Lactamotion:

Postpartum mobility in northwestern Namibia

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

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.

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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.

3 Results

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The initial sample of 48 participants (40 reproductive aged and eight post-menopausal) was pared down at several stages before beginning analysis of mental rotation performance. An additional two reproductive-aged women (ID: 13, 19) and three post-menopausal women (ID: 9, 38, 77) were unable to complete the task due to vision impairment. An additional one post-menopausal women (ID: 78, 79) were unable to move beyond the practice stage and thus recorded no score on the task. Finally, seven reproductive aged women (ID: 25, 26, 61, 75, 98, 99, 116) and two post-menopausal women (ID: 63, 103)

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

Pointing task	Total	Missing	Practice	Performance	Other
Women	58	1	0	0	1
Post-Menopausal	15	1	0	0	1
Reproductive-aged	43	0	0	0	0
Breastfeeding	24	0	0	0	0
Not	19	0	0	0	0
Men	62				1

who did complete the task had their scores dropped because they failed to exceed RANDOM?? performance and thus did not appear to understand the task.

3.1 Sex Differences

The study enrolled 129 participants in total, with 65 men and 64 women.

3.1.1 Cognition and Navigation

In order to make scores easier to compare, all measure are re-coded such that a higher score indicates better performance on the task.

Mental Rotation The initial sample of 129 (65 men and 64 women) participants was pared down at several stages before beginning analysis of mental

Table 2 Sex differences (Cognition and navigation)

DV	$M|F$	Std. β	Std. Err
Acc	55|43	.448*	.200
RT	55|43	-.149	.204
Span	56|39	.224	.208
Persp	52|29	.531*	.225
Point	62|57	.470*	.180

rotation performance. Two men (ID: 22, 85) and four women (ID:9, 38, 77, 91) were unable to complete the task due to vision impairment. An additional five men (ID: 21, 33, 107, 111) and ten women (ID: 34, 44, 61, 63, 71, 75, 78, 79, 99, 103) were unable to move beyond the practice stage and thus recorded no score on the task. Finally, four men (ID: 16, 20, 76, 83) and seven women (ID: 1, 5, 11, 26, 42, 94, 118) who did complete the task had their scores dropped because they failed to exceed random performance and thus did not appear to understand the task.

As expected based on work in Western populations, previous work among the Twe, and the fertility and parental care hypothesis, men's responses in the mental rotation task were more accurate than women's.

Corsi Blocks The initial sample of 107 participants (59 men and 53 women) was pared down at several stages before beginning analysis of mental rotation performance. One man (ID: 85) and five women (ID: 9, 13, 38, 77, 91) were unable to complete the task due to vision impairment. An additional one man (ID: 111) and two women (ID: 78, 79) were unable to move beyond the practice stage and thus recorded no score on the task. Finally, one man (ID: 24) and nine women (ID: 25, 26, 61, 63, 75, 98, 99, 103, 116) who did complete the task had their scores dropped because they failed to exceed RANDOM?? performance and thus did not appear to understand the task.

There is no significant difference between Twe men's and women's performance on the Corsi Block task (see table). However, this lack of finding is dependent on the decision to remove all participants who scored below two on the task. If we instead work from the assumption that these participants did in fact understand the task but simply performed extremely poorly, there is a strong sex difference (report stats).

Perspective Taking One woman (ID: 38) and one man (ID: 85) were unable to complete the task due to vision impairment, and another woman abstained from the task because she was scared of the toy cheetah (ID: 42). An additional 12 men (ID: 22, 24, 32, 40, 46, 65, 76, 84, 95, 107, 111, 114) and 33 women (ID: 3, 4, 8, 9, 11, 13, 25, 26, 31, 34, 37, 45, 49, 61, 63, 67, 71, 74, 75, 77, 78, 79, 86, 93, 94, 99, 103, 104, 105, 108, 109, 116, 126) were unable to move beyond the practice stage and thus recorded no score on the task.

Men performed significantly better on this task than women (see table), making smaller errors in setting the dial.

Table 3 Sex differences (Anxiety)

DV	$M|F$	Std. β	Std. Err
SAX	27|27	-0.745**	.255
HA	28|27	.-0.357	.268

Table 4 Sex differences (Mobility)

DV	$M|F$	Std. β	Std. Err
Visits	42|45	.685**	.203
Solo	40|40	.565**	.216
Daily	20|18	.902**	.293

Pointing Accuracy One woman (ID: 38) and one man (ID: 85) were unable to complete the task due to vision impairment, and three men (ID: 2, 6, 112) and six women (ID: 1, 3, 4, 5, 7, 8) were unable to participate because the apparatus was unavailable at the time of their testing.

Three locations were dropped from the list because the majority of participants were not comfortable enough with their knowledge of the location to confidently indicate its bearing. We arrived at a participant specific pointing accuracy score by averaging the error (i.e. difference between indicated and actual bearing to the location) across all attempted points.

Men pointed significantly more accurately to distant locations than women.

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.

Men recorded significantly lower scores on the spatial anxiety survey... Not on the harm avoidance...

3.1.3 Mobility

Forty-two men and forty-five women participated in the annual mobility interview. We are unable to calculate the percentage of trips made alone for two of those men and five of those women because these individuals did not spend the night anywhere outside their home village in the past year. Twenty men and eighteen women carried trackers to measure daily movement.

3.2 Fertile vs. non-fertile women

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Table 5 Menopausal effect (Cognition and navigation)

DV	$Fert|Post-fert$	Std. β	Std. Err
Acc	38|5	-.386	.478
RT	38|5	-1.194*	.444
Span	33|6	-1.053*	.415
Persp	26|3	.059	.621
Point	43|14	.189	.309

3.2.1 Cognition and Navigation

The set of women above includes forty-three women of reproductive age and sixteen post-menopausal women.

Mental Rotation The initial sample of 59 participants was pared down at several stages before beginning analysis of mental rotation performance. One reproductive-aged woman (ID: 91) and three post-menopausal women (ID: 9, 38, 77) were unable to complete the task due to vision impairment. An additional four reproductive-aged women (ID: 44, 61, 75, 99) and six post-menopausal women (ID: 34, 63, 71, 78, 79, 103) were unable to move beyond the practice stage and thus recorded no score on the task. Finally, five reproductive-aged women (ID: 1, 5, 26, 94, 118) and two post-menopausal women (ID: 11, 42) who did complete the task had their scores dropped because they failed to exceed random performance and thus did not appear to understand the task.

The post-menopausal ... 61.5% of the women in the initial post-menopausal set were unable to pass out of either the practice set or perform above chance on the actual task, compared to 21.4% of reproductive-aged women having similar issues. This may be a sign of weakened spatial-cognitive ability, but it could also be due to some other factor.

Corsi Blocks The initial sample of 48 participants (40 reproductive aged and eight post-menopausal) was pared down at several stages before beginning analysis of mental rotation performance. An additional two reproductive-aged women (ID: 13, 19) and three post-menopausal women (ID: 9, 38, 77) were unable to complete the task due to vision impairment. An additional two post-menopausal women (ID: 78, 79) were unable to move beyond the practice stage and thus recorded no score on the task. Finally, seven reproductive aged women (ID: 25, 26, 61, 75, 98, 99, 116) and two post-menopausal women (ID: 63, 103) who did complete the task had their scores dropped because they failed to exceed RANDOM?? performance and thus did not appear to understand the task.

Perspective Taking One post-menopausal woman (ID: 38) was unable to complete the task due to vision impairment, and another woman abstained from the task because she was scared of the toy cheetah (ID: 42). An additional 12

Table 6 Menopausal effect (Anxiety)

DV	$Fert|Post-fert$	Std. β	Std. Err
SAX	19|8	-.740.	.404
HA	19|8	.019	.430

Table 7 Menopausal effect (Mobility)

DV	$Fert|Post-fert$	Std. β	Std. Err
Visits	35|10	-.342	.359
Solo	30|10	.389	.365
Daily	15|3	1.240*	.574

men (ID: 22, 24, 32, 40, 46, 65, 76, 84, 95, 107, 111, 114) and 33 women (ID: 3, 4, 8, 9, 11, 13, 25, 26, 31, 34, 37, 45, 49, 61, 63, 67, 71, 74, 75, 77, 78, 79, 86, 93, 94, 99, 103, 104, 105, 108, 109, 116, 126) were unable to move beyond the practice stage and thus recorded no score on the task.

Pointing Accuracy One woman (ID: 38) and one man (ID: 85) were unable to complete the task due to vision impairment, and three men (ID: 2, 6, 112) and six women (ID: 1, 3, 4, 5, 7, 8) were unable to participate because the apparatus was unavailable at the time of their testing.

3.2.2 Anxiety

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3.2.3 Mobility

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3.3 Fertile women with/without young dependents

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3.3.1 Cognition and Navigation

Your text comes here. Separate text sections with

3.3.2 Anxiety

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Table 8 Post-partum effect (Cognition and navigation)

DV	$BF|NBF$	Std. β	Std. Err
Acc	24|14	.033	.341
Acc.5	21|13	.162	.357
RT	24|14	.037	.341
RT.5	21|13	-.105	.358
Span	21|14	.079	.350
Span2	18|11	-.030	.390
Persp	15|8	.168	.447
Point	24|14	.526	.330

Table 9 Post-partum effect (Anxiety)

DV	$BF|NBF$	Std. β	Std. Err
SAX	12|7	1.082*	.413
HA	12|7	.281	.485

Table 10 Post-partum effect (Mobility)

DV	$BF|NBF$	Std. β	Std. Err
Visits	20|11	1.049**	.328
Solo	19|7	.015	.451
Daily	7|7	-.162	.554

3.3.3 Mobility

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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 post-partum 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.
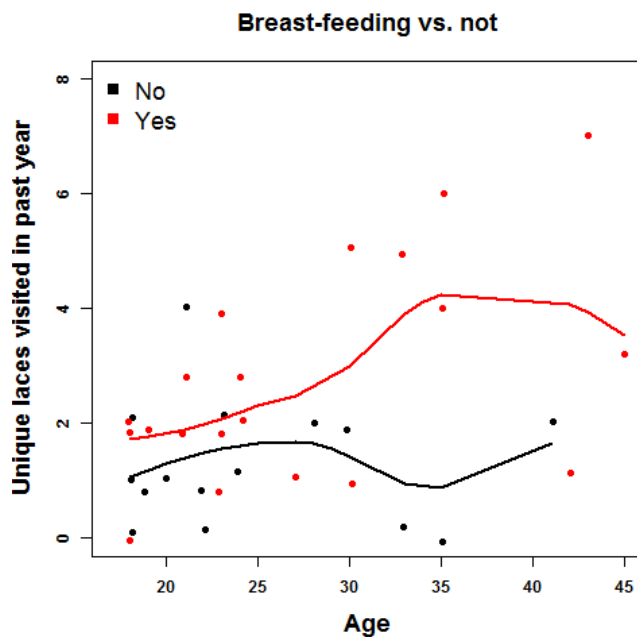
Breast-feeding vs. not

Fig. 1 Please write your figure caption here

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)
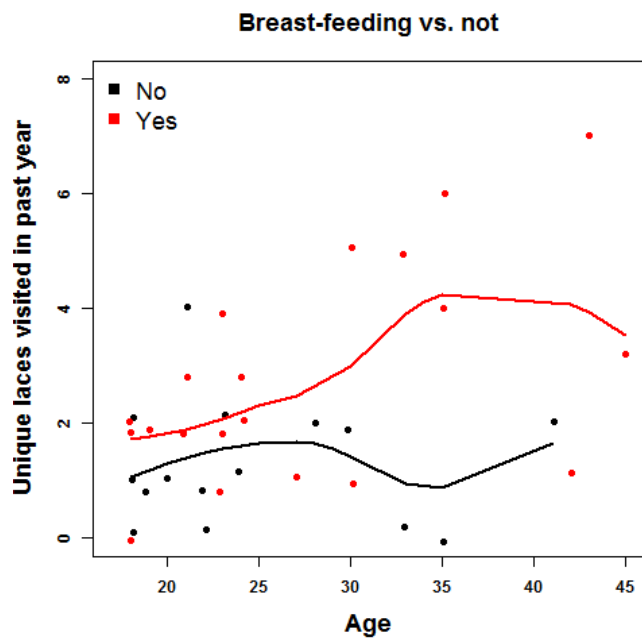2. Author, Book title, page numbers. Publisher, place (year)

Fig. 2 Please write your figure caption here