

Assessing the Psychological Health of Captive and Wild Apes: A Response to Ferdowsian et al. (2011)

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As many studies of cognition and behavior involve captive animals, assessing any psychological impact of captive conditions is an important goal for comparative researchers. Ferdowsian and colleagues (2011) sought to address whether captive chimpanzees show elevated signs of psychopathology relative to wild apes. They modified a checklist of diagnostic criteria for major depression and posttraumatic stress disorder in humans, and applied these criteria to various captive and wild chimpanzee populations. We argue that measures derived from human diagnostic criteria are not a powerful tool for assessing the psychological health of nonverbal animals. In addition, we highlight certain methodological drawbacks of the specific approach used by Ferdowsian and colleagues (2011). We propose that research should (1) focus on objective behavioral criteria that account for species-typical behaviors and can be reliably identified across populations; (2) account for population differences in rearing history when comparing how current environment impacts psychological health in animals; and (3) focus on how changes in current human practices can improve the well-being of both captive and wild animals.

Keywords: welfare, chimpanzees, nonhuman primates, captivity, psychological well-being

Assessing the psychological health of captive primate populations is a critical issue for researchers who seek to understand the animal mind in a comparative perspective, as many experiments

and behavioral observations involve captive animals. This is particularly important for cognitively complex animals such as apes and other nonhuman primates, who may be especially sensitive to aspects of captivity because of their need for space, complex social groupings, and long lives (Pruetz & McGrew, 2001). A recent study by Ferdowsian and colleagues (2011) addressed levels of psychopathology across different populations of chimpanzees. To evaluate this issue, they used human diagnostic guidelines for major depression and posttraumatic stress disorder (PTSD). Drawing on criteria from the Diagnostic and Statistical Manual of Mental Disorders IV (*DSM-IV*), they developed a modified set of criteria for use with apes. Raters first evaluated case studies of potential mental illness in chimpanzees reported in the literature, primarily using anecdotes from biomedical settings. They then applied the modified checklist to assess individual apes from (1) three sanctuaries in North America, Asia, and Europe, (2) two African sanctuaries, and (3) three wild populations. The authors argue that sanctuary-living chimpanzees exhibit more signs of depression and PTSD relative to wild chimpanzees and conclude that placing apes in captivity can lead to psychopathology.

We commend the authors' attempt to draw theoretical links between the study of psychopathology in humans and the study of psychological health in other species. We believe that all scientists working with animals should be concerned about the welfare of their subjects both for ethical and pragmatic reasons (Hare, *in press*). Their

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article is also timely given ongoing efforts to halt biomedical testing with apes: even the United States, the sole Western country that still engages in biomedical use of chimpanzees, is considering a ban (e.g., the Great Ape Protection and Cost Savings Act H.R.1513/S.810, currently under consideration in the U.S. Congress). In addition, this topic has bearing on current debates concerning the split levels of protection given to chimpanzees in the United States, where wild chimpanzees are listed as endangered by U.S. Fish and Wildlife, whereas captive chimpanzees are classified only as threatened to allow for their commercial use (Department of the Interior: Fish and Wildlife Services Docket #FWS-R9-ES-2010-0086; MO 92210-0-0010 B6).

The authors' claims about the impact of captivity on apes also have implications for the study of comparative psychology. A significant portion of comparative research on the cognition and behavior of other species is conducted with captive animals. Indeed, many questions concerning the psychological abilities supporting complex behaviors cannot feasibly be answered with wild studies that typically use observational methods rather than controlled experiments (Tomasello & Call, 2008). Thus, the study of comparative psychology must unite observations from the wild—which illuminate the diversity and complexity of behaviors that animals exhibit in their natural environments—with experiments from captivity that can use controlled manipulations to tease apart the psychological mechanisms supporting those behaviors. If captivity per se has negative effects on the psychological health of animals, however, this raises questions concerning the validity of many cognitive and behavioral experiments. More generally, strong evidence that captivity significantly diminishes the psychological health of animals would represent a challenge to a field that uses studies of captive populations as a window to understanding the minds of other species.

Here, we respond to the challenge posed by the work from Ferdowsian and colleagues (2011). We show that their study has a number of methodological issues that hinder its usefulness in assessing the impact of captive conditions on apes. First, their use of human diagnostic criteria does not provide a powerful measure for assessing psychological health in nonhuman animals, who lack language and cannot report their subjective experiences. Second, the use of different raters across chimpanzee populations makes it difficult to use their data to compare psychological health in captive versus wild chimpanzees. Third, the article analyzes sanctuary-living chimpanzees in and outside of Africa as part of the same group. Sanctuaries in Africa and sanctuaries in the United States, Europe, and Japan care for populations of apes with different rearing histories, making analyses that group these individuals uninformative. We finally propose that the critical question in addressing the psychological health of primate populations is how we can change current human practices to improve their well-being—both in terms of the level of care given to captive populations, as well as for understanding the impact of human behavior on wild apes. This type of research can more rigorously address the strong claims made by Ferdowsian et al. (2011) regarding the impact of captivity on the psychological health of chimpanzees. Thus, it is an open question for future research to what degree different types of captive environments shape various aspects of cognition and psychology more generally in animals.

Human Diagnostic Criteria Are Difficult to Apply to Nonverbal Animals

Ferdowsian and colleagues (2011) used a checklist approach to identify psychopathology in apes, following the basic criteria used in the *DSM-IV* to diagnose major depression and PTSD in adult humans. Raters read anecdotal reports in the literature that described aberrant behaviors in chimpanzees and had to rate whether or not the animal exhibited the criteria in the *DSM-IV*. For example, to assess PTSD in chimpanzees, raters would score criteria such as whether that chimpanzee exhibited “intense psychological distress at exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event” (*DSM-IV* Criteria B4, Table 2). In addition, the authors assessed a second set of criteria that had been modified following previous work with young children (Scheeringa, Zeanah, Drell, & Larrieu, 1995). In particular, young children on the cusp of acquiring language may have difficulties giving complex verbal descriptions of their mental states. Consequently, some alternative diagnostic criteria proposed for children remove the most language-dependent items that require the child to describe their experiences in detail (De Young, Kenardy, & Cobham, 2011). Similarly, Ferdowsian et al. (2011) modified the *DSM-IV* checklists for use with apes primarily by removing the same criteria. The authors' results indicated that raters showed higher reliability on applying the modified checklist to the chimpanzee anecdotes than they had with the adult *DSM-IV* diagnostic criteria. This modified checklist thus served as the basis of Phase 2 of the study, where it was used to assess apes living in sanctuaries and in the wild.

Ideally, a checklist for psychopathology would consist of objective measures that identify whether the apes do or do not engage in particular behaviors, such that independent observers can agree whether a certain behavioral symptom was observed. Unfortunately, the modified checklist used by Ferdowsian et al. (2011) in Phase 2 of their study—while removing the most explicitly language-dependent items—still included many items assessing subjective mental states in the chimpanzees. For example, raters assessed whether chimpanzees often got “upset,” whether they had “interest” in certain activities, and whether they had difficulties with attention or concentration (from Ferdowsian et al., 2011; Tables 2 and 3). Applying these types of criteria to animals is difficult because animals have no language to report their interests or desires in even a basic fashion. Unlike small children, they also do not have a parent who routinely observes their behavior across contexts over time and can therefore report on their actions. For example, it is unclear how the criteria “poor attention to tasks or difficulty concentrating” (Ferdowsian chimpanzee PTSD criteria D3 and depression criteria 8) should be assessed in chimpanzees. This is especially the case for individuals that do not routinely participate in cognitive experiments or other types of mentally taxing activities (such as complex foraging behavior in the wild) that require sustained attention. Even for such individuals, it is currently unknown how much attention an ape should “normally” devote to various activities. Establishing such an initial baseline would therefore be necessary to interpret any results and identify pathological changes in attention.

Human raters may further be unable to apply these types of criteria to apes in a consistent fashion because of the manner in which observers or animal caregivers routinely interact with animals. First, humans may not be present at necessary times to make relevant

observations. For example, criteria such as “awake or easily awakened during evening observations, difficulty falling asleep, or excessive sleep” (Ferdowsian chimpanzee PTSD criteria D1 and depression criteria 4) may be observable in principle but not in practice. Most caretakers and fieldworkers typically do not spend the night in the presence of apes and therefore cannot know with any certainty how easily they do or do not fall asleep. At the Kibale Chimpanzee Project in Uganda, one of the wild sites involved in the Ferdowsian et al. (2011) study, field workers cannot typically see chimpanzees once they are in a night nest, and chimpanzees sometimes continue foraging after dark when fieldworkers have left the ape group (personal communication, Richard Wrangham, Kibale director).

Second, human raters may have no ability to score a given ape’s typical behaviors because of short observation times. That is, some criteria are impossible to apply in the absence of good knowledge about an individual ape’s long-term history. Most notably, the diagnosis of PTSD in humans requires the experience of trauma. It is unique among *DSM-IV* diagnoses in that it requires the experience of a particular etiological event to be diagnosed: regardless of all other symptoms, a person *must* have experienced trauma to be diagnosed with PTSD. This diagnosis has therefore been debated ever since its original inclusion in the *DSM-III* in 1980; in particular, the operational definition of what should be considered “trauma” has shifted (McNally, 2003). When applying these PTSD criteria to animals, there are additional problems. As in the *DSM-IV* criteria for adult humans, the modified chimpanzee criteria specify that apes must have experienced a trauma (Ferdowsian chimpanzee PTSD criteria A1) and experience intrusive, negative reactions (criteria B1, B4, and B5). However, validating the experience of trauma in nonverbal animals who cannot describe their history is difficult. Trauma could perhaps be identified for some laboratory-living chimpanzees based on long-term medical records (e.g., apes may have been placed in isolation for extended periods, or experienced particular types of medical experimentation). Identification of traumatic events—such as being maimed by snares—may also be possible for some wild-living individuals who have been followed for decades (i.e., at Gombe Stream National Park in Tanzania). However, this sort of detailed knowledge is impossible to acquire for sanctuary-living apes in Africa who have been confiscated and have undocumented previous histories, or for wild individuals who have been followed for shorter periods. For example, observations of wild female chimpanzees typically commence or end at puberty, given that females transfer between groups at this age (Kahlenberg, Thompson, Muller, & Wrangham, 2008; Pusey & Packer, 1987). Similarly, the existence of fission–fusion group structures in chimpanzees means that sometimes individuals are not observed for weeks or more at a time at wild sites. It thus seems untenable in many cases to determine whether an individual has undergone trauma at all, not to mention discerning whether individuals have strong negative responses to reminders of their trauma.

A final weakness of the approach used by Ferdowsian et al. (2011) is that the guidelines do not specify any directions for identifying “normal” (as opposed to pathological) variation in nonhumans. As such, raters may only be identifying individual differences in behavior—either because of differences in personality traits, or because of aspects of the specific social context where these behaviors are expressed. These types of behavioral differences between individuals do not in any way imply that a particular ape is expressing pathological changes. For example, dominance relations with conspecifics who are also present at

observation could play an important role in shaping chimpanzees’ behavior across the categories used in the modified criteria. To take one such category, grooming is a common behavior in non-human primates, including chimpanzees. Accordingly, lack of interest in grooming was used as one criterion for chimpanzee depression (Ferdowsian criteria C4). However, it is well documented that not all chimpanzees groom or receive grooming at the same rates. In particular, higher-ranking males typically have more grooming partners than lower-ranking males (Watts, 2000). Thus, this checklist item could potentially identify lower-ranking males as expressing more “depressive” symptoms. However, this designation would not account for the fact that reduced grooming may reflect normal variation, or changes resulting from shifting social status. A similar problem has been documented with humans: some evidence suggests that these types of checklist measures may confuse normal reactions to life events with pathological symptoms of disorder (Rosen & Lilienfeld, 2008).

Assessing Animal Psychological Health Requires Objective Behavioral Measures

An alternative to the checklist derived from human diagnostic criteria is to identify more objective—and more easily observable—species-specific behavioral measures for psychopathology in apes. This approach has already been used in animal models of depression and anxiety. For example, experimental tasks are used to assess psychopathology in mouse models, including open field tests, social interaction tests, or forced swim tests (Kalueff, Wheaton, & Murphy, 2007). While we are not necessarily advocating the use of any of these particular measures, we do emphasize that these types of tests emerged from knowledge about species-typical behaviors across contexts. That is, these tests use *species-specific* fear responses (such as freezing or amount of activity in exposed environments in rodents) that do not necessarily align well with *human* diagnostic criteria. In considering the expression of psychopathology in nonhuman primates, we therefore argue that behavioral measures must take into account both species-typical behaviors (what behaviors do chimpanzees exhibit when expressing normal fear or stress reactions?) and aberrant changes (what behaviors are not normally seen in chimpanzee populations?). However, just as in rodents, species-typical and species-aberrant behavior in chimpanzees may not fit neatly into human diagnostic criteria.

Notably, there are already valid markers of psychopathology in apes based on the normal range of typically observed behavior. These types of measures identify aberrant behaviors that are rarely, if ever, seen in wild populations—including coprophagy, rocking, eye-poking, regurgitation and reingestion, and feces painting (Bloomsmith, Baker, Ross, & Lambeth, 2005; Davenport & Menzel, 1963; Turner, Davenport, & Rogers, 1969; Walsh, Bramblett, & Alford, 1982). Indeed, these behavioral criteria for psychopathology in apes have been successfully used to assess rates of aberrant behavior in particular ape populations (Lilienfeld, Gershon, Duke, Marino, & de Waal, 1999) as well as to compare different populations of apes (Wobber & Hare, 2011). Although these behaviors do not align with any human diagnostic criteria per se, they are clear markers of unusual, species-atypical reactions to certain environments. However, because these behaviors are not components of the human diagnostic

criteria, these signs of aberration in chimpanzees were not included in Ferdowsian's (2011) analysis.

In addition, there is a long history of studying hormonal markers of stress (such as cortisol) in both captive and wild populations of primates (Bergman, Beehner, Cheney, Seyfarth, & Whitten, 2005; Sapolsky, 1982). These types of measure take advantage of stress reactions that are a normal response to certain events and can assess whether individuals show uncharacteristically high levels of responsiveness. For example, in wild populations of primates, cortisol spikes are observable in response to events that might meet criteria for what constitutes a trauma, such as the death of a close relative as a result of a predation event (Engh et al., 2005), or infanticide (Engh et al., 2006). This suggests that current behavioral and hormonal assays of behavior in primates can provide a measure of psychopathology in apes that has been further validated by field studies of natural responses to trauma and adverse life events. In contrast, *DSM-IV*-like diagnostic checklists for animals have not been validated in this fashion.

Criteria for Psychopathology in Apes Must Demonstrate Interrater Agreement

A major methodological issue with the data reported by Ferdowsian et al. (2011) concerns the reliability of their checklist measures: do multiple raters agree that a specific ape meets their criteria for psychopathology? In Phase 1 of the study, three raters assessed whether literature case studies met criteria for PTSD and depression using the complete adult human *DSM-IV* criteria. Case studies were taken from multiple facilities, including Yerkes National Primate Research Center (NPRC; Clarke, Juno, & Maple, 1982; Menzel, Davenport, & Rogers, 1963; Turner et al., 1969), Fauna Foundation (Bradshaw, Capaldo, Lindner, & Grow, 2009), Southwest NPRC (Bourgeois, Vazquez, & Brasky, 2007), Primate Foundation of Arizona (Howell, Fritz, Downing, & Bunuel, 1997; Struck, Videan, Fritz, & Murphy, 2007), M. D. Anderson Cancer Center (Struthers, Bloomsmith, & Alford, 1990), Lion Country Safari (Noon, 1991; Pfeiffer & Koebner, 1978), and Mahale National Park (Hiraiwa-Hasegawa & Hasegawa, 1988). To create their modified criteria for psychopathology in apes, the authors assessed what subset of the full *DSM-IV* criteria showed the highest interrater reliability and used this as a basis to select their final criteria for modified psychopathology criteria in apes.

Interrater reliability did improve on the alternative criteria set. For example, average Cohen's kappa values across all *DSM-IV* criteria for PTSD was 0.0, whereas it was 0.5 for the modified criteria set (see Ferdowsian et al., 2011, page 6). However, it is important to note that reliability across all criteria in the modified PTSD set ranged from 0.1 to 0.7, and for depression it ranged from 0.1 to 1.0. This indicates that several of these new criteria did not meet standard levels of reliability and often did not even approach acceptable levels. Specifically, the Kappa value of 0.0 reflects chance agreement between two raters, and the average Kappa value of 0.5 is still indicative of poor interrater agreement. The type of analysis should therefore be restricted to coding criteria with values greater than 0.7, as is standard practice for behavioral studies (Bakeman & Gottman, 1997; Martin & Bateson, 1993). Thus, the criteria used in the checklist have the further drawback of being difficult to apply consistently across raters. Importantly, trained doctors use *DSM-IV* checklists for diagnostic purposes in

humans, in conjunction with structured interviews to make criteria more reliable. However, it is not possible to conduct such interviews with nonverbal animals.

In Phase 2 of their study, Ferdowsian and colleagues assessed rates of chimpanzee psychopathology in (1) three sanctuaries in North America, Asia, and Europe (AAP Sanctuary for Exotic Animals in the Netherlands; Chimpanzee Sanctuary Northwest in the United States; and Uto Sanctuary in Japan); (2) two African sanctuaries (Ngamba Island Chimpanzee Sanctuary in Uganda and Sweetwaters Chimpanzee Sanctuary in Kenya); and (3) three wild chimpanzee populations (including the Kibale Chimpanzee Project in Uganda). Here, the authors reported intrarater reliability using a test-retest method. That is, caretakers or observers rated the apes they worked with, and then the same raters assessed the same chimpanzees again after a 2-week interval. This intrarater reliability ranged from 0.4 to 0.8, suggesting that the same person using the checklist at a different time did not necessarily report whether chimpanzees exhibited these symptoms in a reliable manner. Consequently, this test-retest method neither demonstrated that raters across populations were reliable in how they scored the chimpanzees' behaviors, nor did it show that the same rater was consistent in how they applied these criteria to the same chimpanzee across time.

In addition, a major problem with this methodology is that different raters assessed different populations. That is, because local caretakers or observers rated each population, different raters—possibly with different preconceived notions of the chimpanzees' mental health—assessed the different populations of chimpanzees, without any reported cross-population measures of reliability. Notably, the results from phase 1 of their study demonstrate large differences in how individual raters assessed the psychological health of the chimpanzees in the case reports. For example, in the PTSD scores from phase 1, one human rater identified three chimpanzees that met the criteria, whereas the other two raters identified no chimpanzees as meeting the criteria (see Ferdowsian et al., 2011, page 6). The use of different raters across sites (e.g., sanctuary vs. field) is therefore problematic. First, there may be differences concerning whether raters at different sites can even assess specific criteria for pragmatic reasons. For example, sites may vary as to whether it is possible to observe the apes sleeping (to evaluate criteria involving difficulty sleeping), as previously discussed. Second, there may be bias in how willing people at different sites are to endorse different behavioral criteria: caretakers working with captive chimpanzees known to have experienced social or physical deprivation, or with known histories of traumatic medical procedures, may be more willing to endorse psychopathological symptoms in those chimpanzees. Ideally, attempts to compare psychopathology across populations would use the same raters across populations. Alternatively, different raters could initially observe the same individuals to demonstrate reliability in use of the behavioral criteria and then later observe different populations.

Different Types of Sanctuaries Care for Different Populations of Apes

As previously mentioned, Ferdowsian's (2011) Phase 2 comparison of psychological health in wild and sanctuary-living apes examined five sanctuary populations (two in Africa and three outside of Africa). This analysis obscures an important difference between sanctuary populations. In America, Europe, and Asia, sanctuaries typically care for former biomedical chimpanzees who

have lived in conditions of relative social and/or physical deprivation for extended periods of time. In contrast, African sanctuaries care for a very different population, typically wild-born orphans of the bush meat and pet trade (Andre, Kamate, Mabonzo, Morel, & Hare, 2008; Beck, 2010; Farmer, 2002). These sanctuaries thus foster broader conservation goals in enforcing African laws banning the trade of primates as food or pets. African sanctuaries are also able to rehabilitate these apes by providing highly enriched social and physical environments given their unique access to primary tropical rainforest and other habitats more similar to chimpanzees' wild environments.

Overall, current knowledge about how life experiences impact the expression of aberrant behaviors in apes suggests that grouping data from individuals living in African sanctuaries with individuals from sanctuaries in the United States, Europe, and Japan is not valid. Typical laboratory conditions for chimpanzees in the 1960s and 1970s often involved severe sensory and social isolation during nursery rearing (Bloomsmith et al., 2005). These outdated practices resulted in high levels of aberrant behaviors in these individuals, including major deficits in social behavior that precluded copulation, infant rearing, or normal social interactions (Davenport & Menzel, 1963; Menzel et al., 1963; Turner et al., 1969). As apes can live more than 60 years in captivity (Dyke, Gage, Alford, Swenson, & Williams-Blangero, 1995), these practices continue to have repercussions for the composition of current ape social groups. Studies examining modern rearing practices—which typically involve more enriched social and physical environments—indicate that early rearing conditions are a critical factor in apes' later behavior. In particular, infants removed from their mothers before one year of age show the most aberrations (Bloomsmith et al., 2005). While the only longitudinal comparison of mother-reared and peer-reared chimpanzees found that peer-rearing had few significant effects on adult social behaviors (Spjorkerman, van Hooff, Dieneske, & Jens, 1997), some data suggests that different types of peer rearing have different impacts: individuals given intensive human parenting in addition to peer interactions in infancy show the most positive behavioral outcomes relative to individuals with less human caretaker contact (van Ijzendoorn, Bard, Bakermans-Kranenburg, & Ivan, 2009).

Together, this suggests that apes that were raised in isolation for long periods have a very different psychological profile than apes with early experiences that were enriched by mother-rearing, peer contact, and/or supportive interactions with human caretakers. As different captive contexts provide care all along this spectrum—from intensive deprivation to mother-rearing to intensive rehabilitation with human parenting and peer contact—the rearing history of a particular individual must be taken into account when examining psychological health. In particular, apes in African sanctuaries have different rearing histories than apes in sanctuaries in the United States, Europe, and Japan. While apes in African sanctuaries do typically experience an acute trauma in childhood (the capture and death of their mother), the majority of apes in African sanctuaries were mother-reared in infancy (typically 1–3 years)—the time period that appears to be most critical in shaping later aberrant behavior in laboratory apes (Bloomsmith et al., 2005). Furthermore, apes that arrive at the sanctuary are cared for by a human surrogate parent and are rapidly integrated into a peer group (Cox, Rosen, Montgomery, Seal, & SSC/IUCN, 2000), a care regimen that most closely resembles that experienced by

nursery-reared chimpanzees with the most positive outcomes (van Ijzendoorn et al., 2009).

Two pieces of evidence suggest that early experience with mother-rearing, peer contact, and supportive human caretakers fosters well-being in African sanctuary apes. First, studies of patterns of behavior and cognition in African sanctuary apes indicate that they have both lower rates of aberrant behavior (such as rates of coprophagy) and higher rates of normal behaviors such as foraging than do zoo-living chimpanzees (Wobber & Hare, 2011). Furthermore, apes in African sanctuaries have also been shown to perform equally well or even better than zoo-living apes on several diverse types of cognitive tasks (Hanus, Mendes, Tenie, & Call, 2011; Herrmann, Wobber, & Call, 2008; Vlamings, Hare, & Call, 2010; Wobber & Hare, 2011), with no major differences in the performance of mother-reared individuals and orphans. Second, growing population pressures at sanctuaries have led several such organizations to pursue wild releases, where sanctuary-living apes are returned to the wild (Faust, Cress, Farmer, Ross, & Beck, 2011). Long-term observations of these chimpanzees suggest that apes from African sanctuaries can be successfully released, and have the capacity to survive, integrate into social groups, and reproduce in the wild (Farmer, 2002; Goossens et al., 2005; Goossens, Setchell, Vidal, Dilambaka, & Jamart, 2003; Humle, Colin, Laurans, & Raballand, 2011; Le Hellaye, Goossens, Jamart, & Curtis, 2010; Moscovice, Mbago, Snowdon, & Huffman, 2010; Tutin et al., 2001). Together, these data suggest that grouping different captive populations of apes can obscure the very real differences that may exist both in their prior experiences and their current captive contexts.

Research Must Focus on Improving Animals' Psychological Status

The methodological issues with the work by Ferdowsian and colleagues limit the study's utility in assessing the impact of captivity on apes. However, it is critical for comparative psychologists to assess the influence of the captive environment on the psychological health of their study populations. Ferdowsian et al. (2011) focused on comparing different populations of animals (some captive and some wild). While these types of comparisons are important for identifying group-level differences, they do not allow researchers to disentangle the impact of current conditions versus past rearing history. For example, apes currently receiving a high standard of care in American, European or Japanese sanctuaries may nonetheless exhibit behavioral deficits resulting from previous long-term care in biomedical facilities. An alternative approach is to compare the same population before and after a change in human management practices. That is, how can we shift management practices to foster the long-term psychological health of captive animals? This approach prioritizes identifying substantive changes that can improve the living conditions of animals. It can therefore be used to assess welfare in animals already in captivity, for example by comparing measures of psychological health in apes before and after they have been transferred to a sanctuary. Importantly, this approach can also be used to assess how changes in human practices can positively impact wild apes, who are also negatively influenced by human activities in some ways. Here, we outline the research we envision as an alternative to the approach taken by Ferdowsian et al. (2011).

We first examine how this approach has been used in captive settings. Current evidence suggests that retiring biomedical apes to sanctuaries substantially improves their welfare—despite the fact that these apes may have experienced extended periods of deprived physical and social living conditions. For example, Chimp Haven in Louisiana serves as the United States' national chimpanzee sanctuary, where former research, pet, and entertainment chimpanzees have been retired. While many of these animals had lived in restricted social and physical environments for years, the efforts of the Chimp Haven staff have successfully introduced chimpanzees into new, more complex social groups (Fultz, Brent, & Panu, 2006; Fultz, Orchard, & Brent, 2007). In addition, chimpanzees at Chimp Haven have begun to exhibit a suite of natural behaviors in their outdoor habitat, including making nests, foraging on vegetation, and using tools such as fishing for ants and termites (Amy Fultz, personal communication; Fultz & Brent, 2008). Other sanctuaries have shown improvements in behavioral and stress profiles when chimpanzees are permanently retired from biomedical research (Reimers, Schwarzenberger, & Preuschoft, 2007).

However, it is important to note that apes may exhibit aberrant behaviors even in enriched sanctuary settings, because these are entrenched behavioral patterns retained from earlier deprived conditions (Fultz & Brent, 2008, 2010; Fultz, Brent, & Loeser, 2010). This does not in any way mean that their current environment has a *causal role* in the emergence of those aberrant behaviors. Thus, comparisons of apes before and after their introduction to new, more enriched environments can help identify the best way to care for apes' psychological health across different types of environments. That is, research must account for both previous life experiences as well as any behavioral changes that apes experience at a sanctuary (Brent & Fultz, 2007). This approach can help to distinguish between responses to current captive settings and long-term impact of past events (such as early rearing history or orphaning) to identify the features that make up highest-quality captive care settings. For example, African sanctuary apes have overall lower rates of aberrant behavior than other captive populations (Wobber & Hare, 2011), likely resulting at least in part from their normal early mother rearing experiences in the wild. However, there has been little systematic study of the changes in the psychological status of individuals once they enter the sanctuaries. Some individuals in African sanctuaries have faced more deprived conditions or lived as a pet for a longer period before arrival than others. This may result in more behavioral abnormalities in those individuals upon arrival at the sanctuary. How does the care provided by the sanctuary impact these apes' psychological and health status, and how can these individuals be rehabilitated to most effectively provide them with rich social and physical environments? As the number of orphans in African ape sanctuaries continues to grow, many sanctuaries are at or reaching capacity, so this will be a critical problem for the future. Furthermore, as the majority of African chimpanzee sanctuaries are pursuing wild release projects (Faust et al., 2011), these type of data could help assess the best rearing strategies and most psychologically healthy individuals for such projects.

Finally, the approach by Ferdowsian and colleagues (2011) obscures the fact that wild apes also experience traumatic events. Some of these traumas—such as injury from conspecific aggression, serious illness, falls from trees, and orphaning of dependent offspring—are risks that wild apes naturally face. However, wild

apes also face traumatic injury or death that is caused by humans (Carter, Pontzer, Wrangham, & Peterhans, 2008; Jurmain, 1989). For example, 10 of 11 chimpanzees with limb injuries studied at Budongo forest, Uganda—including claw hands and missing digits or entire limbs—appear to be the result of snares set by poachers (Waller & Reynolds, 2001). Previous observations of bonobos at Wamba, DRC suggest that almost 50% of adult bonobos have limb abnormalities (Kano, 1984), and many of the injuries are likely attributable to snares (such as missing hands, feet, or digits). While the physical impact of such injuries has been documented, it is currently unclear whether these events have *psychological* ramifications as well. Anecdotal data on the behavior of wild apes undergoing other traumatic events, such as maternal abandonment, suggest that they may show signs of psychological distress (Hiraiwa-Hasegawa & Hasegawa, 1988). Thus, more systematic study of the psychological impact of other types of traumatic events could be useful in combating practices such as the use of snares and traps that continue to maim wild apes. Moreover, by measuring the behaviors and physiological signatures associated with this type of trauma, we can better understand how chimpanzees exhibit stress in ecologically relevant contexts. This will then help us understand how chimpanzees, and other apes, have evolved to deal with stress. This type of information can inform both wild conservation strategies, as well as captive care and management.

Conclusions: The Future of Ape Psychological Health

We believe that the methodological problems in Ferdowsian (2011) limit the article's usefulness in understanding the psychological health of captive and wild apes. However, we do agree with their overall message: the lives of wild apes should be the benchmark that all captive care practices strive to meet. In particular, we follow the recommendations of Pruett and McGrew (2001) that the care practices used in captivity should be based on the living conditions of wild apes. Those authors' "top 10" suggestions for care focus on both enriched social conditions (such as the ability to fission-fusion, to form partnerships and rivalries, and to engage in extended mother-offspring contact), as well as enriched physical conditions (ability to travel and move in three-dimensional environments, access to resources for foraging, and sites for elevated nesting at night). Many of these recommendations focus on giving captive apes the control over their environment that wild apes already have: deciding where to be, what and when to eat, and with whom to interact. Importantly, overwhelming data suggest that animals and humans alike desire control, such that some researchers have even declared it to be a fundamental biological drive on par with the need for food and water (Leotti, Iyengar, & Ochsner, 2010).

However, captive contexts vary in how well they currently meet these requirements. African sanctuaries are generally successful at meeting most of these high standards: many of these recommendations—such as mixed social groups and access to tropical rain-forest environments—are routine aspects of captive care in African sanctuaries. Many zoos and sanctuaries in the United States, Europe, and Japan also prioritize placing apes in complex social groups and giving them access to more rich, naturalistic environments. Indeed, recent studies of cognitive abilities have revealed that captive apes living in zoos and sanctuaries can display incredibly sophisticated skills across many domains—including social cognition, physical reasoning, tool use, and planning (Tomasello &

Call, 2008). While it is impossible to conduct similar studies in the wild, current data suggest that many of the rich natural behaviors observed in wild chimpanzees are supported by the complex skills that psychologists can test in captive contexts. However, not all laboratory, pet, or other captive environments necessarily prioritize the types of social and physical environments that foster psychological health in nonhuman primates. Thus, the future challenge for researchers is to continue to identify what aspects of captivity impact the psychological (and physical) health of apes, as well as to assess the types of changes that can be made to current captive contexts to further improve apes' health. As a majority of comparative research on cognition is conducted with captive animals, addressing these types of questions is vital for the field as a whole.

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