Deviant Cartographies: A Contribution to Post-critical Cartography

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Abstract
Based on the recently developed approach of 'post-critical cartography', this article addresses how developments in cartography can be interpreted functionally, dysfunctionally, afunctionally, and metafunctionally. This interpretation takes up the sociological topic of deviance. Normatively, this article bases on Ralf Dahrendorf’s concept of life chances. It includes established terminology which can be applied to the development of cartography. For example, the development and dissemination of digital cartography, in different development stages, has shown to be functional. Cartographic representations restricting life chances due to disinformation and manipulation can be described as dysfunctional. Cartographic representations that do not receive positive responses from the public or the professional community can be characterized as afunctional. Metafunctional representations are capable of highlighting the contingency of the world and its cartographic interpretation, particularly by including the stylistic device of irony. Critical cartography has made some functional contributions to cartography, but it also comprises dysfunctional effects originating in its moral rigorism. This article intends to contribute to the preservation of its functional and to overcome its dysfunctional impacts.

Keywords Deviance · Deviant cartographies · Post-critical cartography · Critical cartography · Cyberwar · XR · Mobile cartography

1 Introduction
The development of cartography is premised on the accomplishment of the daily challenge to improve orientation in a (material) geographic space, often beyond one’s own scope...
of perception. Due to increasing demands on the accuracy and efficiency of this intersubjective orientation (e.g., nautical navigation or infrastructure development), a standardization and digitalization of the acquisition, processing, and presentation of geospatial data were built on an (often not explicitly stated) positivistic understanding. Moreover, geospatial data and its access were under public maintenance and control.

Since the 1980s, cartography has been subject to an intensified theoretical reflection (for overviews, see: Dodge et al. 2011; Fernández and Buchroithner 2014). These debates receive a new relevance due to different ongoing developments, such as the establishment of new technology and mass media (e.g., augmented and virtual realities), the increasing availability of geospatial data resources (including the data which were previously subject to close governmental control), and new ways of generating and disseminating cartographic representations on the Internet (see, for e.g., Edler et al. 2019a, b; Gryl and Jekel 2012; Könen et al. 2018).

A concise theoretical engagement with cartography is 'critical cartography', which, at first, highlighted the social ‘constructedness’ of maps and, secondly, the power-bound nature of map-making. This caused a third core aspect: the creation of cartographic media should only be the outcome of participatory processes (Crampton and Krygier 2005; Harley 1989; Kim 2015). Following the critique of this position, Kühne (2021a, 2021b) suggested a more nuanced understanding of cartography, one that is more pragmatic and normatively oriented toward life chances. Following this argumentation, we will examine cartographic developments using the sociological concept of deviance. It addresses violations of norms in society and deals with the functions of these violations. Using this approach, we investigate different forms of deviance in the development of cartography. Thus, we intend to show an alternative understanding of a linear progress. This includes changes in paradigms and replacements of research foci (Kuhn 1970; Lakatos 1974). Moreover, we refer back to the fact that innovations in cartography are bound to research perspectives and contexts. As the normative basis, we built on Ralf Dahrendorf's concept of life chances (Dahrendorf 1979). Having shown our understanding of deviant cartographies, we will address critical cartography and the aspects of its critique.

2 Life Chances and Deviance: Some Basic Considerations

Dealing with deviance, i.e., a deviation from more or less shared norms in social contexts, requires a normative justification, in case it is not limited to a mere descriptive approach. As this normative basis, we use Ralf Dahrendorf’s concept of life chances, which we introduce briefly before dealing with the different and established forms of deviance.

2.1 Life Chances

Ralf Dahrendorf (1929–2009) developed the life chances concept by following Max Weber. This concept deals in a non-deterministic way with the relations between individuals and society, and it allows the integration of spatial aspects. In other words, the concept can be used to trace societal, spatial, as well as spatially mediated societal restrictions for the individual. Moreover, the individual’s possibilities can also become spatially and socially innovative (Kühne 1970; Kühne et al. 2021a; Kühne and Leonardi 2020; Leonardi 2014).

Dahrendorf understands life chances, figuratively speaking, as “the baking forms of human life in society; they determine how far people can develop” (Dahrendorf 1979, p. 24). In his understanding of chances, Dahrendorf (1979, p. 98) follows Max Weber (1972 [1922]): On the one hand, chances are “structurally based [...] probability of behavior”. On the other hand, they are “something that the individual can have, something as an opportunity to satisfy interests” (Dahrendorf 1979, p. 98). Chances are in turn “socially shaped. Social structures order opportunities” (Dahrendorf 1979, p. 98). Life chances need a meaning that is based on certain “value concepts that provide standards” (Dahrendorf 2007, p. 44). These value concepts are called ligatures (Dahrendorf 2007, p. 45). They are “structurally marked fields of human action. Individuals, by virtue of their social positions and roles, are placed in bonds or ligatures” (Dahrendorf 1979, p. 51.). Ligatures form the static element of peoples’ engagement with the (especially social) environment, and they provide the framework for options.

Options are understood as dynamic components of life chances (Dahrendorf 1979, p. 50): “Options are choices given in social structures, alternatives of action”. Ligatures and options are subject to an intensive interdependent relationship (Dahrendorf 1979, p. 51f.): “Ligatures without options mean oppression, while options without ties are meaningless”. Only the interplay of ligatures and options gives rise to life chances: “Life chances are opportunities for individual action resulting from the interrelation of options and ligatures” (Dahrendorf 1979, p. 55).

Furthermore, Ralf Dahrendorf interprets historical development (Dahrendorf 1983, p. 124) as a “struggle for the expansion of human life chances through the multiplication of options”. Options, in turn, result from the practical use of reason, which consists of “not acting according to the given laws of nature, but imagining laws for oneself, e.g., balanced relationships between ends and means. This implies recognizing the imagined laws as principles and acting according to them. The property to act according to the imagination of
laws is also called will, so that practical reason is nothing other than the property of will” (Höffe 1992, p. 174). Such 'self-legislation' (or 'self-determination') of the will (Kant 1993 [1790], § 8) means liberty, in the sense of 'autonomy'. On the one hand, practical reason enables the questioning of ligatures and provides the basis for deciding which ligatures to follow and with what intensity. On the other hand, reason creates options by understanding internal and external contexts. The use of reason, in turn, “suggests an impartial, tolerant, responsible attitude” (Dahrendorf 2008, p. 76; similarly Strenger 2015). Options, in turn, can be transformed into ligatures, which can grow into social conflicts. In the face of the 'less powerful' (Paris 2005), the powerful strive to secure options in the form of privileges, and they transform these privileges into ligatures, with the effect of limiting the generation of options of the 'less powerful' (Dahrendorf 1992, 2007; Strasser and Nollmann 2010).

Applying the previous thoughts to cartography, the task of the discipline is to contribute to increasing life chances. Such a normative basis implies three main aspects:

First, to generate knowledge about the world by developing new possibilities of cartographic presentation and cartographic representations of further topics and phenomena, as well as to publish the principles of cartography. Second, to evaluate and criticize those representations which are designed to reduce life chances. Third, to maintain a critical distance from whether and how options for securing power are transformed into ligatures (this is the essential starting point of critical geography and cartography).

In other words, cartography is required to enlarge options, to reflect on ligatures and, built on this reflection, to accept, update, or reject them, and, last but not least, to critically question whether and how it transfers options into ligatures. These processes are bound to dealing with norms that can either be followed or deviated from. This leads us to the topic of deviance.

2.2 Deviance: Some Basic Considerations

The concept of deviance is a core concept in sociology and refers to behaviors “that violate the social norms in force in a society or one of its substructures and, if detected, provoke social reactions aimed at punishing, isolating, treating, or correcting the person in question who exhibits this behavior” (Peuckert 2006, p. 106). Deviance can be determined by five dimensions:

1. The prerequisite is the existence of norms in a society.
2. The norms may be shared across society, but may also apply only to parts of society.
3. Deviance unfolds in a relation between individuals and society.
4. This relation involves a violation of at least one applicable standard.
5. Upon discovery of the violation, a negative sanction will be imposed.

Norms can be understood as that part of the ligatures which are applied to individual persons in the form of generalized expectations. Norms make an essential contribution to the determination of 'normality'. This normality is rarely discussed, as it is taken for granted (cf. also Berger and Luckmann 1966). Normality, as a social and individual construct, only becomes conscious through deviance. On the one hand, the contradiction to normality is understood in dichotomous multiple opposites (Fig. 1). Normality with its norms and role expectations thus actualizes the 'vexatious fact of society' (Dahrendorf 1971 [1958]). Deviance from these norms is often socially evaluated as dysfunctional. It is subject to stigmatization processes, including criminalization processes (e.g., Stehr 2013). On the other hand, deviance can also have a functional character for society or its parts. Only if there is deviance from an existing norm, genuine progress can be achieved. In societies, but also within parts of society, the understanding of deviance can be different: while some religious societies reject homosexuality, it is accepted in societies that are more tolerant. Violence is considered normal in hooligan communities, while it is deviant for educated classes.

Deviance can also increase a society's tolerance of ambiguity, as already pointed out by Émile Durkheim (Durkheim 1961 [1895]): the more a society adheres to its norms, the narrower are the limits of tolerated deviance from these norms. Furthermore, deviance serves to clarify norms (after all, positive things only get meaning through negative things—no heaven without hell). In addition, it is also possible to assume a functional deviance. This is noticed but
neither positively nor negatively sanctioned, i.e., a simply accepted deviance.

In the context of the life chance approach pursued here, deviance can be understood as an expression of the striving for (individual) life chances. In this context, norms, as the component of ligatures applied to the individual from the outside, are transgressed. Thus, their meaning is denied situationally or generally. Options develop beyond ligatures, but again remain bound to them constitutively (though, in this case, negatively). Whether deviance is evaluated as functional, dysfunctional, or afuncational is again (partially) socially and temporally contextualized. As a result of the increase of options, ligatures are dissolved. Options develop into new ligatures through normalization.

A normative understanding of cartography is that it has, like other research disciplines, the task to increase life chances that especially originate in options. Ligatures only frame life chances if they give a meaning to options and do not restrict them. Based on this understanding, we intend to address functional, dysfunction, afuncational, and metafunctional fundamentals of cartography.

### 3 Forms of Deviant Cartographies

Cartography dominantly appears in the knowledge stocks of the common sense (the generally expected level of knowledge in a society or parts of it). It also occurs in the knowledge stocks of experts acquired through professional education processes. As a result of their cognitive centeredness, they are of less importance for more emotions referring to home (Kühne and Jenal 2020b). Common-sense understandings of the cartographic version of the world are essentially fed by expert access. They are systematically conveyed in the process of socialization (e.g., in geography classes) and supplemented by (mostly unsystematic) exposure to cartographic representations, for example, on the Internet or in the press (cf. Schiewe 2017). The development of cartographic representations is linked to the everyday problem of being able to find orientation in (geographic) space—beyond one's own perceptual space—and to share this orientation with others.

In relation to the five dimensions of deviance, the following classification can be made with reference to cartography:

1. Differentiated norms for cartographic representation exist in societies.
2. These norms are differentiated between expert and common-sense understandings.
3. Deviance arises with regard to cartographic representations by the fact that ‘something’ is represented by a person ‘in a different way’ than previously surveyed.
4. This violates at least one applicable standard, since it deviates from a previously applicable standard or convention.
5. Upon discovery of the violation, a negative sanction is applied, and the deviation requires at least explanation (by the professional community).

The central aspect in the creation of deviant cartographies is point no. 3. It is bound to the questions of what, how, and by which means deviance is created. This can refer to new topics of representation, new forms of expression and new media of cartographic representation. This deviance can be understood as development of options, as they allow for new interpretations of the world. Point no. 5 then examines whether the deviance is negatively or positively sanctioned, whether it is ignored, or whether it receives the status of a norm. Thus, a conversion of options to ligatures takes place.

These considerations can be operationalized against the background of the norm of increasing life chances (in Ralf Dahrendorf’s sense). Accordingly, four types of deviant cartographies can be distinguished:

1. **Functional deviance** It deviates from the normatively set standard and contributes to the increase of life chances through a gain in knowledge (related to form or content). Of particular importance is the increase in contingency (i.e., what is possible but not necessary): information that have not been presented before, information that have been presented differently before, or information that have been presented differently using other methods and techniques or information that is raised into the realm of what can be presented.

2. **Dysfunctional deviance** It deviates from the normatively set standard and intentionally or unintentionally limit life chances. This applies, for example, to moral prohibitions to visualize something which could be visualized, to present something in a manipulated way (with the aim of reducing life chances) or not to use certain methods and techniques of visualization.

3. **Afunctional deviance** It deviates from normality with varying intensities (in terms of form and content). It is established neither in common sense nor in expert special knowledge. As a result of its ineffectiveness, afuncational deviance shows that deviance does not necessarily have consequences if it does not trigger any social or (partially) social resonance.

4. **Metafunctional deviance** It is understood as a special case of functional deviance. It can contribute to a (playful) questioning of cartographic standards. This questioning can include a reflexive or ironically distanced way. It stimulates an examination of cartographic standards and thus serve criticism in the sense of “critical distance from a matter of course of one's own society”
Following Richard Rorty (1997), irony can be regarded an expression of the awareness of contingencies referring to the world, form, content of representations, and technological possibilities.

In the following, we present established development lines in cartography. Then, we interpret these developments against the background of our understanding of deviant cartographies.

### 4 Deviant Cartographies: Developments as Dealing with Deviance

The development of cartography includes some examples in which approaches of deviance from the normatively set standard have not only contributed to a further development of the discipline, but also establish connections with the concept of life chances according to Ralf Dahrendorf. After a short introduction to basic paradigms (Kuhn 1970) in cartography, which are shaped by technical and societal changes, the above-introduced manifestations of deviant cartographies (functional deviance, dysfunctional deviance, afunctional deviance, metafunctional deviance) are further explained using different examples.

#### 4.1 Development Phases in Cartography

Paradigms and paradigm shifts were regularly suggested and discussed in the cartographic literature (e.g., Brodersen 2007; Fernández and Buchroithner 2014; Freitag 2000; Griffin et al. 2017; Jiang 2019; MacEachren and Kraak 2001; Virrantaus et al. 2009). Such publications, even if some of them are labeled as research agendas of the International Cartographic Association (ICA), are difficult to consider as an agreement of a global understanding of cartography. Different research foci, approaches to technical innovations, policy measures (e.g., Open Data initiatives in the positive or prohibitions and information restrictions in the negative sense) or spatial data services and infrastructures (in the public and private sectors) have certain spatial spheres of influence. Such impacts offer different development potentials and shape the subject of cartography with different ‘spatial accentuations’. Hence, some publications on cartographic paradigms or paradigm shifts are directed at specific study areas, such as USA (Clarke et al. 2019; McMaster and McMaster 2002).

Jean-Claude Müller et al. (2001) provide an example of how the basic “development phases” of cartography, including their changes or shifts, can be classified, from the 1960s onwards, up to the beginnings of an audio-visual cartography in the early 2000s. The authors arrange the phases of cartography roughly by decades (Fig. 2).

From the 1960s onward, advances in printing technology shaped automated map production, so that, for example, official maps such as topographic maps could be produced in a more standardized manner and were made more accessible to a broader public. In the 1970s, influences of the computerization of the labor market have begun to shape the possibilities of producing not only paper-based maps, but also the first approaches of digital maps, coined as “virtual maps” by Moellering (1975, 1977). The 1980s were characterized by a “democratization of map-making “ (Fairbairn 1995, p. 42, cited in Scharlach 2002, p. 9, see also Rød et al. 2001). This process was due to the spread of technology and the further establishment of computers as standard tools, in professional as well as leisure-time contexts. Mass-market hardware and software became accessible. They served individual interests in the use and creation of maps. Consequently, cartography left a strongly institutionalized orientation. The creation and production of (often standardized) maps and the potentials of participation increased, which can be seen as the beginnings of citizen involvement in cartography [today understood as “Citizen Science”, going back to Irwin (1995) and Bonney (1996)]. The increasing dissemination of hardware and software also characterizes cartography in the 1990s. The use of expert software, especially Geographic Information Systems (GIS) and graphics or animation software, led to new spatio-temporal media in cartography going beyond ‘classical’ static 2D representations. This marked the beginnings of an interactive and animated web and multimedia cartography (DiBiase et al. 1992; Dickmann 2001; Müller 1997; Peterson 2007; Taylor 2005). These map applications were able to leave the purely visual dimension of cartographic communication and information transfer. They communicated and conveyed spatial
information in a multisensory, especially audio-visual way (see further Edler et al. 2019a, b; Laakso and Sarjakoski 2010; Lammert-Siepmann et al. 2017; Schito and Fabrikant 2018).

Further professional developments of cartography since the 2000s shall still play an important role in the course of this essay. However, at this point (and building on the introduced concepts), a temporary stop is worthwhile: the example of audio-visual cartography illustrates that deviance from the previous norm of the discipline, and in this case functional deviance predominates, can lead to an updated normative understanding of the medium map. The map in its established understanding as a (plane, generalized, scale-dependent, and explained) graphic 2D model for conveying spatial information (cf. Bertin 1967; Bollmann 2002; Harley 1990; Monmonier and Schnell 1988) receives new impulses through technological, and at the same time socially accepted, possibilities of acoustic enhancement. This is a consequence caused by the further development of automation technology, digital cartography, and the individualization of map-making as well as by the increasing acceptance of a multimedia cartography (cf. Fig. 2).

Since the 1990s, sound design has been explored in cartography. The original deviance of audio-visual design used to transfer spatial information in map applications, which can be traced back to John B. Krygier’s basic essay (1994) as well as to preceding isolated examples from the film industry (Caquard 2009) and computer or video games (Edler and Dickmann 2017), became an accepted standard due to its functional potential. This led to adaptations of definitions of the key term “map” in the 2000s: “In multimedia cartography, additional media such as audio, animation, and video are used in addition to the traditional map to convey information in a vivid and user-friendly way” (Dransch 2002, p. 164–165; see also Dickmann 2018, pp. 169–171; Leser et al. 2017, p. 62). Moreover, at the professional association level (Weisensee 2012, p. 284), using the example of the German Cartographic Society (DGfK e.V.), it became apparent that deviance can find its way into the norm: “Alternatively or even complementarily, the board proposes to update the definition of the discipline of cartography. Cartography as science, technology, and art of communication of spatio-temporal information not only extends the previous limitation to visualization and thus also includes haptic and acoustic forms of presentation […]”.

If the norm is not accepted alone, but is also associated with meaning by the professional community, a ligature emerges. Further current examples of functional deviance in cartography are presented in the following (and without any claim to completeness in the scope of a single article).

Based on the understanding of the four types of deviance, we will propose an alternative interpretation of this rather ‘traditional’ characterization of the development of cartography. We will start with a ‘productive type’, i.e., functional deviance.

### 4.2 Functional Deviance

Functional deviance in cartography can be found in some 2D cartographic media. Anamorphosis (including distortion and reshaping) can be understood as a cartographic visualization method, which deviates from the norm of creating a scale-bound 2D model (see above), but generates advantages in the application of corresponding media and thus, following Dahrendorf, promotes life chances. By consciously distorting map representations (caused by the inevitable constraints of Euclidean or spherical geometry for map projections), the importance of certain spatial themes or parameters is increased in anamorphic maps. Area cartograms, in which, for example, population size can determine area proportionality, are established cartographic media used in geography education at schools (Hüttermann 1998). Shape-warping contiguous cartograms, non-contiguous isomorphic cartograms, and variable-scale city maps that incorporate geometric distance distortions and give priority to other spatial indicators are other established examples of anamorphic maps in cartography. The purposeful omission (generalization) of information from topographic maps that deviates from the norm of ‘purpose neutrality’ can also pursue the goal of enhancing overall security, such as by withholding military-relevant locations and information (see examples in Davies and Kent 2017, pp. 64–69).

This is also linked to the current interventions in the (also geospatial data-based)—“cyberwar” (during the Russia–Ukraine war in 2022). A well-known twitter call by the hacker consortium Anonymous (see Fig. 3) supports a...
strengthening of the reconnaissance, digital dissemination, and evaluation of the war events in Ukraine.

The mass use of content ratings, which can be linked to specific locations (restaurants and stores in Russia) in web mapping platforms (Google Maps), is a new approach in the Internet community and in (geopolitical) cartography, to the extent that it deviates from the previous norm of usage. Interactive and large-scale geopolitical (web) cartography is being created through the participation of active mappers—with the goals of concentrating worldwide resistance on a well-known web service, calling for protests against war, making contributions to peace and saving lives, and thus preserving life chances.

Further examples of functional deviance can be named meaningfully with the continuation of the development phases mentioned above. Following Müller et al. (2001, see above), Scharlach (2002, p. 9) describes a development phase of mobile cartography that (approximately) began with the turn of the millennium. Worldwide digital developments from the 2000s on are substantially linked to this. The Internet as an everyday data and communication platform has become socially established—first a brief overview:

The increase of interactivity and collaboration on the Internet (also referred to as “Web 2.0”) from the 2000s onwards led to an even more digital continuation of ‘democratizing’ (geospatial) data and, accordingly, map use and map-making (cf. Fig. 2). The web user, who in the past received rather institutionalized geospatial data offerings on the Internet, could now benefit from rising computerized networking, communication, data sharing, and media production opportunities. The web user’s role was no longer limited to a data consumer. Web users began to produce and share their own data and content. This shift from consumer to prosumer strengthened the proliferation of user-generated content, both in professional and private or volunteering contexts. Today, well-known open geospatial data resources, such as the Volunteered Geographic Information (cf. Goodchild 2007) in OpenStreetMap (OSM),\footnote{https://www.openstreetmap.org/ [last access: 02 Apr 2022].} were set up. The mass availability of (geo)data not only required the (further) development of exchange platforms and formats, but also influenced communication: professional and private everyday life underwent a transformation into digital systems, including increased access to (geospatial) data (instant messaging), flexibilization of access locations, and the need for permanent and location-independent accessibility. This gave impetus to governance measures used to promote participation, exchange, interoperability, and transparency (e.g., open initiatives). In addition, a societal need arose for technological advancement of, among other things, web technologies and their usability (simplicity as a suitable approach for mass use; e.g., Edler and Vetter 2019; Horbiński and Lorek 2022). Other technological innovations are modern sensor technologies and flexibly deployable software and hardware, such as mobile devices (Fig. 4)—and, from the mid-2010s, systems for (real-time) representation in extended reality (XR, see, for e.g., Carbonell Carrera and Bermejo Asensio 2017; Jerald 2016; Kersten et al. 2018).

Mobile cartography These technological and social developments (which are still continuing) have led to an omnipresent mobile cartography whose interactive (and often animated) map applications, especially smartphone apps, can be customized and are thus geared to the specific requirements of individual users or user groups (see, for e.g., Lobben 2004; Wei and Schiewe 2019). For example, approaches of barrier-free visualization (including possible integration of acoustic or audio-visual means) as well as maps that address barrier-free accessibility in public spaces provide, for example, wheelchair users with optimized support. The research direction of cognitive cartography also supports these developments through map-experimental studies, from which (also user group-specific) design recommendations can be derived. These are based on effective and efficient cognitive processing of cartographically mediated spatial information (Montello 2002; Edler et al. 2015; Fabrikant and Lobben 2009; Keil et al. 2020; Roth et al. 2017).

The example of mobile (web) cartography illustrates that the deviance from classical cartographic standards (digital vs. analog, interactive vs. static, portable screen size vs. large format print map or PC desktop in full screen, 3D vs. 2D, see also Fig. 4) changes the original norms through
the functional added value. The example of a newly gained audio-visual design (discussed above) is also a fundamen-
tal part of mobile cartography, which is mirrored by many modern navigation apps in our everyday lives.

**XR Cartography** The preceding examples of functional deviance in the development of cartography are mainly shaped by technological innovations. XR systems (including augmented reality and immersive virtual environments), which find origins in gaming, are also experiencing increasing acceptance in geoinformation science and cartography (see, for e.g., Dong et al. 2020; Edler and Kersten 2021; Hruby et al. 2019; Keil et al. 2021; Koegst 2022; Lindner et al. 2021; Vetter 2020).

AR applications are discussed as highly accurate cartographic media that support navigation in real time and at individual locations chosen by the users (Dickmann et al. 2021). Moreover, by incorporating elements of *gamification* (widely known through the games Pokémon Go, Harry Potter: Wizards Unite, Minecraft Earth, or Ingress), they can link ‘physical-material landscapes’ with the socially accepted and widespread interest in *location-based gaming*. Location-based animated visualizations expand potentials of accessing the physical-material landscape through physically non-existent virtual extensions, which not only serves the purpose of gaming or entertainment, but can also reduce the complexity and complicatedness of the landscape and increase contingency at the same time (Kühne et al. 2022a). In these examples, spatial visualization primarily serves the purpose of location-based gaming or entertainment. Secondly, it is associated with the learning of spatial information (e.g., through mobile mapping, see Pánek et al. 2018), which somewhat degrades the higher level function of cartographic media. However, at the same time, it gains high acceptance by the group of location-based gamers (for an overview of location-based services (LBS) in cartography, we recommend Gartner et al. 2007).

A comparable example, however, in purely virtual environments is “minimaps”. These maps originate in video and computer games (including VR games), a rather non-established field of map-making by cartographers and thus pointing to deviance. Here (interactive and animated), cartographic 2D representations primarily serve to support a game mission. The represented game environment can be completely disconnected from representations of ‘real’ landscapes, e.g., in fictional game settings (Edler et al. 2018; Horbiński and Zagata 2022) or virtually recreated historical landscapes (Horbiński and Zagata 2021; Zagata et al. 2021). In this example, again, acquiring spatial knowledge is subordinated to winning the game. In terms of Dahrendorf’s concept of life chances, AR and VR games (based on cartographically presented geospatial data) can be seen as an innovative field of application of cartographic media supporting new individual entertainment and leisure potentials based on technologically advanced forms of representation.

A productive development of cartographic representations is closely linked to functional deviance. Critical cartography emphasized that the development should not (only) be interpreted as success story. Cartographic representations can also be dysfunctional, which we address in the following.

### 4.3 Dysfunctional Deviance

Dysfunctional deviance in cartography can also be related to examples of AR and VR applications discussed before in this paper. Their methodological development is based on game engines that used to be ‘in-house software’ of companies some of which are now freely offered to interested web users. A prominent example is the popular *Unreal Engine* developed and owned by Epic Games. Today, game engines can be used in professional and personal contexts, and some web platforms (e.g. ‘marketplaces’ of the individual engines) facilitate the worldwide exchange of modeled and textured 3D objects designed for VR environments. Objects and object packages (assets) can be offered and downloaded (freely, also commercially), further (technically) processed, as well as commented and discussed in web-based communication. Beyond the gaming community (see above), the worldwide interest in the design of (immersive) virtual environments, which can also be coupled with modern VR hardware systems, is rising.

In their origins, game engines served the development of ethically and morally questioned and often age-restricted first-person shooter games (Edler et al. 2020). A former methodological tool for the creation of (at least partly) socially forbidden media is on its way to become a default software of 3D cartography due to its functional added value for the visualization of spatial information. This points to a change from originally dysfunctional deviance (socially sanctioned by prohibitions, and reduced to the user circle of the developer companies due to its proprietary licence) to functional deviance. The functionality lies in particular in the potentials to strengthen leisure-time activities of 3D visualization through free availability and improved web-based data exchange and communication options. Moreover, 3D geospatial data resources are expanded, which is another contribution to cartography.

Further examples of dysfunctional deviance can be found in geopolitical and military cartography. Mark Monmonier, in his book *How to Lie with Maps* (1996, pp. 87–112), devotes an entire chapter to how maps are used by states for political propaganda. He cites and illustrates examples of how territorial demarcations, including territorial claims, are
expressed through graphic representations in maps. Manipulative cartographic approaches of territorial claims made by certain states (e.g., Nazi Germany and Argentina; Monmou-nier 1996, p. 96/107) interfere with territories of other states. Through these maps, fears are deliberately provoked and restrictions on the life chances of the affected people are (carto)graphically fixed and propagated.

Up to this point, we dealt with functional and dysfunction cartographic representations. In the following, we address those cartographic representations that did not cause a lasting effect, i.e., afunctional deviance.

4.4 Afunctional Deviance

Afunctional deviance in cartography refers to cartographic media that do not experience a considerably social resonance (positive or negative). This may include specific content or map themes, as well as approaches of cartographic representation.

For example, in the development of multimedia cartography, it was, temporarily, a common standard to provide animated introductory sequences (Intros) to map applications (Scharlach 2002, p. 112). To design these opening sequences, sophisticated audio-visual design options were often exploited in animation software. However, the purpose was not always essential for the actual cartographic communication of spatial information. In contemporary multimedia cartographic web applications, corresponding intro sequences are hardly included. It seems that the interest in exploring new software possibilities (with deviance from the norm of that time) generated a temporary functional added value. The intro sequence was never dysfunctional with an intended suppression of life chances, but a continuing added value cannot be observed. From today’s perspective, this temporary functional deviance can be evaluated as afunctional.

Afunctional deviance in cartography also refers to cartographic visualization approaches that have only been used sporadically so far due to a lack of technical innovations. Olfactory maps belong to these examples. They rarely include odor qualities and intensities as cartographic features used to transfer of spatial information (Henshaw 2014; McLean 2016). Mass-market olfactometers are still under development (Dodt et al. 2017). However, they are not yet considered an established component of cartographic communication—even though the olfactory dimension has been investigated in cartography and geography for quite some time (Porteous 1985; Dulau and Pitte 1998; Lauriault and Lindgaard 2006).

The examples of deviant cartographies introduced so far refer to the object level of cartographic representation. We leave the object level and focus on metafunctional deviance in cartography.

4.5 Metafunctional Deviance

Metafunctional deviance stimulates a confrontation with established standards and conventions. According to Rorty (1997), an ironic perspective can also be adopted. Examples of metafunctional deviance in cartography can be found in the OpenStreetMap project. While geospatial data which are acquired and administered by public authorities, such as governmental surveying departments, are subject to strict legal regulations (clearly defined object categories), the OSM project, which is supported by volunteering mappers, allows more flexibility in terms of (geospatial) data content. Thus, according to decisions made by the volunteers, individual attributes (properties) can be recorded and linked with specific locations (geometries) in the OSM database (Fig. 5). However, a high reliability of each semantic record cannot be expected.

For example, the recording of the availability of certain beer brands or outdoor seating options in pubs is (currently) not a legal mandate for the official geodata-holding agencies. Even if no high topicality of the recorded data and attributes is guaranteed and errors may occur, the availability of the data in the OSM project offers small-scale special information supporting, for example, the planning of spontaneous leisure activities. The level of detail and the subject matter of some of the attribute information stored in OSM can certainly convey an ironic undertone in comparison to standardized maps produced by public agencies.

Other examples of metafunctional ironic cartographic representations are atlases that play with peculiarities of cities, such as “Portlandlandness. A Cultural Atlas” (Banis and Shobe 2015) or, inspired by it, “Cultural Atlas of TÜbingen-ness. Kleine Karten aus dem großen TÜbiversum” (Cultural Atlas of TÜbingenness. Small Maps from the Big TÜbiverse) (Kühne et al. 2022b). In these maps, it is not so much a matter of depicting ‘objective’ information that is considered relevant according to the valid norms of thematic cartography. The decisive factors are presenting peculiarities and ‘quirks’ of places and their inhabitants. This implies the experiences and views of the cartographers, which may also comprise unfamiliar or unusual approaches to the cartographic visualization. The same is true for an ironic cartographic synthesis of regional geographic research results which emphasize the contingency of spatial syntheses. Such approaches may also encourage a critical examination of the representations (Kühne and Jenal 2020a). Another example refers to the engagement with topics that are rather unusual in academic cartography, but which make use of maps or map-like visualizations representing their own subcultural standards that have become ligatures, such as pinball playfields (Edler 2020) and model railway tracks (Kühne et al. 2021b).
Based on the ‘vocabulary’ (Rorty 1997) of functional, dysfunctional, afuncational, and metafunctional deviance, we discuss which types of deviance are relevant for the development, practice, and impact of critical cartography.

5 Deviance and Critical Cartography

Engaging with cartography from a meta-perspective, but without being metafunctional, refers to the characteristics of critical cartography. It was shaped in the 1980s to criticize essential practices, paradigms, and social effects of cartography from a neo-Marxist perspective. The central point of criticism is—in the terminology chosen here—the transformation of options into ligatures and their protection by power structures. This can take the form of ‘power driven by data’, in the sense of Heinrich Popitz (1992) by prescribing technical norms of data collection, analysis, and presentation. Moreover, this can also take the form of exclusive access to geospatial data.

The first point is connected with the question whether the transfer of options to ligatures is also linked with a gain of life chances. After all, standardization does not only restrict, but also contributes to reducing the danger of misinterpretation (with fatal consequences, for example, in the application of navigation maps). Moreover, standardization serves to clarify which possibilities of functional deviance (in the case of other cartographic representations) are possible.

The second point of criticism has become largely obsolete, since in many countries (for, e.g., Australia, Canada, Germany, Japan, New Zealand, and USA), geospatial data are available free of charge and many softwares used to process these data are also freely accessible (see the discussed examples of the game engines). Another central point of the criticism of ‘traditional cartography’ is its positivistic understanding of the world, a certainly justifiable criticism in the

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Fig. 5 Filtered geospatial data query (pubs in Bochum) with the web-based data mining tool Overpass turbo. The pop-up window displays the semantic attributes captured by OSM volunteers for the marked (red) location (as of March 30, 2022). © OpenStreetMap Contributors

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past (1980s). However, this positivist perspective is only one among many today (cf. Dürr and Zepp 2012; Fernández and Buchroithner 2014; Kühne et al. 2021c; Schiewe 2021). It has a deep and important rootedness in, for example, geodetic and geoinformatics approaches to cartography or in the above-mentioned creation of navigation maps based on the results of quantitative studies on user cognition. In this respect, critical cartography certainly had a functional effect. The (moral) position to replace a cartography based on expert special knowledge (while demands on geospatial data literacy are rising, cf. Jürgens 2020) by a participatory one, especially that mainly focuses on issues of ‘social injustice’, can be classified as an example of dysfunctional deviance in cartography (again, the example of the navigation map underlines this argumentation). The development of cartographic representations (presented in Sect. 4.1) also builds on the work by people outside professional cartographic institutions and organizations. This suggests that these processes initially remained without influence by critical cartographic interpretations. It seems more of an attempt to use the established practices for their own purposes. Finally, and to return to the entry point of this case study, critical cartography can hardly be said to have a spirit of irony, or even self-irony; in this respect, it is hardly connected with metafunctional deviance.

6 Conclusion

This paper builds on the recently developed approach of a ‘post-critical cartography’ (Kühne 2021a). It includes reflections on how developments in cartography can be functional, dysfunctional, afunctional, and metafunctional for the development of the discipline (in particular) and society (in general). These reflections are based on the understanding of deviance as discussed in sociology and on Ralf Dahrendorf’s concept of life chances. This provides the normative basis for evaluating the functionality of deviance, as the normative basis of our considerations is the maximization of individual life chances. The development of the cartography can be interpreted using the established terminology related to these approaches (Rorty 1997).

Technological innovations, for example, can be classified as functional, which expands the design and usage potentials in cartography. It has also enabled access to the production of cartographic representations for people who were not active in institutions and organizations dedicated to cartography. Dysfunctional cartographies are especially found in representations used to manipulate people. Afunctional representations are those that are publically available but have not received a significant response by the professional community or the broader public. Metafunctional cartographies encourage us to consider the contingency of the world in general and cartographic representations of it. Particularly suitable for such a reflection are cartographic representations that make use of the stylistic device of irony. It leads to an increase of contingency when interpreting the world. It highlights the contingency of apparently unchangeable ligatures, which creates options.

The derivation of our terminology was deductive. Its suitability for the interpretation of cartographic development is based on selected examples, without claim to completeness. In light of a general suitability worked out, a more systematic elaboration in future research seems to be reasonable.

Post-critical cartography postulates to preserve the functional components of critical cartography and to overcome the dysfunctional ones. In view of the current developments (for e.g., the increasing offer of open geospatial data, free and open software, straightforward online data sharing and communication platforms and also the widely accepted multi-perspective views of cartography such as positivistic, social constructivist, and neopragmatic perspectives), critical cartography, today, rather appears like an ‘attitude’ than a substantial research direction of cartography. This attitude exists regardless of whether the points of criticism have not already become obsolete.

Following on from what has been introduced above about deviance, however, critical cartography has a functional meaning for the development of cartography, especially in terms of constructedness and relationships of power. Constructedness, however, has become a commonplace today; power relations have lost relevance considering the aforementioned increasing accessibility of data, software, and online sharing and communication resources. The up-to-date topic of using tools of a commercial web mapping platform (Google Maps) to deliver political messages in a large-scale citizen activity shows that power relations are not unidirectional (cf. Fig. 3).

What remains, then, are the attestations of dysfunctionality (as a result of the rejection of the positivist understanding) and non-existent metafunctionality due to an understanding of the world reducing contingency and without irony.

In this respect, we understand this article as a contribution to the development of a post-critical cartography which preserves the approaches of functional deviance originating in critical cartography (the awareness of the social constructedness of maps and their power immanence). In addition, post-critical cartography aims to avoid dysfunctional deviance (such as moral constraints). Strengthening metafunctional aspects, such as ironic and self-ironic engagement with cartographic representations (cf. Garfield 2012), could generate additional value.

Based on the sociological concept of deviance, this article presents a contingent and adjusted interpretation of the development of cartography. The discrimination between functional, dysfunctional, afunctional, and metafunctional deviance suggests an alternative view on the development of cartography. This view is not directed at exclusivism,
such as the description of paradigm sequences. However, it
focuses on the functionality of deviance from ‘traditional’
approaches and interpretations. We explored and presented
this alternative perspective in a first attempt. In further steps,
we plan to take a more detailed view on how the concept of
deviance could contribute to a re-interpretation of cartogra-
phy and neighboring disciplines, such as geography.

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