Noname manuscript No.
(will be inserted by the editor)

Lactamotion:

Postpartum mobility in northwestern Namibia

Layne Vashro

Received: date / Accepted: date

Abstract Insert your abstract here. Include keywords, PACS and mathematical subject classification numbers as needed.

Keywords First keyword · Second keyword · More

1 Introduction

Researchers consistently find differences between men and women in spatial-cognitive and navigational tasks, as well as measures of traveling range. These differences are well-documented in Western industrialized societies and have increasingly been replicated cross-culturally (cite cite cite). Evolutionary psychologists have put forward several distinct theories that link the sex differences across these traits into a single cohesive story. In most of these theories, past selection favored the males who were better at traveling long distances and into unknown environments and this required superior navigation ability and the spatial-cognitive traits that facilitate it. The key point of disagreement among these arguments is simply the presumed payoff of that travel (mates (cite), hunting (cite), or warfare (cite)?). However, one explanation for the sex differences in ranging, spatial cognition, and navigation ignores the payoffs to males and instead turns the focus on the fitness ramifications of women's long-distance mobility. This "fertility and parental care hypothesis" put forward by [**?**] argues that the observed sex differences can be explained in terms of the potential costs to women traveling, particularly during key period of reproduction.

L. Vashro
270 South 1400 East, Salt Lake City, UT 84112
Tel.: +001 (801) 581 6251
E-mail: layne.vashro@anthro.utah.edu

1.1 Fertility and parental care

The idea of risky males and risk-averse females has been broadly applied in the evolutionary literature.

Winner takes all... Decreased infant survival [**?**,**?**]

Discuss Cambell... Mobility especially in the form of travel outside of one's home range, seems a particularly appropriate topic for applying this heuristic.

Female Gorillas (Gorilla gorilla gorilla) avoid transfers when they have infants [**?**,**?**]. Female Chimpanzees (Chimpanzee chimpanzee) typically disperse from their natal home when they reach reproductive maturity then never make a secondary transfer. However, the threat of attacks from out-group males is a danger to females with dependent offspring travel the periphery of their home region. [**?**,**?**] (cite others also)

Particular issues. Cambell and "staying alive"... segue into issues of infanticide and rape... Caloric expenditure

Mechanism: i.e. mediated by estrogen and probably other stuff.

Much of this evidence comes from hormones...

Looking across the entire life-cycle, it is true that women's estrogen level rise as they enter reproductive maturity (is this tru?), and fall after menopause. This lines up with the theory linking decreased mobility as a risk reduction strategy that is mediated by estrogen. However, looking within women of reproductive age the pattern of estrogen cycles is more difficult to link with at least a simple version of risk reduction. The problem is that women's estrogen level drop post-partum. The team between birth and weaning is likely *the* time when the concerns highlighted by the fertility and parental care hypothesis should be most important. Instead, at least among mice, this period is associated with improved performance in maze tasks ans increased range (nest visits?... check this).

1.2 Expectations

The fertility and parental care hypothesis makes several assumptions about the relationship between demographics and life history and cognition and mobility. In many instances these assumptions are consistent with the observed pattern in Western industrialized nations, but have not been substantiated in natural fertility populations, or societies where mobility demands are more consistent with those humans faced throughout most of their evolutionary history.

1) Women should be less mobile and perform worse in spatial cognition tasks than men, and this difference should be particularly pronounced during peak years of fertility. 2) Women's mobility

2 Methods

2.1 Population

This study includes all women living in the *Ovizorowe* mountain valley in northwestern Namibia. This sample includes mostly members of the Twe ethnic group who live in several villages dispersed throughout the valley, as well as women from some Himba and Tjimba communities bookending the valley.

Text with citations [2] and [1].

2.2 Mobility interviews

Participants were asked to name each place they traveled to and spent the night in the past year. In addition, they were asked who they traveled with, who they stayed with, and why they made the trip. These data were used to create two highly-correlated measures of annual range size. 1) The number of unique places visited in the past year, and 2) the number of kilometers needed to visit each place visited in the past year. In addition, the analysis is able to discriminate between pair, group, and unaccompanied travel, and identify patterning in the function of travel.

2.3 Spatial cognition

This study includes four different measures of spatial cognition: Mental rotation, Corsi blocks, real-world distant pointing accuracy, and a perspective-taking task (check whether performance is good enough to seriously include).

2.3.1 Mental rotation

This task was administered on an N-inch touch-screen computer. Participants are shown a screen with two cartoon bodies, one with a left and the other with a right hand outstretched and each rotated on a two-dimensional axis. The participants are also shown a third figure on the (bottom?) oriented perfectly vertical with either a left or right hand outstretched. The participant is then asked to indicate which of the two rotated bodies is the same as the third. Performance is measured both in accuracy across N trials and response time.

This task was readily understood by most participants, but not all...

2.3.2 Corsi blocks

This task was also administered on an N-inch touch-screen computer. Participants are shown a screen with N ? colored squares on a black background. The participant was asked to watch as blocks are highlighted in a set sequence and then asked to touch the same squares in the same order. The first two

iterations required participants to recall a two-block sequence, the next two iterations required participants to recall a three-block sequence... and so on until the participant failed on two consecutive trials. (make sure "two" is correct here and it isn't actually three).

Participants had minimal trouble understanding this task. In several cases, the participant's fingers were too calloused to use the touch screen and instead they indicated for the experimenter to touch on their behalf. This does not appear to have impacted the results (is this true?)

2.3.3 Perspective taking

2.3.4 Pointing

The researcher named a distant location and the participants rotated a Brunton compass mounted on a tripod until it indicated the bearing to that location, to the best of their knowledge. This process was repeated for ten known locations ranging from 10km to 140km (recheck these figures). In addition to collecting the bearing indicated by participants, the researcher also asked when was the last time the participant had visited each place, and whether they had been there "once", "a few times", or "many" throughout their lives. For the analysis, participants' bearing was compared to actual bearing based on GPS coordinates from the point-of-origin and targeted locations.

Participants were tested at N different locations. This creates a problem for comparing pointing accuracy because the varying points-of-origin results in a different task for each participant. In addition, not all participants were comfortable pointing to all of the locations. Some of the locations had not been visited by all participants, and you cannot point to a location you do not know. To account for both of these issues, I analyzed the data across each pointing event while treating the individuals as random effects. This allowed me to estimate a "distance" effect, which was then applied to each pointing event to create difficulty-adjusted measures of accuracy that could then by averaged for each individual creating a single measure of each participant's pointing accuracy.

2.4 Analysis

The cognitive measures included in this task were heavily adapted to suit the unique challenges of working in the field with a population with minimal exposure to computers or any form of schooling. However, the tasks still ask participants to overcome a great deal of novelty in understanding the tasks and in many cases participants are unable to demonstrate comprehension before proceeding, or perform at a level low enough to indicate they did not understand. We include a missing data table (see Table 1) to help document how these cases of "Missing Not At Random" (cite Rubin) distribute across the relevant demographic categories for reference throughout these results.

Table 1 Missing data table

Mental Rotations					
	Total	Missing	Practice	Performance	Other
Women	64	21	10	7	4
Post-Menopausal	16	11	6	2	3
Reproductive-aged	43	10	4	5	1
Breastfeeding	27	6	2	3	1
Not	21	4	2	2	0
Men	65	11	5	4	2
Corsi Blocks					
	Total	Missing	Practice	Performance	Other
Women	54	16	2	9	5
Post-Menopausal	13	7	2	2	3
Reproductive-aged	41	8	0	7	1
Breastfeeding	22	3	0	3	0
Not	19	5	0	4	1
Men	59	3	1	1	1
Perspective Taking					
	Total	Missing	Practice	Performance	Other
Women	64	35	33	0	2
Post-Menopausal	16	12	0	11	1
Reproductive-aged	48	22	0	22	0
Breastfeeding	27	12	0	12	0
Not	21	10	0	10	0
Men	65	13	12	0	1

3 Results

Your text comes here. Separate text sections with

3.1 Sex Differences

3.1.1 Cognition and Navigation

Men responded more accurately in the mental rotation task, averaging 89.3% correct responses compared to 82.7% correct for women (see Table 2). However, men responded slightly slower to the mental rotation stimuli than women (5.9 seconds compared to 5.6 seconds on average), but this difference is not statistically significant (see Table 2). Men also made significantly smaller errors than women in both the perspective taking task, missing the correct bearing by an average of 43.6° compared to 55.1° for women (see Table 2). Men similarly outperformed women in the pointing task, our measure of real-world navigational skill. Men's points diverged from the correct bearing by an average of 15.2° while women missed the target by an average of 19.2°. This difference is statistically significant (see Table 2).

Complicating these findings is the fact that women were consistently more likely to not be included in the sample due to failure to demonstrate understanding in the initial practice phase or perform poor enough to call under-

Table 2 Sex differences (Cognition and navigation)

Task	$M\|F$	Cohen's D	Lower	Upper
MR Accuracy	55|43	0.457*	0.043	0.871
MR Reaction Time	55|43	-0.149	-0.558	0.260
Block Span	56|39	0.225	-0.195	0.644
Perspective Taking	52|29	0.481*	0.108	0.855
Pointing Accuracy	62|57	0.546*	0.071	1.022

All measure are recoded such that a higher score indicates superior performance. Comparisons where the 95% confidence interval does not include 0 are denoted with a "*".

standing into question. This is obviously not data missing at random, and thus biases the results, likely by underrating the strength of the male advantage. This issue is particularly relevant in the case of the Corsi block task. Within the sample passing the threshold for "understanding" men barely outperform women, with an average block span of 3.69 compared to an average of 3.49 for which. However, nine women were dropped due to low scores while only one man was dropped. Reintroducing these sub-two scores only drops the men's average score by 0.05 while women's average drops by nearly half a span to 3.06, resulting in a statistically significant sex difference (Cohen's D = 0.537*).

3.1.2 Anxiety

Twenty-eight men and twenty-seven women responded to the harm avoidance questionnaire, and all but one of the men also responded to the spatial anxiety survey. The average man scored a 2.29 our of 4 on the spatial anxiety scale, while the average woman scored a 2.64 (see Table 3). Both men and women were more likely to choose the more "harm avoidant" responses. Men chose the harm avoidant response 68% of the time while women chose those responses 76% of the time. This difference is not statistically significant.

Table 3 Sex differences (Anxiety)

Task	$M\|F$	Cohen's D	Lower	Upper
Spatial Anxiety	27|27	-0.743*	-1.325	-0.161
Harm Avoidance	28|27	-0.345	-0.905	0.216

3.1.3 Mobility

Forty-two men and forty-five women participated in the annual mobility interview. The sample of men had traveled much more widely than the sample of women. Men spent the night at between zero and twenty unique locations away from home in the past year, with the average man staying at 4.3 different

locations. Women spent the night at between zero and seven unique locations away from home in the past year, with the average woman staying at two different locations. This difference in annual range is statistically significant (see Table **??**).

Two men and five women did not travel to and stay at any locations in the past year, and thus it is not possible to calculate a percentage of trips made without a companion. Comparing the remaining forty men and forty women, a man's trip is nearly twice as likely (46% compared to 24%) to be a solo venture (see Table **??**).

These analyses use data from all 38 participants (20 menand 18 women) who used the GPS trackers to measure daily movement. The average man traveled 8.75 kilometers each day, which is slightly more than twice as far as the average woman at 4.38 kilometers per day (see Table **??**). Men's daily travel ranged from 0.88 kilometers to 22.4 kilometers, while women's daily travel ranged from .64 to 11.23 kilometers.

Table 4 Sex differences (Mobility)

Task	$M\|F$	Cohen's D	Lower	Upper
Visits	42|45	0.725*	0.280	1.171
Solo	40|40	0.586*	0.125	1.046
Daily	20|18	1.000*	0.280	1.720

3.2 Post-menopausal effects

3.2.1 Cognition and Navigation

The set of women above includes forty-three women of reproductive age and sixteen post-menopausal women. As noted above, women in general failed to demonstrate understanding more often than men. This problem was particularly acute among older women (see Table 1). Despite the resulting problematically small sample of post-menopausal women, there do appear to be some noteworthy patterns in the comparison with reproductive-aged women.

Table 5 Menopausal effect (Cognition and navigation)

Task	$M\|F$	Cohen's D	Lower	Upper
MR Accuracy	38|5	-0.384	-1.372	0.604
MR Reaction Time	38|5	-1.280*	-2.306	-0.253
Block Span	33|6	-1.125*	-2.088	-0.163
Perspective Taking	26|3	0.058	-1.238	1.355
Pointing Accuracy	43|14	0.188	-0.441	0.816

Post-menopausal women scored slightly worse than reproductive-aged women (77.1% compared to 83.4%) on the mental rotation task though the 95% confidence interval around the Cohen's D statistic does not exclude 0. However, the reproductive-aged women responded 28% quicker than the post-menopausal participants (5.40 compared to 7.46 seconds on average). Even given the limited sample, this difference appears to be meaningful, as does reproductive-aged women's superior ability in the Corsi blocks task (see Table 5). Post-menopausal women averaged 2.67 in the Corsi blocks task, nearly an entire span below the reproductive aged women's average score of 3.64. There does not appear to be a meaningful difference between the two groups in the perspective taking task or the pointing accuracy task.

The structure of the missing data also carries important information about potential differences between reproductive-aged and post-menopausal women. A large fraction of post-menopausal women were not included in the cognitive analyses because they did not demonstrate understanding of the tasks. Looking across the mental rotation, Corsi block, and perspective taking tasks, 61.5%, 40%, and 73% of post-menopausal women with sufficient vision were dropped for this reason compared to only 21.4%, 17.5% and 45.8% of reproductive-aged women (see Table 1). This limited understanding may be a function of some cognitive feature(s) unrelated to the spatial cognitive abilities in question, however, to whatever extent the traits of interest help explain their omission these results understate the difference between reproductive-aged and post-menopausal women's spatial cognition.

3.2.2 Anxiety

Post-menopausal women averaged only 2.45 on the spatial anxiety scale, lower than the average of 2.72 for reproductive-aged women and above the average score for men reported above. The sample only included nineteen reproductive-aged women and eight post-menopausal women, which leaves too much uncertainty for the 95% confidence interval around the Cohen's D to exclude zero. There does not appear to be any difference between these two groups in responses to the harm-avoidance scale.

Table 6 Menopausal effect (Anxiety)

Task	$M\|F$	Cohen's D	Lower	Upper
Spatial Anxiety	19|8	-0.773	-1.705	0.159
Harm Avoidance	19|8	0.019	-0.883	0.92

3.2.3 Mobility

What differences we find between post-menopausal women and reproductive-aged women in terms of annual visiting and propensity to travel alone are too

small to draw much interest given the small sample of only ten older women. Among the three post-menopausal women to participate in the daily task, one recorded the highest average travel of all eighteen women included in the study (11.22 km), while the other two older women averaged a kilometer more daily travel than the average of the reproductive-aged women (4.97 km compared to 3.85 km). A larger sample is clearly needed, but these initial findings are intriguing.

Table 7 Menopausal effect (Mobility)

Task	$M\|F$	Cohen's D	Lower	Upper
Visits	35|10	-0.341	-1.085	0.402
Solo	30|10	0.390	-0.374	1.154
Daily	15|3	1.361	-0.161	2.882

3.3 Post-partum effects

3.3.1 Cognition and Navigation

There do not appear to be any compelling differences in performance on the cognitive measures among reproductive-aged women that are explained by post-partum status at the time of testing. There are also no noteworthy differences in the patterning of missing data.

Women who had a dependent breastfeeding child during the time of testing managed to point to distant locations more accurately than those who were not (16.7° error compared to 21.4° error). However, the 95% confidence interval around the Cohen's D includes the possibility of no real difference.

Table 8 Post-partum effect (Cognition and navigation)

Task	$BF\|NBF$	Cohen's D	Lower	Upper
MR Accuracy	21|13	0.039	-0.641	0.719
MR Reaction Time	21|13	-0.032	-0.712	0.648
Block Span	18|11	-0.064	-0.800	0.672
Perspective Taking	15|8	-0.004	-0.857	0.848
Pointing Accuracy	24|14	0.470	-0.174	1.114

3.3.2 Anxiety

The average post-partum woman scored a 2.83 on the spatial anxiety measure compared to 2.54 for the other reproductive-aged women. We found no similar difference in the harm avoidance scale.

Table 9 Post-partum effect (Anxiety)

Task	$M\|F$	Cohen's D	Lower	Upper
Spatial Anxiety	12|7	1.246*	0.083	2.409
Harm Avoidance	12|7	0.276	-0.790	1.342

3.3.3 Mobility

Post-partum women reported visiting 2.8 locations in the past year, which is more than twice as many as women without young dependents who visited 1.27 locations. These trips were no less or more likely to be made without company.

Table 10 Post-partum effect (Mobility)

Task	$M\|F$	Cohen's D	Lower	Upper
Visits	20|15	0.972*	0.214	1.730
Solo	19|11	0.111	-0.693	0.915
Daily	8|7	-0.057	-1.259	1.144

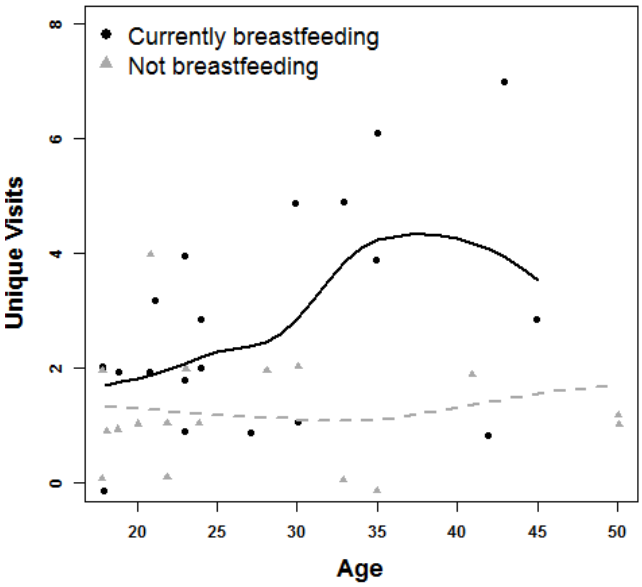

Fig. 1 Please write your figure caption here

4 Discussion

Comparing reproductive-aged women living in the *Ovizorowe* Valley with and without nursing depends highlights interesting differences in both cognition and mobility. Breastfeeding women performed better across our measures of spatial cognition (excepting the perspective-taking task), which is consistent with expectations based on the decline in estrogen associated with the postpartum period. In addition, breastfeeding women were more mobile, traveling to more unique locations and covering more ground in doing so than their peers who were without an unweaned child over that period of time. This increase in mobility may also be consistent with the down-tick in estrogen and improved spatial cognition from the perspective of several theories linking spatial cognitive ability to distant ranging.

These findings simultaneously support the patterns of cognition and behavior anticipated by the fertility and parental care hypothesis while complicating the interpretation with the fact that women are most mobile exactly when it seems least likely from the perspective of minimizing risk to offspring.

Why would it be beneficial for women to range further when they have unweaned children? One study among conducted among a nearby Himba population (Scelza) showed women traveling the most to visit their mothers during periods of peak childcare need. This seems an appealing answer to this situation as well, however, most of these women were actually moving *away* from their mothers (is this true??) as a much greater fraction of this population lives matrilocally. In addition, none of the women explicitly cited visiting their mother. Several other alternatives... 1) "Facebook" effect... "Look at the baby, look at the baby"... making connections to relatives who may be called on in future times of need. 2) Rape deterred... then what about pregnancy?? Don't like this.

Interested in future work looking at the volume and function of women's postpartum mobility in other populations, including the US.

Text with citations [2] and [1].

References

1. Author, Article title, Journal, Volume, page numbers (year)
2. Author, Book title, page numbers. Publisher, place (year)