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Impact of navigation tools on pedestrian navigation: preliminary results

Bernard Guelton[1,*]

[1]1st Institut ACTE, Université Paris 1Panthéon Sorbonne

Abstract

Since some experiments analyzed impact of navigation tools on pedestrian navigation (Ishikawa, Fujiwara, Imai & Okabe 2008; Wang & Worboys 2016) few have studied how interactive devices between mobile participants possibly transform their cognitive maps. After many years of interactive artistic experiences between participants in distant cities, the goal of the present research is a better understanding of the links between mental, instrumental and shared maps. The question is whether connected and dynamic applications renew our shared mental representations of urban spaces. We will approach the notion of mental maps (introduced by Tolman) in its individual and collective dimension with regard to the new uses created by connecting devices. The hypothesis is that new access to cartographic tools is likely to produce new kinds of individual mental representations. Method: in these preliminary results, the objective is to compare the mental maps evidenced by maps drawn after the exploration of a single urban district between 2 groups of participants: 1) group of individuals equipped simply with a passive GPS tracking tool, 2) group of individuals equipped with an urban navigation application (Google map). Measures will include: 1) comparison of landmarks hierarchies, 2) Comparison of routes traces and icons, 3) Direct comparison by distances between geographical landmarks and drawing landmarks by superposition of the two kinds of maps, 4) Relative comparison between internal distances in geographical landmarks and internal distances between drawings landmarks. We will compare the two groups relative to these measures. In these preliminary investigations, and contrary to some assumptions (Ishikawa, Wang) we cannot find obvious confirmation that pedestrian's users of Google map have worse results from cognitive mapping that others without this device.

Keywords: cognitive maps, navigation tools, walks, pedestrian navigation, collective representation, collective interactions

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*Corresponding author. Email:Bernard.Guelton@univ-paris1.fr

1. Introduction

After many years of interactive artistic experiences between participants in distant cities, the goal of the present research is to better understand the links between mental,
instrumental and shared maps. The question is whether connected and dynamic applications renew our shared mental representations of urban spaces. Since some experiments have analyzed impact of navigation tools on pedestrian navigation: (Ishikawa 2008[1] Wang 2016[2]), few have studied how interactive devices between mobile participants possibly transform their cognitive maps.
First, with these preliminary results, we will focus on the use of a navigation tool, such as Google map, in comparison with users without this device.

2. Context: Four general backgrounds and context for the study

2.1. Walks as art

Mobility in art launched a very important topic in the 50s, with Guy Debord's "théorie de la dérive situationniste",

and found many different contexts in Land art, (Robert Smithson, Hamish Fulton, Richard Long), architecture (Walkscapes, Francesco Careri[3]) and performance. A very good synthesis was done by Thierry Davila[4] with *Marcher-créer, Déplacements, flâneries, dérives dans l'art de la fin du XXe siècle* in 2007. More than 10 years after, art-walking practices boomed, especially with mobile technologies devices.

2.2. Group artistic performances by walkers in distant cities

Figure 1. Example of combined simultaneous walks and tracks between several walkers in Rio de Janeiro's Jardim Botatnico and the Jardin du Luxembourg in Paris, Fictions & interactions Team & ORBE.

Example of combined simultaneous walks and tracks between several walkers in Rio de Janeiro's *Jardim Botatnico* and the *Jardin du Luxembourg* in Paris, in late august 2015. Walkers in each town (with different colours) create and locate photographs in their surroundings. Since the two maps of the two districts are combined in one single map, each walker arriving at the geo-localization point of photographs can see the specific photograph on his-her smartphone.

http://fictions-et-interactions.net/
http://fictions-et-interactions.net/category/ateliers/
http://fictions-et-interactions.net/en/category/workshops/

2.3. Space representations

During these different experiences an important question emerge: How do different kinds of navigation and interactive applications transform our representation of urban space and more significantly, our mental representation of space? How do mental images develop in an interaction situation while using connected and evolving maps? Consecutively, how do they develop, when shared? There will be new forms of entanglements between egocentric, allocentred and distributed spaces. In these preliminary results, I'll focus only on the two first groups: 1) with passive trackings but without any navigation tool, 2) with Google map application.

2.4. Mental maps

A series of experiments have highlighted the ability of organisms to use three sources of information during their moving processes, dimension, orientation and movement Through three mechanisms:
1) integration of the trajectory (based on the proprioceptive data related to body movements, see Etienne & Jeffrey (2004);
2) orientation to landmarks (highlights in the environment);
3) and geometric calculations based on spatial dimensionality (Taylor & Tversky 1992, 1996, Tom & Tversky 2012, Tversky 2003, 2004).

3. Fundamental questions about mental maps

In the brief overview of the issue of mental maps, we mentioned that individuals can retrospectively construct a more or less precise map of the space in which they have been moving. This does not exclude, however, a number of important problems, recalled in particular by Colette Cauvin (1999). The difficulty of dissociating "the acquisition process of cognitive maps, which leads to each individual having an image of the space concerned, which we call the "cognitive representation" from the concrete product of this representation, that is to say its "outsourcing", which we call "cognitive map" here. It reminds us, with R. Kitchin (1994), of four positions related to the cognitive representations of space: 1) they are explicit, that is, they are maps, 2) they are analogue, that is, they are like maps, 3) they are metaphors, that is, they function as if they were maps, 4) they are hypothetical constructions and are in fact a fiction practice. "To these basic questions is added the difficulty of synthesizing a set of renditions of individual map as a "single" collective map. To these questions are added 3 subsequent basic questions: 1) how to translate an urban mental map? 2) how to synthesize a set of urban mental maps? 3) how to compare the urban mental maps of two different groups of subjects?

3.1. How to translate an urban mental map?

Following Frédéric Roulier (2010), "We chose to obtain geographic cognitive data using the freehand sketch technique". Often criticized since their beginnings (limits imposed by the format of the sheet, effect of grapho-motor skills differences especially between social groups, cognitive barrier for old people vis-à-vis the technique ...), However, the sketches remain widely used for obtaining individuals' cognitive space. It is true that freehand drawing has many practical advantages: It is rich in

collected information (possible expression of complex spatial configurations), not very demanding in explanation, light in equipment required ... Above all, the apparent simplicity of the technique does not make it a less reliable method than another to express the cognitive representations of space (Cauvin et al., 1998). Nora Newcombe (1985) states that sketch collection was underestimated and that other collection methods were overestimated[6].”

3.2. How to synthesize a set of urban mental maps?

Typically, urban mental maps are individual. Whether they came from drawings or interviews, the difficulty is to synthesize a group of individuals and secondarily to compare different group of subjects. In their study “Aggregation issues in cognitive mapping” (1997), Kitchin[5] & Fotheringham have distinguished 3 kinds of analysis: 1) The individual data sets are analysed separately and only pooled for comparison (disaggregation), 2) Individual data sets are averaged and then analysed (collective aggregation); or 3) The individual data sets are analysed and then results are averaged (individual aggregation). We use the third type analysis for the 3 methods presented and subsequently compare the two groups.

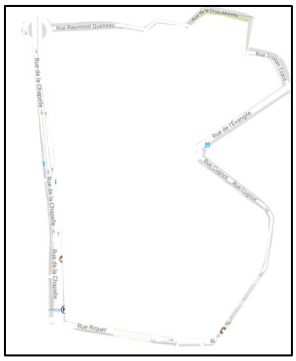
3.3. How to compare the urban mental maps of two different groups of subjects? 4 methods are presented:

1- Comparison of landmark hierarchies
2 - Comparison of route traces and icons
3 - Direct comparison by distances between geographical landmarks and drawing landmarks by superposition of the two kinds of maps
4 - Relative comparison between internal distances in geographical landmarks and internal distances between drawing landmarks

3.4. Experimental protocol

1. Choice of the urban district: Paris (north), a rich, various and heterogeneous district between 2 main railway-lines and a ring-road.
2. Choice and identity of subject groups: 2 homogeneous student groups in arts and geography.
3. Steps of the experiment: instructions, passive tracking tools, limits of the district, an hour of exploration and the place address for the drawing place.
4. Choice of the transcription of mental images by sketch maps through questionnaire.
5. Elements of the questionnaire: types of landmarks, interests, difficulties.

Urban district: Marx Dormoy subway station, north of Paris



Limits of the map distributed to the participants for the exploration of the district and to achieve the drawing distributed to participants

Figure 2. Urban district

4. Examples from the first group drawings with 3 tendencies for the sketch maps:

1) traces & orientations, 2) landmarks, 3) sectorizations, 4) combined strategies

4.1. Examples of Traces & orientations

Figure 3. Example of Traces & orientations

4.2. Examples of Landmarks

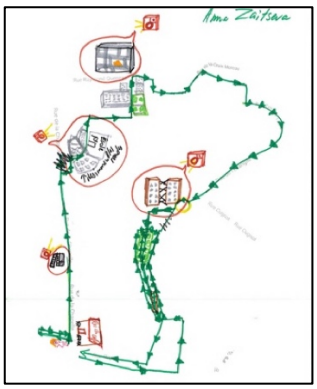


Figure 4. Example of landmarks

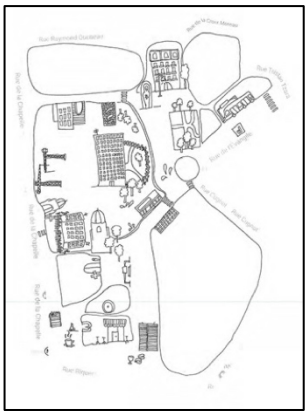


Figure 5. Example of landmarks

4.3. Examples of sectorizations

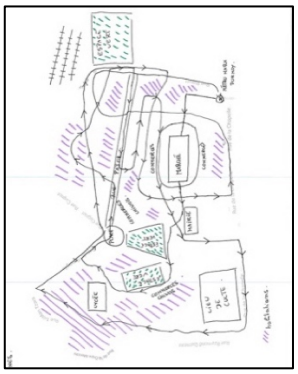


Figure 6. Example of sectorizations

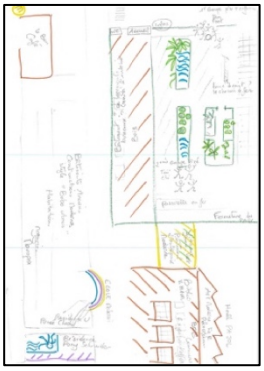


Figure 7. Example of sectorizations

4.4. Examples of Combined Strategies

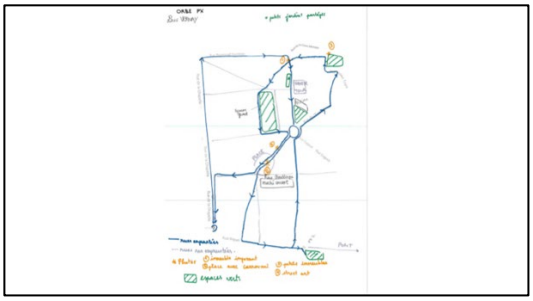


Figure 9. Example of combined strategies

5. Four methods of comparisons

Four methods were used to compare the group of subjects without Google maps with the group with Google Map: 1) comparison of landmarks hierarchies in sketch maps, 2) comparison of landmarks and icons, 3) direct comparison by distances between geographical landmarks and drawing landmarks by superposition of the two kinds of maps, 4) Relative comparison between internal distances in geographical landmarks and internal distances between drawing landmarks.

5.1. First comparison of landmark hierarchies in sketch maps and questionnaires

Group 1	Group 2
1) Café Marx Dormoy, Marché	1) Marché
2) Place Hébert, Églises	2) Place Hébert, Églises, jardin Rachmaninov
3) Jardin Rachmaninov	3) Café Marx Dormoy
4) Rond-point Porte de la chapelle, square Robin	4) Square Seguin, square Robin
	5) Rond-point Porte de la chapelle

Figure 9. When we Count landmarks in sketch map for group 1 & 2, the importance of the landmarks varies from level 3, while the market place, the two churches and the *place Hébert* are common to the first 2 levels. (Frequent mentions of “buildings” and “parks” could not be counted because of the multiplicity of their locations.)

5.2. Example of comparison of routes and icons

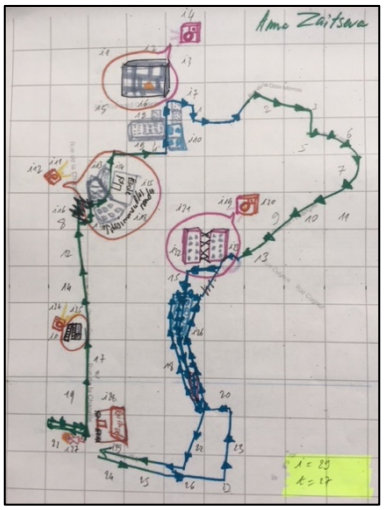


Figure 10. 3 operations were used: 1) Division with a grid of 10 x 15 compartments for each sketch map, 2) Counting of traces or/and icons in each one, 3) Percentage

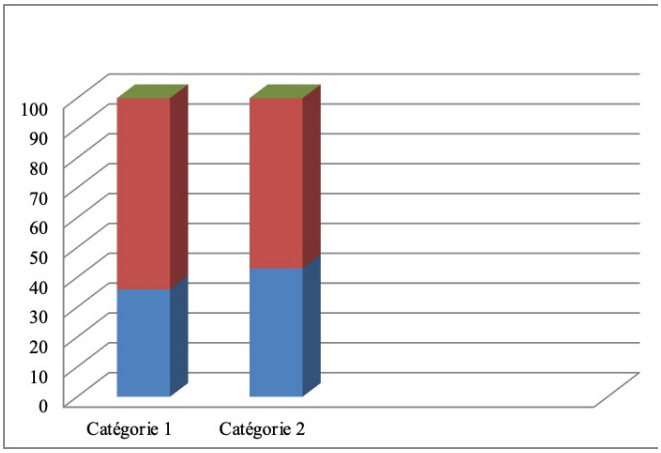


Figure 11. Relationships between icons and route trace drawings, for group 1 & 2

5.3. Example of direct comparison by distances between geographical landmarks and drawing landmarks by superposition of the two kinds of maps

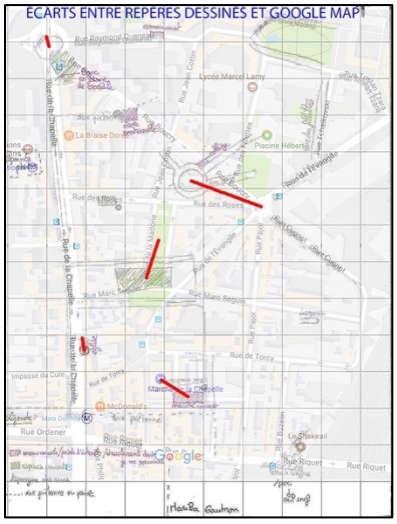


Figure 12. Example of superposition of each sketch map with Google map at the same scale and Measurement of distances between landmarks in Google map and landmarks in sketch map

			Marché	Place Hébert	Jardin Rachmaninof	Églises	Café Marx Dormoy	Rond-point porte de la chapelle	Square Seguin	Square Robin	Piscine Hébert (seulement groupe 1)	Lycée (seulement groupe 1)	Nombre de repères	Somme par sujet
1)	BENJEDIDIA	NADINE	5			11	8						3	24
2)	CANCE	PIERRE-E.	32	5			2	2		55			5	96
3)	COMES	ROMANE	24	2			2					20	4	48
4)	DUHAMEL	EDOUARD	23	42		70	2	2					5	139
5)	FU	XIAOMIN	45			50					12		3	107
6)	GAUTARD	JEANNE		2	22	50	10			15			5	99
7)	GILOT	MARIE			65	48	2				85		4	200
8)	GIORDANA	ZOÉ	30	2	35		2						4	69
9)	GRILLET	ANTONIN	34	2			2		24	15			4	77
10)	NEMBROT	LAETITIA	70			25							2	95
11)	NOBILI	THOMAS	22	2			2						3	26
12)	REMADNA	MÉGANE	35		35	40	2						4	112
13)	VERNAY	LOUIS	50	2	23		2	2					5	79
14)	ZAITSEVA	ANNA					10						1	10
15)	ZHANG	JINGZHUI	72		35	75							4	217
													56	1398

DISTANCE MOYENNE DES REPÈRES DU GROUPE 1 PAR RAPPORT AUX REPÈRES GOOGLE :
1398 : 56 = 24,96

Figure 13. Average distance between landmarks in Google map and landmarks drawn by subjects : Example of results for group 1

5.4. Example of relative comparison between internal distances in geographical landmarks and internal distances between drawing landmarks

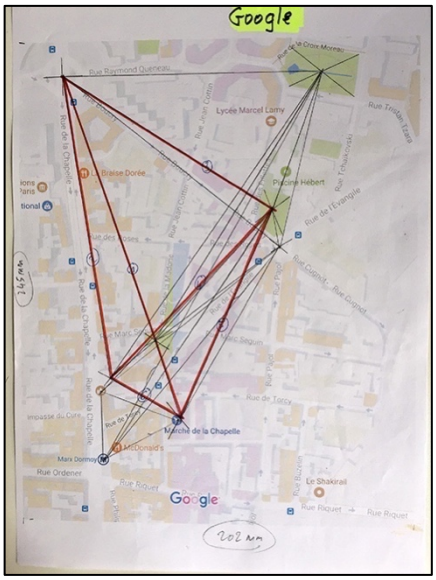


Figure 14. Measurement of distances between 6 landmarks in Google Map. Relative comparison between internal distances in geographical landmarks and internal distances between drawing landmarks

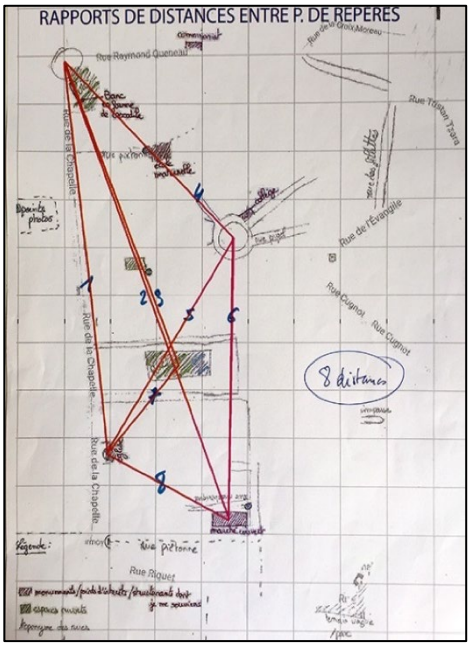


Figure 15. Example of measurement of distances between the same 6 landmarks in the sketch maps of one subject

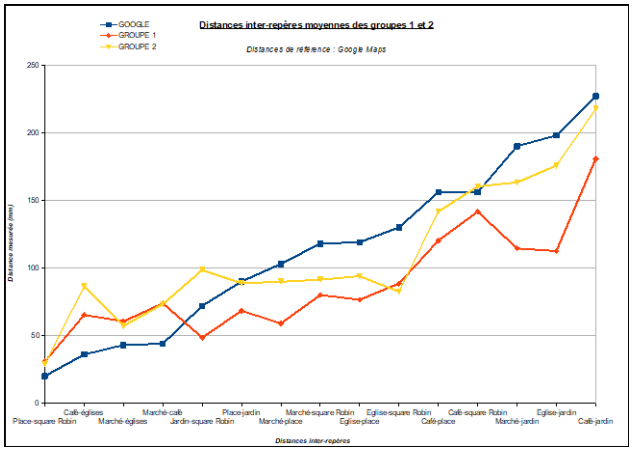


Figure 16. Graph of the correlation between geographical distances in Google Map, group 1 & 2. Correlation Google distances / group 1 = 0.92, Google distances / group 2 = 0.87.
Blue = Google, red = group 1, violet = group 2

6. Remarks and conclusion for these preliminary results

After a subjective categorization of drawings: 1) traces & orientation, 2) landmarks, 3) sectorizations, 4) combined strategies, we use 4 methods: - Comparison of hierarchies of landmarks, - Comparison of routes traces and icons, - Direct comparison by distances between geographical landmarks, - Relative comparison between internal distances in geographical landmarks and drawings landmarks. The 2 first methods are independent from geographical space whereas the 2 last methods are dependant from geographical space. This allows to relativize the question of whether cognitive maps are similar or not with physical maps.

The 4 methods of analysis used to compare the two groups of subjects, (control subjects without navigation tools and subjects using Google Map) do not show any obvious differences.
1) The importance of the landmarks varies from level 3, while the market place, the two churches and the *place Hébert* are common to the first 2 levels.
2) Regarding the differentiation between lane tracing and the iconic representation of landmarks, tracings dominate for both groups, with a larger gap for group 1.
3) The distance between the landmarks drawn with respect to the geographical landmarks is smaller for group 1. It is therefore better, but the average difference between the two groups is not very significant (25 and 28 mm)
4) Finally, if the Pearson-Bravais type correlation between the measurements internal to the geographical space and those of the sketch map is also better for group 1 (0.92), the difference with group 2 is not so important, as it is 0.87.

So, contrary to some assumptions (Ishikawa, Wang), we cannot find obvious confirmations that pedestrian' s users of Google Map have worse results from cognitive mapping than others without this device. These results are to be considered with caution, considering the small number of subjects summoned, the experimental protocol used and the methods envisaged. We need more investigations to know how Google Map transform or not our cognitive maps in comparison to users without this device. One important possible bias is the free use of Google Map in the exploration in the urban district, which means that it was not necessary for participants to find any specific address. Nevertheless, I tried to show that beyond the fundamentally personal character of an urban mental map, it is possible to report a set of subjects with different methods and then to confront them with another group. The next steps of analysis are of two kinds: 1) consolidation of the number of subjects for this first experience, 2) comparison of these two groups with a third group with a navigation and interactive relationship tool experiment. The main perspective of this research is to compare these two first groups with a third one with a navigation tool in an *interactive situation*. The objective is to experiment impact of navigation and interactive tool between participants on *collective representation*. In this perspective, three kinds of investigation will be considered: temporalities of sharing use, temporalities of drawing the sketch maps and temporalities of tracking traces.

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