

GPS TECHNOLOGY AND HUMAN PSYCHOLOGICAL RESEARCH:  
A METHODOLOGICAL PROPOSAL

By

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## STATEMENT BY AUTHOR

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### Abstract:

The following paper is a summary of my experiences working on an Honors Thesis this past year and what I have learned. This will include a brief summary of the project I worked on and a poster of the project. The hypothesis of the project was that depressed people should occupy less space, walk less, and visit fewer places than less depressed people. The results of the project were that spatial activity did not correlate to the measures of depression used. This paper will also discuss future research experiments along with strength and weaknesses in my experience of completing this project.

## Introduction:

*Background.* The current status of GPS (global positioning system) studies within the discipline of psychology is such that while there is extensive use of the technology in animal behavior studies (Sabato, 2006), there is a marked lack of use of this technology in human spatial cognitive research. In cases of animal research, much has been gained through use of GPS, and we believe that employing this technology in human studies would greatly enhance the quality of research to be gained in cognitive studies, especially in relation to hippocampally-activated contextual differences.

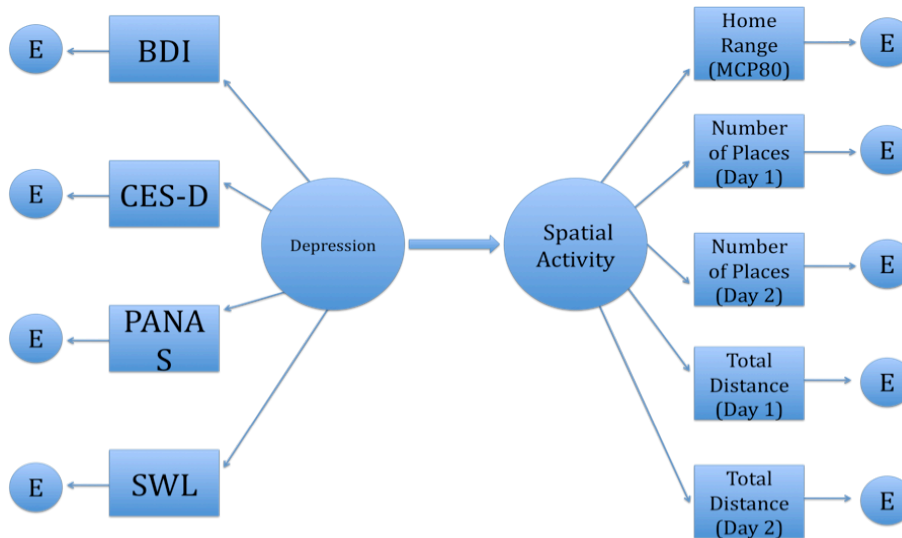
*Purpose and Objectives.* This project is a pilot project intended as an initial test of the external validity of various psychological questionnaires by measures of real world spatial behavior using modern technology. We seek to determine the relations between latitude and longitude coordinates as measured by commercially available GPS units (from Land Sea Air) and various personality measures and one laboratory measure of spatial ability. These measures include the BFI, Satisfaction with Life Questionnaire, Positive And Negative Affect Survey (PANAS), Beck Depression Inventory, Center for Epidemiological Studies of Depression Scale (CES-D), and a Computer Generated Arena (C-G ARENA).

*Significance.* We believe that the study will shed light on aspects of spatial organization within humans, such as how passive or active certain participants are, or how quickly they tend to move from place to place, or how many intermediary stops they make from major landmark to major targets, and it may be possible to correlate these data with certain personality characteristics. Finally, if a direct relationship can be made between this methodology and hippocampal functioning and/or activation, then this

methodology, or various modifications thereof, could possibly be used to measure context-based differences in a control group versus a group afflicted with a specific phobia or general anxiety.

*Hypothesis:* The hypothesis for this pilot study was that depressed people should occupy less space, walk less, and visit fewer places than less depressed people. Clinical experience, the DSM IV and intuition support this idea that depressed individuals go less place and occupy less space.

*Visual Representation of Hypothesis:*



Will be using multiple measures that are imperfect indicators of depression and spatial activity and conducting unit weighted factor analysis.

## General Method

*Participants.* The participants were 100 University of Arizona undergraduates, 42 males and 58 females ranging from 18 to 33 years of age. They were recruited from Introduction to Psychology courses. They received extra course credit in exchange for participating in these experiments.

*Apparatus.* A personal computer loaded with customized CG-Arena software and an active internet connection was used, as well as a USB GPS logging device, provided by Land Sea Air. The monitor was used to not only display the surveys that were administered via a secure online database, but to also display the CG-Arena software, and the data points collected by the GPS logging device.

*The GPS logger.* The GPS logging device, when detecting movement, immediately powered on and logged a secure GPS signal coordinate once every fifteen seconds, until the movement detected ceased for a period of 2 minutes. In this experiment, when minimum movement is not achieved to activate the device, it is assumed that the subject is “sedentary” at the last observed location. The information provided by the GPS device is a list of addresses the person visited, amount of time spent there and total distance travelled.

*The CG-Arena.* The CG-Arena is a free software program downloadable from the Anxiety Research Group of the University of Arizona’s website. This software, when activated, displays a virtual space of 460 units radius, and puts the viewer at 60 units height from the arena floor. Unseen by the user of the program, the circular room was split up into four quadrants, with a “target” square placed in one of the quadrants. The

goal of the participant was to find the target under varying conditions. Each subject performed a total of nine trials.

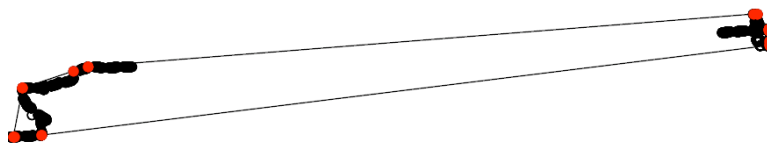
*Procedure.* Each participant registered for two separate days when deciding to participate in the study each, with a period of at least two days between. Participants were asked to answer the questions in each of the inventories by following a web address, where they could complete the inventories confidentially. Participants were then asked to carry a GPS device throughout the remainder of the next three days (~72 hours). These individuals were asked to return the GPS device at the end of the third day during their scheduled appointment for data retrieval. They were permitted to observe the data points on a map and allowed to delete any data they wanted to keep private. Following this, they were asked to sit in front of a computer and complete the CG-Arena. Finally, they were debriefed and experimental credit was allotted.

## Results

A unit-weighted factor for the imperfect measures of depression and spatial activity. The measures for depression were from the CES-D, Positive Affect, Negative Affect, Satisfaction with Life and Beck Depression Inventory. The following table summarizes the results of the depression unit-weighted factor:

	<i>Depression UWF</i>
<i>CES-D</i>	<i>0.83</i>
<i>Positive Affect</i>	<i>0.69</i>
<i>Negative Affect</i>	<i>0.74</i>
<i>Satisfaction with Life</i>	<i>0.81</i>
<i>Beck Depression</i>	<i>0.79</i>

The measures for spatial activity were total number of places the first full day with the GPS device, the number of places the second full day, the total distance of the first full day, the total distance of the second full day and the home range. The home range was measured using the Minimum Convex Polygon (MCP) method. This method finds the minimum number of points needed to encompass all points and calculated the error. The following figure is an example of the points obtained for one participant.



The program used to collect data using the MCP method, first plots all the points

(the black dots in the figure) then finds the minimum number of points necessary to encompass the rest of the points (the red dots in the figure). The program then calculates the area of the polygon as an estimate of the individual's home range. The MCP method is only a rough estimate of home range and can include large expanses of space the individuals never went to, because of this extra space there can be some error with this method. Due to this error the analyst can systematically subtract some of the error about 20% of the points can be considered error to an individual's home range. Therefore the home range is 80% of the area of the polygon found through the Minimum Convex Polygon.

The following table summarizes the results of the spatial activity unit-weighted factor:

	Spatial Activity UWF
Home Range (MCP80)	0.60
Number of Places Day 1	0.54
Number of Places Day 2	0.49
Total Distance Day 1	0.68
Total Distance Day 2	0.78

Once the unit-weighted factors for depression and spatial activity, they were compared using a multiple regression to test for curvilinear effect of spatial use to see if depression and spatial activity might have a curvilinear relationship and the following

table summaries the results.

	B weights	Standard Error	P values
Intercept	-.04754	.12607	.708
Spatial	-.21306	.24206	.383
Spatial <sup>2</sup>	.01201	.14403	.934
Model	R squared	.0209	P=.5594

N=57

The results show that there was no relationship between our depression measures and spatial activity.

## Discussion

Our hypothesis was not supported by the results. The data did not show that depressed individuals occupied less space, walked less or visited fewer places than non-depressed individuals. Our results could have been skewed because participants were not as depressed enough to see the effect or the population of individuals we chose. The participants were University of Arizona undergraduate students and we may not have seen an effect because everyone, depressed or not, had to go to school, work, etc. We also only collected data from 100 participants and had an  $N=57$ , we may have seen an effect if we had collected data from 150 participants in order to increase the size of  $N$ .

*Future Directions:* The next step is to analyze the data using a different method to calculate home range that will provide less error. The two methods that will be used will be the Kernel Plot method and the Nearest Neighbor Convex Hull (NNCH) method. The Kernel Plot method finds the area around a cluster of points, which limits the error in the MCP method by not including the area between clusters. However the Kernel Plot also adds area around the cluster more than the MCP method would, because of this extra area the analyst can also estimate a 20% error. The final method to be used to calculate home range will be the Nearest Neighbor Convex Hull (NNCH) method. This method takes one point and its two nearest and calculates the area of the triangle formed. The area of this triangle is then added to the triangle formed for another point and its neighbors. The NNCH method is like the Kernel Plot method because it eliminates the empty space between clusters however it also eliminates the extra area outside of the cluster that the Kernel Plot method adds. The only weakness of the NNCH method is that it takes exponentially longer as you add more data points. Participants carrying the

GPS units around for three days with a sampling rate of once per second can produce around 30 thousand data points, this massive number of points would require days using the NNCH method to analysis one person's home range on a personal computer. In the future this method will be used when we have access to the high performance computing resources at the University of Arizona.

GPS technology can be used in future studies, for example in clinical situations. According to the literature some disorders, like agoraphobia and Post-Traumatic Stress Disorder, definitely have an impact on spatial behavior pattern. GPS technology can be used as a pre and post test measure of clinical intervention; if the clinical intervention worked there should be some movement outside the individuals residence. GPS technology can also be used with participants with left and right hippocampal lesions and provide real world validity to current neuropsychological exam. Finally, GPS technology can be used with businesses to see how the public utilizes their establishment.

*Reflections on the Project:* It has truly been a privilege to work for Dr. W. Jake Jacobs and with the Anxiety Research Group. Though this experience I have been able learn about and help on many projects. A strength of the group is the close bound formed between research assistants and graduate students. Everyone in the lab is willing to help out on other projects and learn about other areas of research. The lab group also function very much like a family helping in more then just lab projects but helping navigate life. The project I conducted for my senior thesis project was strength because of these bonds and the willingness of others to help me collect and analyze data. However, one weakness was that the project data analysis was too advanced for me to conduct but I have had to opportunity to run a data analysis in another project. It truly has been a great

experience being able to work in a lab and conduct a project. I hope that I will be able to continue some of the research I began in this lab the only thing I am certain of is that I will use the problem solving skills I learned in other settings.

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