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Spatial Behaviors and Mental Representations: Interactions of artistic and scientific perspectives

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Abstract

Contemporary artistic research has successively integrated preoccupations with the experimentation of space and mobility, as well as collective interactions between participants in situations of proximity or remoteness. In the scientific field, an important part of spatial cognition study has recently turned towards understanding the collective aspects of spatial cognition, integrating an understanding of the acquisition of spatial knowledge and studying cognitive maps, as well as research on navigation and individual and collective memorization. In both cases, spatial behaviors and mental representations are fundamental focuses. Using CORES research combining artistic and scientific perspectives as an example, we clarify specific differences within a framework common to the arts and sciences. This article will develop three points: 1) Artistic and scientific research contexts, 2) Interactions between artistic and scientific perspectives, 3) Proposal of a 7-step joint arts and sciences research cycle. In so doing, this study aims to counter the divide between the artistic and scientific fields by demonstrating a shared creative dynamic.

Keywords: Spatial behaviors, Mental representation, Artistic and scientific perspectives, Space, Mobility, Collective interactions, Cognitive maps

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1. Introduction

The practice of walking has undergone considerable change since the emergence of navigation tools, not only for utilitarian purposes, but also for playful and artistic ones (Debord, 1955), (Fujihata, 1994), (Davila, 2002), (O'Rourke, 2013), (Careri, 2013), (Guelton, 2020), (Quesnot & Roche, 2020). In addition to their use in finding and orienting oneself in space, these same tools have enabled participants to locate each other and act collectively. In the artistic context, rather than the production of an object for aesthetic purposes, the matter of individual and collective actions and performances took center stage, implying new behaviors and space representations. Recent developments in the field of spatial cognition are rich and are increasingly focusing on the collective and collaborative aspects of spatial cognition (Quesnot & Guelton, 2023) (Dorfman & al., 2021), (Peer et al., 2021), (Shafer and Shiller, 2018), (Eichenbaum, 2015), (Tavares, 2015), (Dalton et al., 2019), (Bae and Montello, 2019). The study presented here is the fruit of a research into the role of interactive tools enabling interaction between several participants, and their impact on collaborative representation and memory. After several years of experimentations on collective walks using a shared mapping application, a central question clearly emerged: to what extent are instrumental and shared maps likely to change our behaviors and spatial representations? The originality of this study lies in the fact that it was initially undertaken as an

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artistic experiment, then developed in a scientific context. However, more than sharing the same investigation field, this article intends to question what links and differentiates the perspectives and methods used between artistic and scientific approaches. The artistic background is developed around three points: 1) new spatial practices akin to cartographic practices, 2) an historical evolution gradually associating research on space, mobility, interactions between people, and art as a collective practice, 3) Considerable transformations of the artist and the spectator notions. Positioning in relation to navigation and spatial cognition, we develop four points to frame the research in the spatial cognition field: 1) Tolman's early experiments, 2) the acquisition of spatial knowledge and 3) the individual and collective aspects of spatial behavior, 4) the matter of collaborative inhibition in shared spatial knowledge. We then turn to our study's most important aspects, the different stages of research in both the arts and sciences, a cyclical process in seven stages and discussing the particularities of these stages in these two great fields of knowledge.

2. New spatial behaviors and representations in contemporary art

2.1. Walking and mapping: Artists as cartographers2

The first experiments in shared mobility in the artistic context date back to the late 50s, with Guy Debord, author of the situationist drift, who produced the *Psychogeographic Guide to Paris* in 1956, followed by *the Naked City* in 1957. To these can be added Fluxus' urban wanderings, some forms of *happening*, and the research by G.R.A.V.[3] . They developed not only in urban space, but also, in a very different way, in the 70s, with landscape exploration by artists Hamish Fulton and Richard Long. In his book *Marcher-Créer*, Davila (2002) analyzes the performances and walks of Gabrie Orozko, Francis Alys, the Stalker group and more generally the new paradigm of walking as a work of art (see Careri, 2013; O'Rourke, 2013). In the 1990s, connection technologies and portable devices increased the possibilities for sharing collective mobilities by adding visual, sound, textual and, above all, performative regimes, all within a reality-virtuality continuum theorized as early as in the mid-1990s by Milgram et al., (1994). Artists' collectives based on participatory theater, such as Blast Theory[4] and Rimini Protokoll[5], are emblematic examples of the alternating-reality artistic games and devices that have been proliferating since the 2000s.

At the early 90s the arrival of cartographic technologies and the mobile Internet considerably transformed the practice of walking in urban environments. Beyond utilitarian considerations (i.e., getting from point A to point B), a significant number of contemporary artistic practices seized on CT (see Cosgrove, 2005 and Wood, 2006) and real-time dissemination of geographic information to envisage new collective and (re)creative uses (see Guelton, Quesnot and Roche 2020). From then on, the collective walk became a performative medium for practicing and hybridizing several participants' experiences in a common or distant space, with digital supports derived from existing uses or designed for purely artistic and playful purposes. It is precisely in this context that the *fictions & interactions* team, in collaboration with the media ORBE company has been working for several years on interactions between walkers and distant cities. These have led to the development and testing of innovative mobile and interactive devices.

When it comes to artists' creative cartography practices, there are probably no better examples than those provided by Debord or Fujihata, a very good overview of which was sketched out by Herbet and Magnan (2014). According to Debord, "[...] *in addition to the practice of drifting as a lived experience, should be mentioned the beaconing signaling the psycho-geographical articulations of the city, i.e., "the precise effects of the geographical environment" operating consciously or unconsciously and "acting directly on individuals' emotional behavior". Many of these events take place over the course of a day, with each participant carrying a walkie-talkie and simultaneously exchanging impressions. This practice, inseparable from a "psycho-geographical" apprehension of urban space, contributes to the location of "ambiance zones" that are exploited and evaluated according to their potential. Most drifts are transcribed in a sketch and/or accompanied with a written report; all documents collected that way were used, in part, to draw up the Psycho-geographical Guide to Paris*" (Herbet & Magnan 2014). Fujihata was the first artist who used GPS technology, in his 1994 project *Impressing Velocity*. "The map in *Impressing Velocity*[6] is not an image, it's a map of the deformations that wandering may have generated on a territory"; the data collected by Fujihata models the itinerary and produces a contraction of the form when moving fast, or an expansion of it, when moving slowly (Herbet and Magnan, 2014).

Artistic practices of space, and especially interactions between distant walkers, do not simply provide a context for study here, but form a kind of anticipation of the post-representational paradigm of cartography, with examples such as the psychogeography of the the late 50s Situationists. As early as 1994, an artist like Fujihata used GPS technology in his *Impressing Velocity* project. The data collected by Fujihata models the itinerary by producing a contraction of the form when moving fast, or an expansion of it when moving slowly. But it was not until the 2000s that participatory theater groups such as Blast Theory began using

[2] As an echo to O'Rourke, K. (2013). *Walking and mapping: Artists as cartographers*. MIT Press.
[3] https://fr.wikipedia.org/wiki/M%C3%A9dias_localis%C3%A9s
[4] https://www.blasttheory.co.uk/
[5] https://www.rimini-protokoll.de/website/de/
[6] http://www.medienkunstnetz.de/works/impressing-velocity/ (consulted on 18/03/19)

GPS technologies and visual as well as verbal interactions to link walkers in exploration or playful interaction tasks.

2.2. From a historical point of view, four independent contexts can be identified and then gradually cross-fertilized in the perspective of the CORES project:

- Art conceived as "space", then more specifically as "situation", is certainly the oldest question in the redefinition of the artistic perimeter concerned. [7] (For artists, see: Robert Smithson, Daniel Buren, Felice Varini, James Turell, Carl Andre, Michael Asher, Robert Irwin, Giovani Anselmo, Fred Sandback, and theorists: Rosalind Krauss, Jean-Marc Poinsot)
- Art conceived as "mobility" is clearly identified in the practices of individual and collective performative walks (For artists, see: the group Stalker, Hamish Fulton, Richard Long, Francis Alys, Masaki Fujihata) ; and theorist: Guy Debord, Thierry Davila.
- Art conceived as an interactive practice emerged in the early 1960s. "In 1963, Ivan Sutherland introduced the *Sketchpad*, an interactive drawing method that involved drawing directly onto the cathode-ray tube with a light pen, then modifying the geometric images with the keyboard keys. One of the first art installations was Myron Krueger's *Videoplace* in 1974/75. In *Videoplace*, the viewer's image is digitized via a camera, enabling him or her to interact with the computer images[8] .
- Art conceived as a collective practice – not as a practice as old as art itself – but as an activity clearly asserted as such, pertaining to the aims and content of the work itself. A "synthesis" of the latter two paradigms is apparent in interactive art installations. "Interactive art installations enabling co-located audience participation in real time emerged as early as the 1960s, with works such as Kinoautomat (1967), SAM - Sound Activated Mobile2 (1968) and Glowflow3 (1969). With the advent of personal computers and advanced surveillance and tracking technologies such as computer vision techniques, collocated interactive art projects became more common in the 90s[9] ." But, art collectives such as Blast Theory or Rimini Protokoll have brought the last three paradigms up to date in exemplary forms: art as mobility, art as interactive device, and art as collective practice.

2.3. The emergence of new configurations in contemporary artistic creation

Through these main reference points for contemporary artistic creation, and especially the last one (art as collective practice), the foundations of art are being challenged until they possibly disappear altogether: 1) the notion of the spectator, in the first place (Riado & Trentini 2013) 2) the concept, to a lesser extent, of the artist as an individual author (as distinct from a spectator) (Bourriaud 2001), (Jouannais 2009) and finally, 3) the notion of a work as an autonomous object whose evaluation criteria are a sensitive and aesthetic apprehension (Duchamp 1913). The experiments developed by the *Fictions et Interactions* team with ORBE since 2013 cross over these four major paradigms of contemporary artistic creation. An important background is provided by the experiments developed by the artists' groups Blast Theory and Rimini Protokoll, whose original context is participatory theater. The creation and exponential use of video games form a second field that naturally hybridizes with participatory theater.

2.4. The Fictions & interactions team's artistic experiments as a basis for the scientific research

Between 2011 and 2019, the *Fictions & Interactions* team[10] inked to Université Paris 1 developed a series of performative and interactive experiments using walking as a medium to connect small groups of walkers across distant geographical spaces. These interactions were carried out using widely available applications such as Skype or with applications specially designed by Paris media company ORBE https://orbe.mobi/. These experiments were designed using audio-guided scenarios to be performed successively by the interacting groups (in Paris and Shanghai) who followed instructions presented like in a game or in a merely exploratory manner, in order to confront distant spaces with common urban characteristics. The media company ORBE created the experimental applications for these remote interactions. Xavier Boissarie, game designer and member of ORBE team, contributed to the design of the scenarios. With the workshops presented below, the *Fictions & Interactions* team has amplified its experimental and artistic objectives within a diversity of interactive devices mixing physical, virtual and fictional spaces. Sound and visual interactions as well as applications of shared cartography, allow several stages to experiment hybrid urban spaces with distant walkers. The issues of remote collaboration but also of playful competition are raised through these experiments.

[7] L'oeuvre et son espace, Centre G. Pompidou, Dossiers pédagogique https://mediation.centrepompidou.fr/education/ressources/ENS-oeuvre-espace/ENS-oeuvre-espace.htm
50 espèces d'espaces, Centre Pompidou, 1998
Situations (Varia) Les Cahiers du Musée national d'art modern, MNAM, n° 27, 1989

[8] What is interactivity? Leonardo/Olats & Annick Bureaud, April 2004. https://www.olats.org/livresetudes/basiques/6_basiques.php

[9] Mubarak, O. (2018). *Designing and Modeling, Collective Co-located Interactions for Art Installations*, CNAM Thesis. p. 7.

[10] https://www.fictions-et-interactions.net

The matters of real time interactions are most often experimented but do not exclude other contexts, with the elaboration of delayed scenarios. Workshops between distant walkers such as Paris-Seoul, Paris-Montreal, Paris-Quebec, Paris-Chicago, Paris-Porto Alegre, Paris-Rio, Paris-Shanghai are documented below[11].

Figure 1. Collective trackings between walkers in Paris-Belleville and Rio-Santa-Teresa

Figure 2. Skype view in Seoul of a walker in Paris asking a passer-by for directions

In 2012, there took place the first game experiment entitled "*Hupareel, a game all over the world"*. Hupareel is a real, virtual and fictional city associating different remote life walkers from Paris and Shanghai. A pre-recorded sound scenario is broadcast in successive steps to 2 different groups of walkers in the cities of Paris and Shanghai. Successively, during the broadcast instructions, each of these 2 groups must guide the other in order to find the Shanghai and Paris Hupareel physical centers. In each city, passers-by's contributions help find the different places and directions necessary to reach the Hupareel physical centers of the virtual city located by successive drifts.

In 2013 and 2016, using the Skype application in a reversed way (back camera), walkers in Montreal and Paris performed a combined walk. In this experiment, the walker in Paris can discover views of Montreal – live; and reciprocally the associated walker in Montreal can discover views of Paris – live, as well. In certain circumstances, these walkers find themselves in the same context, for example, following the Saint Laurent in Paris and following the Seine in Montreal and hybridizing the two remote spaces.

In 2015, was performed "*Encircling race"* in the cities of Paris and Chicago. The live tracking movements of one walker in Paris and another walker in Chicago where visible on each of the smartphones. By moving quickly, each walker tries to encircle the other, but was confronted with the vagaries of the obstacles encountered in each city.

"*Remote trackings & shared photographs*" was a new experiment performed between Paris and Rio in 2015. The live movements of many walkers in Paris and Rio were visible on everyone's smartphones. Live photographs can be posted and located. Anyone can post geotagged photographs. By reaching these geolocation points, walkers in the other city can view these photographs on their smartphones. Locations are chosen for their overall similarities, for example the Botanical Gardens in Rio with the Luxembourg Gardens in Paris, the Belleville districts in Paris and Santa Theresa in Rio.

In the following year (2016), the same principle of "encircling race" common to Paris and Chicago was reproduced between Paris and Porto-Alegre, but with many protagonists, which multiplies challenges.

Over the course of 2019, the workshop "*Crossing gates"* aimed to design and experiment meetings between walkers equipped with smartphones and communication with a cross mode Skype camera: a view of Paris in Seoul and a view of Seoul in Paris. Two successive experiments were conducted, a first one with audio-visual communication guidance with the Skype application and the second one only with sound tracking. Small groups of walkers in pairs in Paris and Seoul must search for crossing gates between two neighborhoods in Paris and Seoul and virtually attain the "crossing gate" between the two cities. To discover these gateways, local walkers must ask a passerby for directions to a door of their choice. They follow the specified directions while communicating these same instructions to remote partners via Skype in front camera mode. At the end of a two-way trip via Skype, both "doors" were found.

[11] Workshops Paris-Seoul, 2019: Crossing Gates
- https://vimeo.com/884336369?share=copy#t=57
- Workshops Paris-Montreal, 2016, ORBE linguistics interactions
- Workshop Paris-Quebec, 2016, ORBE Workshop Paris-Chicago, October 2015, ORBE: Combined tracking, drawings and encircling processes
- Workshops Paris-Rio, September 2015, ORBE, UERJ Santa-Teresa (Rio) / Belleville (Paris) Combined tracking and real-time photographic interactions
- Botanical Garden (Rio) / Jardin des plantes (Paris)
- https://vimeo.com/147307150
- https://vimeo.com/142309729
- Workshop Paris-Shanghai, 2014, ORBE, XIYITANG
- https://fictions-et-interactions.net/en/hupareel-an-hybrid-game-project/
- https://vimeo.com/126418630
- Workshop Paris-Montreal, May 2013, ORBE, UQAM
- http://vimeo.com/72679246

3. The scientific background to Spatial Behaviors and Mental Representations with collective interactions

After seven years of artistic experimentation, a central question became clear: to what extent are collective interactions between distant walkers likely to modify the mental representations of the spaces they walk through? Walkers' mobility, their collective exchanges at a distance, and the role of interactive tools, became the key points to be explored and analyzed, this time in a scientific rather than artistic approach. The practice of walking in an urban environment – whether from a purely utilitarian point of view or, on the contrary, from an artistic and playful perspective – has been considerably transformed since the arrival of instrumental mapping tools such as Google Maps. On the basis of an experiment conducted several years ago on walks carried out collectively using a shared mapping application, the question was clarified as follows: to *what extent are instrumental and shared cartographies likely to modify our behavior and spatial representations?* While previous studies have attempted to identify the navigation tools impact on our cognitive representations, very few studies have really looked at the impact of tools for collective interaction between walkers in an urban environment. With this in mind, this research aimed to compare spatial representations – obtained via freehand drawings and graphs – with behaviors in space, transcribed using tracking data collected from cell phones. More specifically, the tracking data will be compared with the drawings and graphs in a fixed way (final result), but above all in a dynamic way: the spatiotemporal evolution of walking and the spatiotemporal evolution of drawings and graphs. The proposed methodology included 3 groups of subjects: i. test group; ii. group using an instrumental mapping application (Google Maps); iii. group using a shared mapping application. It is developed in 3 phases: a) Analysis and confrontation of individual and collective spatial representations; b) Analysis and confrontation of individual and collective behaviors; c) Confrontation of behaviors and spatial representations.

Just as we have attempted to specify the context of artistic experimentation, we indicate below several key notions that contextualize the conceptual and experimental environment of the scientific research undertaken.

3.1. Positioning in relation to navigation and spatial cognition

3.1.1. Cognitive Map: Tolman

By studying the spatial behavior of rats, Tolman proposed the term cognitive map to describe how rats, and by analogy humans, behave in a given environment. Broadly speaking, a cognitive map is a mental construct that we use to understand and learn about our environment. This implies that people store information about their environment, which they then use to make spatial decisions. A cognitive map helps simplify and encode man's complex interaction with his environment. It involves the integration of images, information and attitudes about an environment: it is not an entity isolated from context. According to Kitchin (1994), the cognitive map is a process consisting of a series of psychological transformations by which an individual acquires, stores and decodes information about the location and attributes of a phenomenon, in its spatial environment. The notion of cognitive map, first articulated in 1948 by Tolman (in opposition to behaviorism), has gradually become a central notion in experimental psychology and for the study of spatial cognition. Today, they are taking an increasingly explicit and experimental meaning in brain area neurophysiology (Guelton 2023).

3.1.2. Acquiring spatial knowledge

In the 1970s, Kevin Lynch highlighted a set of structuring elements in the perception and memorization of urban space. These fundamental elements are as follows: *Landmarks, nodes, lanes, boundaries, neighborhoods,* have been taken up in a considerable number of studies and, with many participants, have thus formed an essential basis for the study of intra-urban spatial cognition. A good review and synthetic overview can be found in Ahmadpoor and Shahab's 2019 study[12] . In their article, the authors, first present the background to research on spatial cognition acquisition and theories of spatial cognition development. Next, they examine the main factors influencing the acquisition and formation of knowledge about the environment, looking at the effects of two main factors: 1) the means of acquiring spatial knowledge (direct experience, physical map and moving maps), and 2) the role of different physical environment properties.

3.1.3. Theory on spatial knowledge acquisition: Siegel & White, Ishikawa & Montello

Siegel and White (1975) proposed a framework to explain the development of spatial knowledge microgenesis. The development of spatial knowledge takes place in three sequential stages: landmark knowledge, route knowledge and survey knowledge. Landmark knowledge refers to the knowledge of discrete objects, places and scenes that are salient in the traveler's environment. They assert that "landmarks are a unique pattern of perceptual events at a specific location". They also added that conscious knowledge of where we are going constitutes landmark knowledge (for example, we are going to the park or coming back. According to this framework, landmarks and routes are seen as necessary elements of the cognitive representations that enable us to find our way. Montello (1998) and Ishikawa and Montello

[12] Ahmadpoor, N., & Shahab, S. (2019). Spatial knowledge acquisition in the process of navigation: a review. Current Urban Studies, 7, 1-19.

(2006), consider this framework to be the dominant one, but note that these development stages have not received substantial empirical support. Recognizing these shortcomings in the dominant framework, Montello (1998) proposes a new framework to explain the development of spatial knowledge. This framework opposes the dominant framework's unrealistic assumptions that no metric knowledge is formed in the early stages of spatial knowledge, and argues that "metric configural knowledge begins to be acquired upon first exposure to a novel environment" Montello (1998), Ishikawa & Montello (2006), Warren & Chrastil (2013).

3.1.4. Individual and collective navigation

Cognitive representations of space have traditionally been studied for individual subjects. However, over the last decade, a substantial number of studies have been looking at these representations in a social and collaborative context. We can first recall the salient changes that have contextualized this new interest in social and collaborative navigation: 1) The different modalities of interactions and mutual generations between action and space (Haddington 2013) 2) An increased interest in new modes of interaction enabled by mobility (Licoppe 2009, Arminen & Weilenmann, 2009, McIlvenny, et al. (2009, 2014)[13]. Studies on social and collaborative navigation show a wide variety of approaches. They can be designed according to whether participants are in close proximity or at a distance, in a real or virtual situation, in group interaction or independently, provided with navigation aids (paper, digital tools), in wayfinding tasks or in free exploration of an environment, in guidance and mutual aid between participants and/or more generally in studies of spatial behavior, whether the modes relate to mass transit or pedestrian navigation. Their shortcomings are that they are often limited to studies in virtual situations and to dyads. In a study entitled *Collaborative orientation under distributed spatial knowledge*, Panagiotis *et al,* (2022) unlike most research to date, focused on social orientation under unilateral or fully shared spatial information by presenting an experiment to study collaborative orientation in the face of spatial information uncertainty. Their results show that "on the whole, participants share control over navigation, but they master it more when the task takes them to a familiar destination".

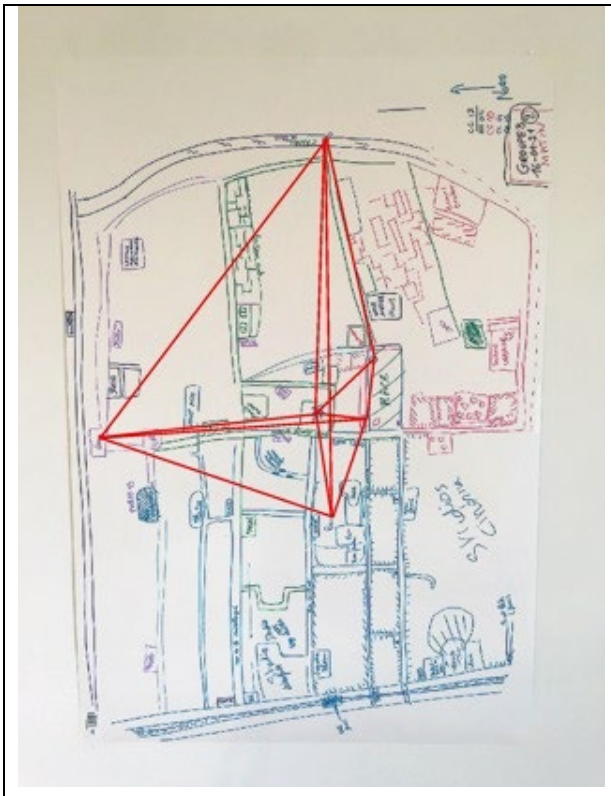
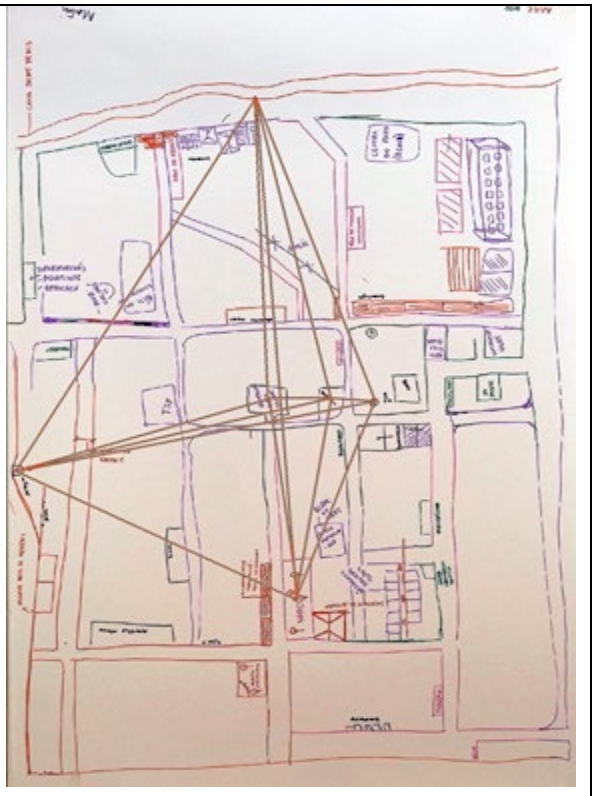
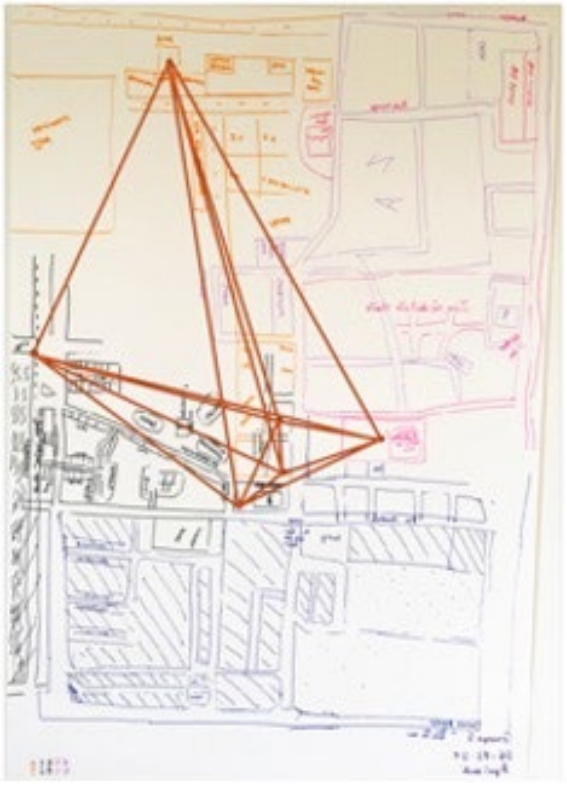
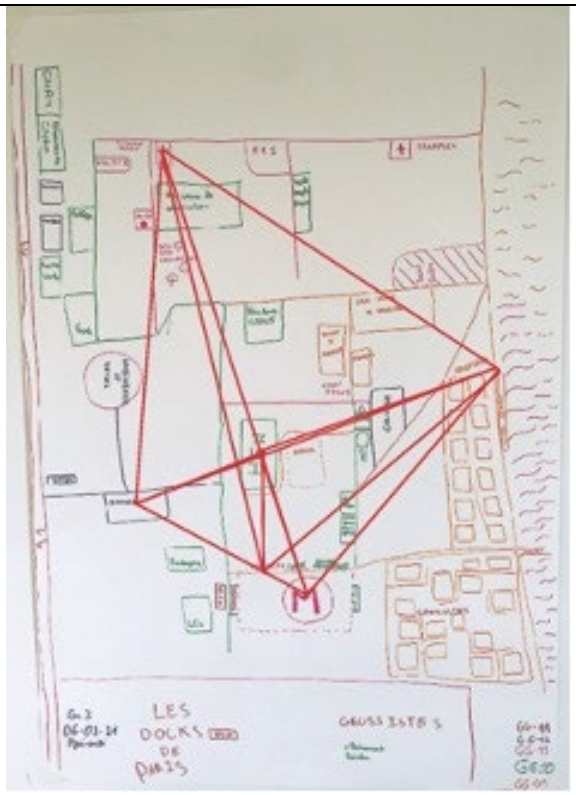
3.1.5. First results from CORES scientific research

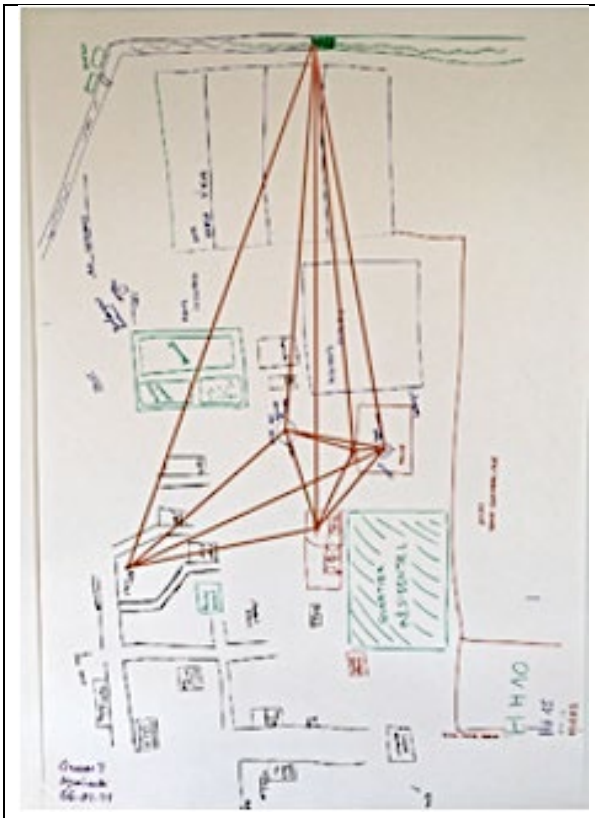
3.1.5.1 Drawing accuracy

A series of *in situ* experiments with three groups of walkers, followed by individual and collective drawings was carried out in the St Denis plain (France). The experiment involved 118 participants divided into three groups: (1) solo explorations without a device; (2) solo explorations with a mobile mapping application; (3) collective explorations with the same application enriched with interaction functionalities (visualization of collective itineraries and photos of places visited). By comparing these three walkers' groups, the aim was to test the impact of navigation and interaction tools on participants' mental representations. First, the accuracy of these representations was measured in relation to geographical space (Google Map), using graphs drawn between 6 fundamental landmarks common to all maps. Initial correlation measurements showed better results for group 2 and 3 compare to group 1, but there was no difference between group 2 (without interactions between participants) and group 3 (with interactions between participants).

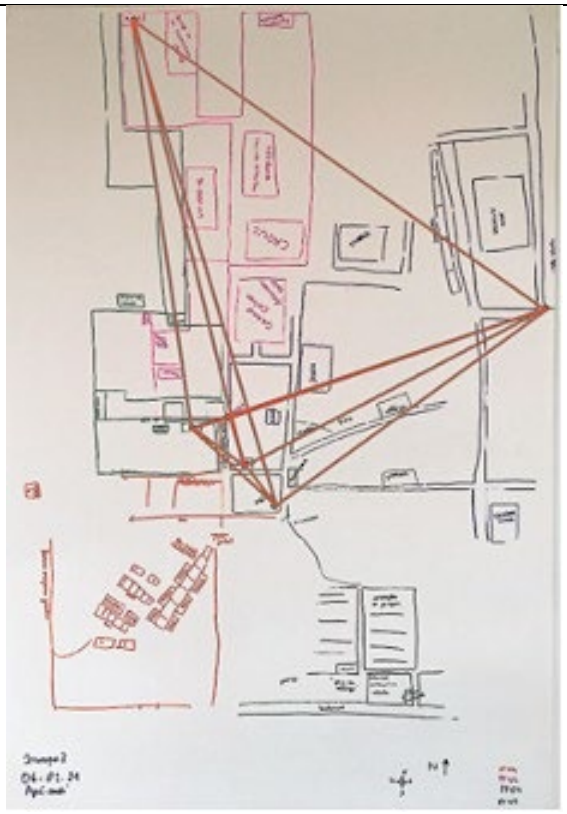
[13] Following in the footsteps of Kendon (1977: 180), Goodwin (2003), Levine (2007: 266), Mondada (2009: 1995), among others, Pentti Haddington (2013), contextualized in her chapter entitled: *Action and Space: Navigation as a Social and Spatial Task*, how actions are closely linked to space, but more importantly "how spatial configurations or understandings of it occasion actions. and how social actions and practices are modified and adjusted in relation to the demands of space".

3.1.5.2. Presentation of graph drawings between 6 subgroups of group 3 (interactions between participants

	
CC3-1	CC3-7
	
CC3-8	CC3-9



CC3-10



CC3-11

Google Map

Figure 3. Graph drawings between 6 landmarks and comparison with 6 sub-groups of 5 participants (with navigation and interaction tool) (Group 3). Last picture: Google Map graph.

Table 1. Identification of the 6 landmarks			
6 landmarks	Code	Category	Address
Église Saint Paul de la plaine	E	Place of worship	131 Avenue du Président Wilson, 93210 Saint-Denis
Quai Lucien Lefranc	Q	Quai	Quai Lucien Lefranc, 93000 Aubervilliers
Métro Front Populaire	M	Subway station	Station Front Populaire, 93210 Saint-Denis
Maison des Sciences de l'Homme – Paris Nord	MSH	Research Institute	20 Avenue George Sand, 93210 Saint-Denis
Square Diderot	S	Park	Square Diderot, 93210 Saint-Denis
Franprix	F	Shop	8 Avenue George Sand, 93210 Saint-Denis

3.1.5.3. Example of edge measurements for group 3

Table 2. edge measurements between 6 landmarks (group 3) and correlation measurements with google

	CC3-1	CC3-7	CC3-8	CC3-9	CC3-10	CC3-11	GOOGLE
QE	1774	1706	1414	1769	2383	2119	1427
QF	1455	1264	1218	1304	1751	1447	1419
QM	1205	1272	1132	1281	1651	1432	1409
QMSH	1368	1191	1119	1092	1664	1423	1311
QS	1841	1959	1580	1659	2075	1571	1574
EF	1309	1200	1863	1870	1100	1942	1555
EM	1417	1367	1969	2028	1215	2133	1693
EMSH	1067	979	1641	1376	904	1723	1433
ES	1198	1159	1892	1535	831	1750	1387
FM	304	170	229	207	126	217	168
FMSH	245	231	223	500	430	214	146
FS	483	788	452	637	440	265	347
MMSH	403	396	409	660	430	417	264
MS	765	823	677	854	437	476	511
MSHS	474	777	453	586	434	156	331
r	0,9322	0,8673	0,9456	0,9390	0,7995	0,9673	0,90

Each combination of two of these letters represents a distance between two landmarks:
Q= Quai, E= Eglise, F= Franprix, M=Metro, MSH= Maison des Sciences de l'Homme, S= Square

Table 3. Measurements of correlations with the edges obtained in the 3 groups and google map

COLLECTIVE MAPS GROUP 1

	CC1-1	CC1-2	CC1-3	CC1-5	CC1-7	CC1-8	Average
Correlations r	0,76	0,68	0,95	0,85	0,89	0,94	0,84

COLLECTIVE MAPS GROUP 2

	CC2-2	CC2-3	CC2-4	CC2-5	CC2-6	CC2-8	Average
Correlations r	0,9425	0,9465	0,9381	0,9461	0,6834	0,9927	0,90

COLLECTIVE MAPS GROUP 3

	CC3-1	CC3-7	CC3-8	CC3-9	CC3-10	CC3-11	Average
Correlations r	0,9322	0,8673	0,9456	0,9390	0,7995	0,9673	0,90

3.1.5.4. Spatial and temporal memories in collaborative map drawing

While a number of studies have distinguished between spatial and temporal memorization at individual level, none seem to have examined these two modes of memorization in collaborative map drawing. Following an initial review of the distinction between spatial and temporal memorization and inhibition in collaborative memorization, we will present analyses carried out on some thirty collaborative drawings from an urban spatial exploration. Metric and temporal measurements carried out on these drawings will be compared in order to identify possible relationships between metric and temporal approaches. Despite three graphical explorations enabling metric and temporal approaches to be related (visualization by curves, radar and anamorphosis), none of them pointed out any significant relationships between metric and temporal measurements. The question is whether the effects of group dynamics are ultimately more decisive than the speed with which these groups position landmarks on the drawings. As a preliminary conclusion, whatever the calculations and visualization methods used, there seems to be no clear relationship between the metric and temporal distances likely to distinguish the 4 groups studied. Radar visualizations, which are entirely dependent on the layout of the data, prove inadequate for showing relationships between metric and temporal distances. Are these biases linked to group dynamics, and more specifically to the phenomenon of collaborative memory inhibition? Other analysis strategies can be envisaged to compare the groups, no longer associating metric and temporal distances, but focusing this time solely on the dynamics of succession between landmarks. Finally, it doesn't appear that participant-groups drew the landmarks in the same order, and in fact the order of appearance of the landmarks may be just as interesting.

3.1.5.5. Collective interactions, collaborative inhibition, and shared spatial knowledge

With my colleague Teriitutea Quesnot we published a recent article[14] 39 reviewing the research and results obtained with the CORES scientific investigation by taking inhibition into account in collaborative memorization. Following the research carried out on the accuracy of mind map drawings between three groups of subjects (non-equipped, equipped, equipped and in an interactive situation in the exploration of the St Denis plain, (see 5.a) we developed the analysis of the results obtained by questioning a now widely-recognized phenomenon: collaborative inhibition in the memorization performed by several people. This refers to the fact that several people remember less well than the sum of their individual memories. As previously presented, this experiment involved 118 participants divided into three groups: (1) solitary explorations without a device; (2) solitary explorations with a mobile mapping application; (3) collective explorations using the same application enriched with interaction functionalities (visualization of collective itineraries and photos of places visited). Comparison of the total number of entities found on individual mental maps with those included in collective sketch maps shows that collaborative inhibition applies to spatial memory. Complementary results showed that collective interactions reduced collaborative inhibition.

4. Interactions between artistic and scientific perspectives

The term "perspective" is open to interpretation. If the aim is to explore new disciplinary contents and boundaries, these perspectives are common to both the artistic and scientific fields. When it is not just a case of the same ambition, but of common objects, the task is more delicate, as the methods obviously differ. In one case (science), context and methods must be specified and reproducible. In the other (art), while context is important, it is only induced by a more or less specific artistic context, and does not necessarily need to be made explicit. What is hoped for is the possibility for participants to receive the novel character of the experience. This is when the project of questioning behaviors and representations makes it possible to specify "interactions" between artistic and scientific perspectives. In one case (science), the aim is above all to understand the relationships between behavior and representations; in the other (art), the aim is above all to explore new configurations linking behavior and representations. But beyond this community of content (representation and behavior in artistic and scientific contexts), it is possible to question a certain community in the steps and method pursued.

4.1. A common starting point, different perspectives

From both artistic and scientific points of view, the common objects are experimentation and apprehension of space, collective interaction, and the matter of interaction tools enabling these interactions. From an artistic point of view, it is all about exploring new forms of collective apprehension of space through distant spaces, in line with the evolution of artistic practices that have historically

[14] Teriitutea Quesnot & Bernard Guelton (20 Oct 2023): Collective interactions, collaborative inhibition, and shared spatial knowledge, Memory, DOI: 10.1080/09658211.2023.2267190

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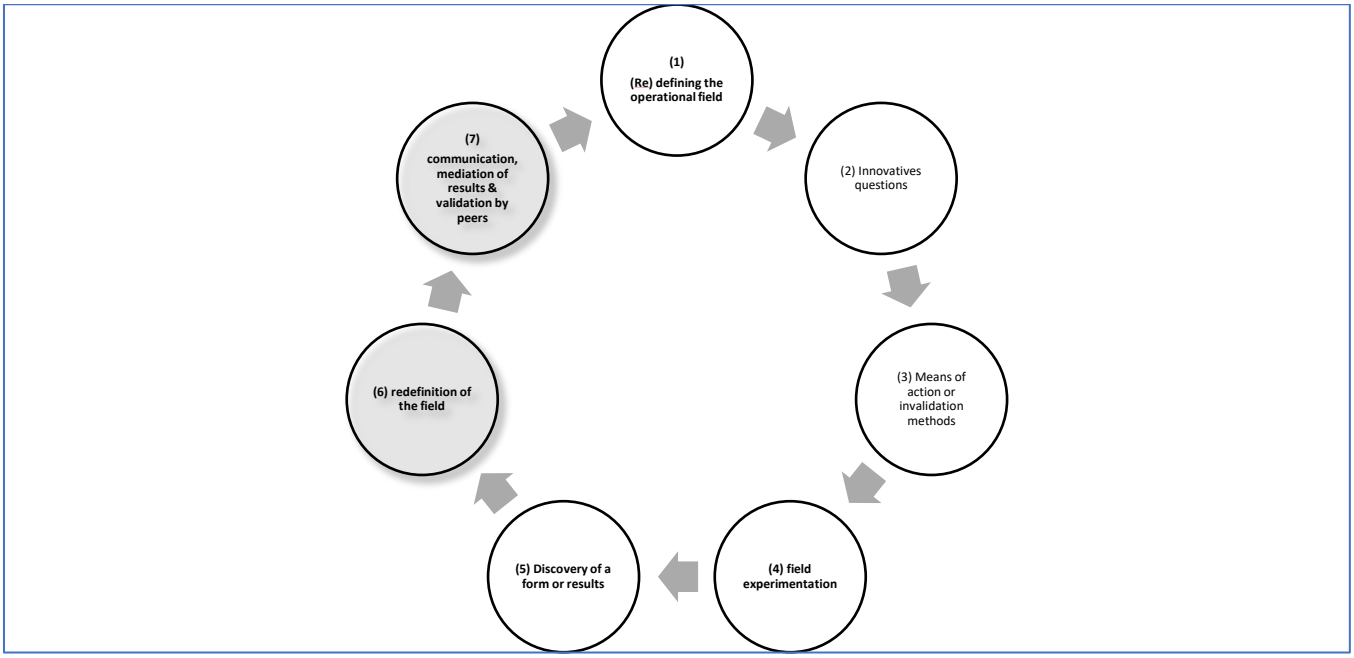
linked the issues of place, mobility and collective interaction. From a scientific point of view, CORES research funded by the French Research Agency (ANR)15 [40] builds on the artistic experiments described above, this time in the context of spatial cognition, to understand and analyze collaborative spatial behaviors, the experience of shared cartographies and access to collective spatial representations. In order to go beyond a mere list of shared concerns, we will consider these relationships between CORES research artistic and scientific perspectives, on the basis of a common cycle in art and science. This common cycle will be developed in seven successive stages, in which we will detail the particularities of the artistic and scientific approaches, keeping in mind that artistic experimentation provided the preliminary support for the scientific approach. The seven stages of the cycle shown in the following diagram are: 1) delimitation of the operational field, 2) innovative question, 3) means of action or invalidation methods, 4) experimentation with the field, 5) discovery of a form or results, 6) redefinition of the field, 7) communication, mediation of results and validation by peers[16]

4.2. The arts and sciences research cycle

Figure 4. Community steps and method pursued in arts and sciences



The Community steps and method pursued in arts and sciences can be described in a cycle in seven steps. These seven stages of the cycle shown in the following diagram are: 1) delimitation of the operational field, 2) innovative question, 3) means of action or invalidation methods, 4) field experimentation, 5) discovery of a form or results, 6) redefinition of the field, 7) communication, mediation of results and validation by peers.

[15] ANR-19-CE38 - 003-01

[16] This common research cycle in artistic and scientific methodology was first presented in conference at École d'architecture de Paris-Villette, France : jeudi 9 février 2012 « Création artistique et médiation discursive », Colloque Art & recherche, Ministère de la culture, 9 et 10 février 2012.

5.3 Specific features of each stage of the arts and sciences cycle in CORES research

5.3.1 Defining the scope of operations

With regard to the delimitation of the operational field common to both art and science, we will define *collective interactions* as the core common to both the artistic and scientific approaches of CORES research. Whereas, in the artistic context, the multiplicity of collectives and locations provided the basis for experimental development, in the scientific perspective, the experimental framework had to be restricted to a single, clearly-defined location, and to precisely configured conditions for collective exploration and interaction.

5.3.2 Innovative question

The modalities and co-construction of the arena provided the innovative questions. While the multiplication and hybridization of distant spaces provided the basis for the artistic context, the issue of collective mental maps and the matter of collaborative memorization emerged as an innovative context, as yet little studied in the scientific context.

5.3.3 Means of action and invalidation methods

The hijacking of consumer applications such as Skype or the development of specially dedicated tools (with ORBE) as interaction tools were envisioned as specific means of action in the artistic context. The delimitation of the territory and the definition of interaction modes and tools, and the confrontation between three distinct groups were envisaged as experimental bases for defining possible methods of invalidation.

5.3.4 Field experimentation

A variety of remote collective interactions in urban situations were experimented with, according to pre-established scenarios or developed *in vivo* in the artistic context. In addition to a clearly delineated reconduction of these remote interactive experiments in a single territory, an experimentation of individual and collective drawings was added in the scientific context to explore participants' mental representations.

5.3.5 Discovering a formatting or results

The discovery of formatting was made possible by coupling walkers' behaviors and goals through the hijacking and appropriation of interactive tools. Closer to the notion of results, CORES scientific research not only accumulated a large amount of data in the recordings and confrontation of the three groups of walkers, but also uncovered unexpected behaviors and representations, such as inhibition in collaborative memorization.

5.3.6 Redefining the field

In the artistic context, limitations linked to experimental contexts have led to new attempts that have scaled back initial ambitions, such as the construction of Hupareel's physical, virtual and fictional city (see section 2.4. above). Rather than a radical redefinition of the field of CORES scientific research, several approaches have been renewed by combining static and dynamic data analysis.

5.3.7 Communication, dissemination and peer validation

Communication, dissemination and peer validation were developed separately in the artistic and scientific contexts. As the artistic approach was initiated in 2013 (compared with 2019), needless to say, the number of symposia and articles communicated has been much greater in the artistic field than in the scientific field.

5. Conclusion

The proposal for a joint research cycle in the arts and sciences was intended to counter the usual divisions in these two major fields of human development, by demonstrating the same creative dynamic. We have tried to show the importance of the prior research context in the arts and sciences, each with its own dynamic. Artistic research has historically integrated successive preoccupations about experimentation with space, mobility and collective interaction, which have found echoes in scientific research. The research presented here, in the broader spatial cognition context, has gradually integrated, more specifically, research on cognitive maps, the acquisition of spatial knowledge, navigation and individual as well as collective memorization. Using the CORES research example, this has provided an opportunity to clarify specific differences within a common framework in the arts and sciences. The CORES research particularity is that it was initiated from an artistic perspective several years before a scientific context could be defined. This research, which initially stemmed from artistic questioning and experimentation, is now unfolding independently. Scientific issues are now at the heart of the adventure.

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- Invitation to a conference at the State University of Rio de Janeiro, Brazil, November 17, 2016
- "Mídias situadas e mobilidades compartilhadas",
- Invitation to a conference at the State University of Rio de Janeiro, Brazil, November 10, 2016
- "Ficções, imagens e intermidialidades",
- Invitation to the University of Porto Alegre Conference, Brazil, October 31, 2016
- "Mídias situadas e mobilidades compartilhadas",
- Conference: CORES: Behaviors and collective spatial representations in urban areas: Interactions of artistic and scientific perspectives, Colloque EGU Exploring the Art-Science Interface, April 2021
- Conference: Table ronde Art et reseaux, Université Paris 1, March 17, 2021
- Conference: International Conference Situated Cognition Rome 2018, September 11, 2018
- New entanglements between instrumental and mental maps in the exploration of urban space: preliminary results
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- "Interactive mobile storytelling and instruction sequences
- Lecture, Sorbonne University Paris 1, December 20, 2014
- "Spaces & Flows: temporal continuities and discontinuities in the construction & experience of a game in alternate realities".
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- Invitation to lecture, Université d'Aix-Marseille, Aix-en-Provence, June 5, 2014
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