Published in final edited form as:

Horm Behav. 2008 August ; 54(3): 480–481. doi:10.1016/j.yhbeh.2008.05.014.

Determining preference requires measuring preference

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Children's preferences for gender-specific toys have spawned an industry of pink and blue aisles in toy stores and the difference in preference between boys and girls have been argued to show how behavioral gender differences arise from socialization. Studies of girls exposed prenatally to elevated levels of prenatal androgens resulting from hypersecretion of adrenal androgens (CAH) have found that despite being reared as girls, they exhibit masculine patterns of toy preference (Berenbaum & Hines, 1992; Meyer-Balburg, et al., 2004; Pasterski, et al., 2005) suggesting that androgen exposure, in addition to socialization processes, influences toy preferences.

In this context, Alexander and Hines' (2002) finding that male and female vervet monkeys showed sex-differentiated patterns of play with human gendered toys broke significant new ground and altered the discussion of toy preference development. When these data were first presented at a meeting of the International Academy of Sex Research, they were met with surprise and great interest. That monkeys showed sex differences in patterns of interaction with human gender-stereotyped toys similar to those seen in humans, strongly supported the notion that gendered preferences in toys could arise without explicit socialization. Prior to Alexander and Hines' (2002) work, few would have imagined that monkeys would differentiate between human toys by sex and that some monkey patterns of toy interaction would mirror patterns seen in humans. Our study, upon which Alexander and Hines (2008) now comment, resulted directly from their pioneering work.

While the Alexander and Hines (2002) study was revolutionary it differed significantly from human studies and our study, in both its design and findings. The primary design difference is that human studies used a preference paradigm, whereas Alexander and Hines used a serial introduction of single toys and inferred preference by the relative proportion of interaction on different tests. As they note in their study "... the serial introduction of the toys does not permit a true contrast of the relative preference for 'masculine' over 'feminine' toys within each sex ..." (Alexander & Hines, p. 472, 2002) Thus, their measure of proportion of time interacting with each toy is at best a proxy for preference and only as good as control of variables between test conditions and within subjects. Hines and Alexander contend that serial introductions provide as a clear measure of preference as does an actual choice test. They offer an analogy to their proportion measure suggesting that if a banquet contains mango on one day and pineapple on another among many other items, that a subject who eats more mango than pineapple shows that they prefer mango over pineapple. One could make this inference from such data. However, with a single trial per toy per subject on independent tests, preference is neither the only inference which could be drawn, nor necessarily the most accurate. For

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example, Hines and Alexander's hypothetical consumption data could reflect that the subject preferred fruit to other banquet items on the mango day, but mango was the only fruit offered. Alternatively, the subject might have eaten fruit the night before the pineapple trial and now had less overall interest in fruit when presented with pineapple in the banquet. It is not possible when using a serial introduction procedure, unless internal and external conditions are exactly matched, to conclude anything definitive about preference. There are far too many uncontrolled variables to argue convincingly that proportional differences reflect preferences and not changes in the environment, the subject, or a myriad of other variables which might differ between tests. The lack of an explicit preference test in the Alexander and Hines' (2002) study led us to directly assess preference as is done in human studies. We were also motivated by the differences between Alexander and Hines' (2002) findings and those reported in children.

Hines and Alexander stress that there are 4 potential sex differences to be evaluated in studies of sex differences in toy preference. They illustrate this with significant findings in humans for all four potential differences using data from Pasterski and colleagues (2005) which they have access to, but which the reader does not. They further contend that their vervet study found three of the four significant differences found in Pasterski and colleagues (2005), whereas we found only two of the four significantly different in our study. As Hines and Alexander appreciate, not all four sex differences are consistently found in all human studies. However there is one sex difference that is found in all of the studies of human sex differences in toy preference we have both cited; that males significantly prefer masculine toys over feminine toys. Other sex differences are found in some studies, but not in others, except for this marked male preference for male-typical toys over female-typical toys. Yet it is exactly this sex difference that Alexander and Hines did not find, as vervet "... males had similar percent contact with 'masculine' and 'feminine' toys, $P=.19$ ", (Alexander and Hines, p. 472, 2002). Their finding contrasts markedly to what is seen in humans, or in our rhesus monkey preference study.

This difference struck us as particularly interesting given how consistently the male preference for male over female toys is found in human studies. Accepting for the moment Alexander and Hines' (2002) proxy for preference as a measure of preference, their failure to find this consistent human sex difference in vervets is of particular importance. It could reflect species differences, but we suspect that it more likely reflects that they did not use a preference paradigm. Clearly the only way to resolve this would be to test vervets with a preference paradigm, which was not possible, so we did the next best thing and used a preference paradigm with our rhesus monkeys. While our results cannot eliminate the possibility that the difference between rhesus and vervet monkeys reflects a species difference, they do show that a consistent sex difference found in humans is also found in a nonhuman primate when a preference paradigm is used. We think this of some importance as it parallels the core finding in humans that males are much more strongly sex-typed in their toy preferences than are females. The meaning of Alexander and Hines' exactly opposite findings, with female vervets showing more strongly sex-typed interactions with toys than did males remains unclear due to the marked differences between their methodology and that used in our study and in human studies.

As Hines and Alexander point out in their letter, both lab's studies used group presentation of stimuli instead of presentation to individuals as in human studies. However, this is unlikely to be a critical difference as we produced clearly comparable results to those reported in humans using group presentation.

We agree with Hines and Alexander that our two studies make the case that sex differences in interaction with gender stereotyped toys can develop without having to resort to a socialization explanation. We suspect that this is the same in humans too as suggested by results from CAH girls. One lesson of these studies would seem to be that if one desires to determine preference,

then one should employ methods that can directly assess preference and not rely upon inferential methods that leave many variables uncontrolled. Future studies will hopefully discover what it is in the nature of gender-stereotyped human toys that appeal differentially to male and female monkeys.

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