Potentials of the Three Spaces Theory for Understandings of Cartography, Virtual Realities, and Augmented Spaces

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Abstract

For about three decades, cartography has been (critically) studied from a theoretical perspective. This perspective has contributed to the recognition of the social preconditions and effects of cartographic representations, but little to their further development. From the theory of three worlds, a theory of three spaces or its special case of landscapes is derived, whose modes of construction are presented as well as the derivations from the different modes. The categories of material, virtual and their combination of augmented spaces as well as the media (such as painting, texts or models) of the construction of space/landscape are added. The formulas derived from this illustrate the different aspects and relations of the constructions of space on the different levels and against the background of the different categories. Thus developed, the theory of three spaces or landscapes provides a framework for neopragmatic exploration, here, of maps, virtual and augmented spaces.

Keywords Theory of three spaces · Landscape · Virtual reality · Augmented reality · Spatial theory · Landscape theory

Potenziale der Theorie der drei Räume für das Verständnis von Kartographie, virtuellen Realitäten und Augmented Spaces

Zusammenfassung

Seit rund drei Jahrzehnten wird die Kartographie aus theoretischer Perspektive (kritisch) untersucht. Diese Perspektive hat zwar zur Erkenntnis der sozialen Voraussetzungen und Wirkungen von kartographischen Darstellungen, jedoch wenig zu deren Weiterentwicklung beigetragen. Aus der Theorie der drei Welten wird eine Theorie der drei Räume bzw. deren Spezialfall der Landschaften abgeleitet, deren Konstruktionsmodi dargelegt werden wie auch die Ableitungen aus den unterschiedlichen Modi. Ergänzt werden die Kategorien materieller, virtueller und deren Kombination der augmentierten Räume sowie der Medien (etwa Gemälde, Texte oder Modelle) der Konstruktion von Raum/Landschaft. Die daraus abgeleiteten Formeln machen die unterschiedlichen Aspekte und Relationen der Raumkonstruktionen auf den unterschiedlichen Ebenen und vor dem Hintergrund der verschiedenen Kategorien deutlich. Die so entwickelte Theorie der drei Räume bzw. Landschaften bietet einen Rahmen für die neopragmatische Erforschung, hier von Karten, virtuellen und augmentierten Räumen.

Schlüsselwörter Theorie der drei Räume · Landschaft · Virtuelle Realität · Augmented Reality · Raumtheorie · Landschaftstheorie

1 Introduction

For a long time, ‘theoretical cartography’ focused on semi-otic questions that examined signs, in this case specifically symbols, on the basis of their syntactic, semantic and pragmatic properties. (Freitag 1971; Ogrissek 1987). Pragmatics’ was also “frequently associated with usability, reference to action and practical disposition”. (Medyńska-Gulij 2012,

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250) was associated with ‘pragmatics’. This theoretical concern within cartography was closely linked to language of cartographic symbology, its use and design. For about three decades, an (intensified) theoretical-abstract preoccupation with maps and the production of maps has developed from the Anglo-Saxon language area (Dodge und Perkins 2015), whereby this theoretical preoccupation has been focused on a critical approach (in the sense of critical theory, not in the sense of Immanuel Kant; e.g. Harley 1989; Wood und Fels 1986). Theoretical approaches which do not explicitly position themselves critically, on the other hand, are far less common in the discussion of cartographic theory (Edler et al. 2018b; Kitchin und Dodge 2007; MacEachren 2004). In issue 3 of KN (vol. 2021), I pointed out in an article the problematic nature of a critical approach tending towards exclusivism. Instead, I advocated for an approach that incorporates some of the approaches of critical cartographic theory (in particular, a constructivist view, but also sensitivity to power relations). Compared to the dominance of a hegemonic worldview, I argued, following Karl Popper and Ralf Dahrendorf (among many: Dahrendorf 1994, 2003; Popper 2011[1947], 2019[1987]), for an object-based pluralism of theoretical approaches (Kühne 2021, a, b).

In this article of the current issue, I refer back to Karl Popper’s three-world theory and deduce a theory of space from it (Kühne 2020; Popper 1979; Popper und Eccles 1977; Weichhart 1999) which is then used to theoretically frame cartography, virtual and augmented reality (VR and AR). However, since cartography (and the practice of VR- and AR-creating guided by it) is based on the standardization of lifeworld concepts of action and thus has made knowledge available beyond practices that are constantly renegotiated (generally: Gethmann 1991; Janich 2004), it has thus contributed to the reduction of the complexity of the world through specialization. Thus, cartography was (and is in large parts) not primarily oriented towards the formation of reflexive knowledge (which has also made it susceptible to ‘critical’ deconstruction). Hence, a brief engagement with the question of why a theoretical perspective on the production, dissemination and use of cartographic representations is worthwhile follows first.

2 So Why a Theoretical Access at All?

Theoretical engagement with an object (here, the creation, dissemination, and impact of cartographic representations) seems useful for several reasons (Kühne 2019; more generally: Kühne und Berr 2021; Poser 2012; Tetens 2013): first, it is practical, because abstraction of the multitude of individual cases facilitates orientation. Second, it has an organizing function, because it makes it possible to classify and compare the most diverse research on the subject

of cartographic representations (which itself is often not or only implicitly connected to theoretical justifications) with respect to theoretical frameworks. Thirdly, it has a function of contingency realization, and it clarifies the multitude of possibilities to deal with a topic (here cartographic representations). Fourthly, it has the function of becoming aware of contexts and how to deal with them; after all, theory shows how different approaches relate to each other, differ from each other, differentiate from each other, and build on each other. Fifth, theoretical reflection can help to regulate conflicts, which are often based on different conceptions of norms, for example, in the selection or representation of objects (material or immaterial), reflection of these conceptions of norms facilitates the understanding of conflicts. Sixth, theoretical reflection has the function of strengthening the interdisciplinary connectivity of cartography (for example, to the social sciences, psychology, or philosophy). So, it does not remain the sole object of theoretical considerations, but contextualizes its own theoretical considerations in an interdisciplinary context. Seventh, a theoretical framing of cartography-making has the function of reflecting the social production of world, for instance the constitution of the normal in its demarcation from the non-normal, here connected with the question of how the non-normal amounts to progress in cartography: the creation of virtual and augmented spaces. Eighthly, theoretical framing has an empirical guiding function, for instance when empirical research is derived from theoretical considerations, empirical research tests the suitability of theories as well as their generalizability. This may be particularly important given the relatively recent academic establishment of cartography as a university science: A university anchorage did not take place until the early twentieth century (Freitag 2008). After these general reflections on the question why a theoretical turn to cartography, VR and AR can be fruitful, a theoretical approach for this will be developed in the following: the theory of three spaces.

3 From the Theory of Three Worlds to the Theory of Three Spaces

Karl Popper, in his three-world theory, calls the world of matter, world 1, the world of individual consciousnesses, world 2, and the world of cultural contents, world 3 (Popper 1979; Popper und Eccles 1977). These worlds are not dichotomously separated from each other, so for example books, but also buildings can be considered as part of the worlds 1 and 3. The human being has a special position, because he is part of all three worlds, and only the individual human being has the possibility to mediate between the worlds 1 and 3, for example by bringing what is observed in world 1 to the social negotiation about this world 1, by manifesting

Fig. 1 The evolution of the three spaces from the three worlds (adapted from: Kühne 2020; Kühne und Berr 2021)

social ideas of world 1 in it. Analogous to these three worlds, three spaces can be formulated: Space 3 as that part of social interpretations, evaluations and categorizations that are related to the constitution and developments of spaces, Space 2 as individual conceptions of spaces that emerge on the one hand through the actualization of social conceptions, and on the other hand also individual references to material Space 1, but also to Space 3. Space 1 comprises material objects as they are spatially synthesized. The three spaces thus represent subsets of the three worlds (Kühne und Berr 2021). From a synthesizing synopsis, landscapes (mostly provided with aesthetic contents) emerge in all three worlds, as special cases of spaces (see in more details: Kühne 2019; Fig. 1). Although these are not centrally addressed in this paper, they provided important impulses for the development of the approach presented here (e.g. Berr 2022; Kühne 2018a; Kühne et al. 2022; Gryl 2022, shows important differences to the theory of Lefèbvre 1974, for instance with respect to normative contents).

The three spaces are subject to constant change, as are the interactions of space 1 and 3 with space 2. The formation of the spaces differs according to different modes of construction. Thus, in childhood, a lifeworldly development of space 1 takes place, the thus developing individual spatial conception (space 2) is centered on one's own body, is unquestioningly accepted as 'normally given' and

is emotionally (usually positively) occupied. This space is marked with the suffix letter a. The supra-individual ideas of space, which are based on a common sense and which are brought to the socializing person, are marked with the suffix letter b (the central idea of space here is that of the spatial container). Expert-like special knowledge about spaces (marked by the suffix letter c) is imparted in particular by completing space-related courses of study, such as geography, geomatics, cartography, and many others (which are associated with specific norms). The consequence is that into the same section of world 1—depending on the mode of construction—different spaces 1, i.e., spaces 1a, 1b and 1c are projected, whereby these can have intersections, but do not have to. A particular tree can be a central part of home in mode a, not individually noticed in mode b, and synthesized into "forest" by the cartographer with neighboring trees in mode c and mapped and translated into the norm-mediated signature language.

The constitutive level for the distinct modes of spatial construction is different, which can be represented by indent 'on the suffix letter: in mode a, the individual (space 2a) is constitutive, dealing with space 1 (thus space 1a'). For modes b and c, the societal level (space 3) is constitutive, thus the individual actualizations in modes b and c are denoted as space 2b' and space 3b', respectively; when observing space 1, spaces 1b'' and 1c'' arise accordingly (Fig. 2). If a person with expert-like special knowledge succeeds in implementing alternative interpretations and evaluations (i.e., interpretations that deviate from the previously valid consensus) in space 3c, a development space 3c → 2c' → space 3c'' occurs. This in turn is transformed—in case of successful implementation—from space 3c'' into space 3c, at a second point in time.

Fig. 2 The modes of spatial construction a, b, and c and their derivatives (adapted from: Kühne 2020; Kühne und Berr 2021)

Fig. 3 The communication of ALTER and EGO by means of a map (own representation)

4 The Generation of Cartographic Representation Interpreted with the Help of the Theory of Three Spaces

With the help of the theory of three spaces, communication by means of cartographic representation can also be understood (Fig. 3). A central criterion for the creation of a cartographic representation lies in the assumption of an intersubjective and intertemporal relevance of what is represented, based on the social stock of knowledge. This representation can be understood as a hybrid of spaces 1, 2 and 3 and is a carrier of information and communication describes—according to Niklas Luhmann (1987)—the synthesis of three selections in a unity of information, communication and understanding. Involved in this (simplified example) are age (the sender) and EGO (the receiver). ALTER, in the course of socialization in the c-mode (such as the study of geodesy, cartography, geography, etc.), incorporates essential professional conventions of observation (step 2), evaluation and selection (step 3) of space 1. He puts these into a cartographic representation (here a map) according to the conventions of representation learned in the c-mode. This map, in turn, is observed (steps 6) by EGO (as part of space 1) according to the conventions acquired in b-mode (common sense) (step 5) and read according to the interpretive conventions acquired. The extent to which cartographic communication succeeds depends on whether and to what extent there is an intersection in the cartographic conventions of b- and c-modes. We will return to this after adding to the levels (1, 2 and 3) modes (a, b and c) and derivations (represented as steps in this example), including categories and media. (A brief side note: this model is also connectable to classical semiotic space theory, as is especially evident in the translation of c-mode to b-mode, as different semantics are related here).

5 The Representations of Maps, Virtual and Augmented Spaces in the Framing Extended by Categories and Media Through the Theory of Three Spaces

The theory of the three spaces or their special cases of the three landscapes, which has been developed up to this point (more detailed: Kühne 2018a; Kühne und Berr 2021; Kühne und Jenal 2020) may contribute to the understanding of the differentiated nature of levels (worlds, spaces, and landscapes, respectively) as well as different mechanisms of construction in modes (a, b, and c) and processes of landscape construction (constitutions and derivations), but it is limited to arrangements that are often referred to as ‘real space’, such as what is depicted in topographic maps. The limitedness is particularly evident when virtual or augmented spaces (or landscapes) are to be theoretically framed. However, this limitedness is also already evident when alternative media to ‘real space’ are used, such as photographs, maps, or even paintings. To be able to integrate the categorical and medial differentiation in the theory of the three spaces/landscapes, a further differentiation was made along the example of model railroads (Kühne 2022a): on the one hand, the categories (virtual, augmented and material), and on the other hand, the media (model, painting, map, photo, etc.) are now not only verbally presented (as it was necessary before), but integrated into the format of the landscape formula by an extension through a prefixed and subscript letter combination (prefix letters, supplemented by special characters). The capital letters move to the first position:

- M for material spaces (‘real landscape’),
- V for virtual spaces,
- A for augmented spaces.

So, on the level of space 1, this means that a material, virtual or augmented space is observed. The observer is the

individual, who must be able to interpret spaces of the different categories—in this respect, these categories are also effective on levels 2 and 3.

In addition to these categories, different media are highly significant for the construction of spaces (and landscapes). These can be added next to the categorical prefix, also subscript, but lowercase for better distinction, and can be specified for VR (here an extension occurs compared to the approach presented in Kühne 2022a). It stands:

- c for cartographic (in category V: computer generated),
- f for photographic (in category V: photorealistic),
- a for painted or similarly artistically designed (in category V: modeled on the physical-material models),
- m for model-like (in category V: designed according to the ‘prototype model’),
- t for textual (in category V: integrated texts),
- p for physical-spatial (in category M, ‘real space’, in category V: a VR that gives the impression of three-dimensionality, i.e. goes beyond the medium f).

This list is not exhaustive and can be extended accordingly (a summary of the current status can be found in Table 1). Combinations and hybridizations can be found (as they are constitutive in AR). The media are then named in order of descending dominance. Thus, in computer games it is common to combine the media p and c, which is indicated by the subscript prefix v_{pc} (Kühne 2022b; Pietsch 2022), when representing space in pinball landscapes, it is common to combine the media p and m, which in combination

with their materiality results in the prefix M_{pm} (more on this way of creating landscapes: Edler 2020; Kühne et al. 2020). Hybridizations between media are indicated by a tilde ~. An artistically designed map is marked accordingly with the prefix M_{c-a} . If now the levels, modes and derivations are added to the categories and media, such a material map, which was generated on the basis of the derivation from expert special knowledge, can be represented in the format $M_{c-a}1c''$. This kind of representation can also contribute to the understanding of the generation and dissemination not only of a cartographic but also of virtual and augmented generation and dissemination of information, interpretations, and valuations, which will be illustrated below. The theory of Three Spaces with its modes, derivations, categories and media, as an aid to understanding virtual and augmented spaces.

The transformation of information, interpretations and evaluations by media serves communication. Communication—according to Niklas Luhmann (1987)—involves ALTER (the sender) and EGO (the receiver). In the terminology introduced above, this means in the case of an everyday communication via the category M: ALTER and EGO must have introduced their spaces 2 so far into the contents of mode b from space 3 that initially an irritation-free communication via space 1 is possible. This arises, for example, if different preferences, starting from the a-mode, have also arisen in the case of spaces 2 to the shared information, interpretations and valuations of the b-mode. However, elements of the c-mode are also able to irritate the interpretations of spaces 1 in the b-mode.

Table 1 Summarizing overview of the generation of the spatial or landscape formulas (own representation)

Subject	Category	Medium	Level	Mode	Derivation
Horizontal position in the formula	Prefix 1	Prefix 2	central element	Suffix 1	Suffix 2
Vertical position	Subscript	Subscript	Normalized	Normalized	Normalized
Type of representation	Letter capitalization	Letter lower case	Number	Letter lower case	Special character: ‘
Meaning of the abbreviation	M = material space	a = painted or similarly artistically designed representation	1 = material space or landscape	a = native normal landscape	No ‘ = origin level
	V = virtual space	c = cartographic representation	2 = individual room/landscape construction	b = common sense	‘ = first derivative
	A = augmented space	f = photographic representation	3 = socially shared information,	c = expert	“ = derivative from the first derivative
		m = model-like representation	Interpretations and evaluations of space and landscape		etc
		p = physical-spatial representation			
		t = textual representation			

To illustrate this with the example of ‘old industrial landscape’ (first in the M-category): the landscape 3b-contents for this essentially comprised (at time t_1) valuations, such as ‘ugly’, ‘dilapidated’, ‘ecologically poor condition’ etc. in the course of socialization this was implemented in ALTER and EGO in the form of landscapes 2b’ in this way, whereby EGO grew up in such an area, correspondingly developed a native attachment in the a-mode. Accordingly, an intrapersonal contradiction between a- and b-mode develops in EGO, but also between ALTER, who evaluates purely in common sense (b-mode) and EGO, who also has (positively evaluating) a-elements to landscape 1a’ in his individual landscape consciousness. A further contradiction arises when, for example, in c-mode a change in evaluation is produced, which no longer connotes old industrial landscape (in the chosen format thus M_p1c'') as negative, but, for example, ‘aesthetic’ instead of ‘ugly’ now as ‘sublime’ (at time t_2). This evaluation is taken up by EGO, so that he now (by combining a-, b- and c-mode) constructs his ‘home landscape’ individually in the form $M_p2a \sim c' \sim b'$, and compared to ALTER whose construction is limited to M_p2b' , by taking up the c-mode, achieves a gain in distinction and legitimacy (on this mechanism in detail: Aschenbrand, 2016; Bourdieu 2016; Kaiser und Maasen 2010; Kühne 2008; Weingart 2015).

The generation of virtual spaces, as well as augmented spaces, first draws on the supply of information, interpretations, and valuations of the b-mode as shaped by the M-categorical view. If this were not to happen, communication in the above mentioned Luhmann’s sense would fail, because the third selection, understanding, would not be successful. Generally speaking: the transfer of information (including interpretations and valuations) from c- to b-mode must in principle be connectable. If only common-sense patterns are

updated in the construction of a virtual landscape 1, this can be described in the simplest case as a landscape v_f1b'' (since we refer to spaces and landscapes, we do not take into account here that expert knowledge is also necessary for the generation of a virtual landscape). However, virtual spaces can also be used in processes of transferring c-mode knowledge, for example by enriching an artistic design with textual and cartographically prepared information, the result is then a $v_{ptc}1c''$ landscape (an example: Edler et al. 2019). If the virtual creation of a landscape takes place by means of the mixture of photographic and artistic representations by experts, a $v_{ap}1c''$ landscape is created (see Fig. 4; Kühne et al. 2021a). If expert information is presented by means of AR, for example in the form of games or excursions, this can be classified as an $A_{pa}1c''$ -landscape if comic-like figures are used. If individually updated landscape common sense knowledge stocks are thereby modified, a landscape $A_{pa}2b' \sim c''$ emerges (examples can be found at: Koegst et al. 2022; Stintzing et al. 2020).

It is at this point that the potential of AR and VR for the developments of landscape understandings, beyond the common sense (the b-mode) becomes clear. Thus, elements of c-mode understandings can be made low-threshold and, when appropriate techniques (such as 3D and noise) are used, can be made immersive as well (Edler 2021; Hruby et al. 2019, 2020). The use of game-like elements also enables an increase in the contingency experience of spatial processes; for example, in round-based games, consequences and side-effects of certain decisions can be experienced in the space $v_{ap}1b'' \sim c''$ without affecting the space $M_p1b'' \sim c'''$ (the same applies, of course, to a-mode constructions). However, the potentials of VR and AR for spatial and landscape research are not limited to possibilities of conveying c-mode information alone, but spaces and

Fig. 4 Example of an immersive large-scale planning scenario in a settlement (including streets, buildings, vegetation and shadows), a representation $v_{ap}1c''$. (illustration by Dennis Edler and Timo Wiedenlubbart, taken from: Kühne et al. 2021a)

landscapes of categories V and A can themselves become the object of research (for example, at Fontaine 2017, 2020) or constructed for the purpose of research (Edler et al. 2018a, 2018b; Keil et al. 2019; Lütjens et al. 2019; Walmsley und Kersten 2020).

6 The Potentials of the Theory of Three Spaces—A Conclusion

At this point at the latest, it becomes clear that the relationships of categories, media, levels, modes, and derivations are subject to a high degree of complexity. The complexity is increased by the fact that space or landscape 1, 2 and 3 are not stable, but are constitutively subject to change. This in turn necessitates the adoption of different theoretical perspectives with regard to the interaction between the levels, but also the modes, categories, the use of media, even the effect of the derivations. If, for instance, the individual experience of $v_{ap}1a' \sim c''$ as $v_{ap}2a''' \sim c'''$ is to be investigated, a phenomenological perspective suggests itself; if the processes of mediation from M_p3b to M_p2b' are to be explored, a social constructivist framing suggests itself, just as a positivist one seems reasonable if the aim is to map M_p1c'' . This illustrates the necessity—should not individual aspects of the complex spatial or landscape relations be considered in isolation—of orienting oneself towards a ‘neopragmatic’ access (Kühne 2018b; Kühne et al. 2021b; Kühne und Jenal 2021). The neopragmatic approach does not follow a classical semiotic understanding of pragmatics, nor an understanding of usability, but goes back to the philosophy of American pragmatism, which did not orient action on (moral) principles but on expediency and fitness (James 1890). Neopragmatism extended this understanding in the direction of a rejection of the concepts of objectivity and truth based on linguistic philosophy. The recognition of pluralistic world views and the ‘insight into contingency’ (Rorty 1997) took their place. This means not least the possibility of a well-founded triangulation of different theoretical approaches (for instance the integration of classical semiotic theory of cartography into the theoretical understanding of the three spaces presented here). To do justice to the complexity of the relations between the levels and especially the categories of spaces and landscapes, it is also necessary to combine the disciplinary backgrounds of researchers. For example, the meaning of a landscape $v_{pat}1a'c''$ generated for this purpose for the changes for individual landscape consciousness in confrontation with M_p3b demands cannot be investigated without technical c-modal knowledge of the generation of a category V landscape, but also not without social science knowledge (likewise c-mode) for the investigation of socialization processes from level 3 to 2 as well as processes of emotional attachment to level 1.

The theory of the three spaces/landscapes presented here can thus be understood as a categorial framework with the help of which the different levels of space or landscape can be structured, and the interactions can be traced with the help of the derivations. Especially the increase of meaning through VR, later through AR, has directed the focus more on the media of the construction of landscape. This is also evident in the organizing framework of the theory of spaces or landscapes. It thus provides a basis for a theoretical framing that is (unless isolated processes or structures are to be studied) of a reasoned multi-theoretical, multi-method, and multi-personal triangulation based on various data sources investigation of a neopragmatic approach. These considerations illustrate—also against the background of making information available—the potential of this approach (especially in comparison to critical approaches): there is a suggestion of mechanisms and effects that support the generation of cartographic representations.

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