilities. *Zoo Biology, 18,* 35–52.

Carlstead, K., Mellen, J., & Kleiman, D. G. (1999). Black rhinoceros (*Diceros bicornis*) in U.S. zoos: I. Individual behavioral profiles and their relationship to breeding success. *Zoo Biology, 18,* 17–34.

Ellis, S., Zhang, A., Zhang, H., Zhang, J., Zhang, Z., Lam, M., et al. (2004). Biomedical survey of captive giant pandas: A catalyst for conservation partnerships in China. In D. Lindburg & K. Baragona (Eds.), *Giant pandas: Biology and conservation* (pp. 250–264). Berkeley: University of California Press.

Feaver, J., Mendl, M., & Bateson, P. (1986). A method for rating individual distinctiveness of domestic cats. *Animal Behavior, 34,* 1016–1025.

Gold, K. C., & Maple, T. L. (1994). Personality assessment in the gorilla and its utility as a management tool. *Zoo Biology, 13,* 509–522.

Gosling, S. (2001). From mice to men: What can we learn about personality from animal research. *Psychological Bulletin, 127,* 45–86.

Hansen, S. W., & Moller, S. H. (2001). The application of a temperament test to on-farm selection of mink. *Acta Agriculturae Scandinavica, 30,* 93–98.

Holm, S. (1979). A simple sequentially rejective multiple test procedure. *Scandinavian Journal of Statistics, 6,* 65–70.

Lehner, P. N. (1996). *Handbook of ethological methods* (2nd ed.). Cambridge, UK: Cambridge University Press.

Lindburg, D., & Baragona, K. (2004). *Giant pandas: Biology & conservation*. Berkeley: University of California Press.

Lindburg, D. G., Huang, X. M., & Huang S. Q. (1998). Reproductive performance of giant panda males in Chinese zoos. In G. Zhang & G. He (Eds.), *Proceedings of the International Symposium on the Protection of Giant Panda* (Ailuropoda melanoleuca) (pp. 67–71). Chengdu, China: Sichuan Publishing House of Science and Technology.

Manteca, X., & Deag, J. M. (1993). Individual differences in temperament of domestic animals: A review of methodology. *Animal Welfare, 2,* 247–268.

Mendl, M., Zanella, A. J., & Broom, D. M. (1992). Physiological and reproductive correlates of behavioural strategies in female domestic pigs. *Animal Behavior, 44,* 1107–1121.

Momozawa, Y., Ono, T., Sato, F., Kikusui, T., Takeuchi, Y., Mori, Y., et al. (2003). Assessment of equine temperament by a questionnaire survey to caretakers and evaluation of its reliability by simultaneous behavior test. *Applied Animal Behaviour Science, 84,* 127–138.

Powell, D. M. (2005). Giant Panda temperament: Insights from interaction with novel enrichment and keeper evaluations. *Proceedings of the Seventh International Conference on Environmental Enrichment* (pp. 264–270). New York: Wildlife Conservation Society.

Powell, D. M., Hong, L., Carlstead, K., Kleiman, D., Zhang, H., Zhang, G., et al. (2008). Relationships between temperament, husbandry, management, and socio-sexual behavior in captive male and female giant pandas (*Ailuropoda melanoleuca*). *Acta Zoologica Sinica, 54*, 169–175.

Schaller, G. B., Hu, J., Pan, W., & Zhu, J. (1985). *The giant pandas of Wolong*. Chicago: University of Chicago Press.

Seaman, S. C., Davidson, H. P. B., & Waran, N. K. (2002). How reliable is temperament assessment in the domestic horse (*Equus caballus*)? *Applied Animal Behaviour Science, 78,* 175–191.

Sheskin, D. (2004). *Handbook of parametric and nonparametric statistical procedures* (3rd ed.). Boca Raton, FL: Chapman & Hall/CRC Press.

Sidak, Z. (1967). Rectangular confidence regions for the means of multivariate normal distributions. *Journal of American Statistical Association, 62,* 626–633.

Siegel, S., & Castellan, N. J. (1988). *Nonparametric statistics for the behavioral sciences*. Boston: McGraw-Hill.

Sih, A., Bell, A., & Johnson, J. C. (2004). Behavioral syndromes: An ecological and evolutionary overview. *Trends in Ecology and Evolution, 19,* 372–78.

Todman, J. B., & Dugard, P. (2001). *Single-case and small-n experimental designs.* Mahwah, NJ: Erlbaum.

Visser, E. K., Van Reenen, C. G., Rundgren, M., Zetterqvist, M., Morgan, K., & Blokhuis, H. J. (2003). Responses of horses in behavioural tests correlate with temperament assessed by riders. *Equine Veterinary Journal, 35,* 176–183.

Wielebnowski, N. C. (1999). Behavioral differences as predictors of breeding status in captive cheetahs. *Zoo Biology, 18,* 335–349.

Wilson, M. L., Snyder, R. J., Zhang, Z. H., Luo, L., Li, C. L., & Maple, T. L. (in press). Effects of partner on play fighting behavior in giant panda cubs. *Play and Culture.*

Zhang, G., Swaisgood, R. R., and Zhang, H. (2004). Evaluation of behavioral factors influencing reproductive success and failure in captive giant pandas. *Zoo Biology, 23,* 15–31.

## APPENDIX

### List of Environmental Enrichment Items Used in Novel Enrichment Tests

Cardboard boxes or burlap sacks filled with hay and chow
Fruit in water-filled tubs
Fruit frozen in ice blocks
Christmas trees
Fruit pieces in plastic containers with holes drilled in the sides
Rosemary
Frozen fruit juice blocks
Cardboard tubes filled with bedding and treats
Milk crates filled with mulch and treats
PVC pipe feeders
PVC wind chime
Fire hose ball