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Resilience: some philosophical remarks on ostensively and stipulatively defined concepts

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The notion of resilience has become widely diffused in sustainability research over the past two decades. This process has not unfolded without contention and critique of the concept has often focused on its content. In this article, we discuss how concepts, including resilience, come to be defined in scientific terms. We distinguish between ostensively defined concepts that point to some phenomena and stipulatively defined concepts where the content is given in the definition itself. We argue that although definitions are remarkably similar across many disciplines where resilience is used—most notably psychology and ecology—they may nonetheless differ in whether they are to be taken as stipulative or ostensive. This situation has interesting consequences for the ways in which different disciplines can be connected and integrated. It is notable that integration on the basis of ostensive definition turns on sharing the extension (the phenomena itself) of the concept, but not necessarily the intension (the definition), whereas integration on the basis of stipulatively defined concepts works in the opposite way.

KEYWORDS: language issues, interdisciplinary studies, comparative analysis, terminology, ecology, psychology

Introduction

The notion of resilience has gained considerable support within sustainability research over the past couple of decades (Walker & Cooper, 2011; Parker & Hackett, 2012). Introduced into the sustainability context by ecologist Crawford Holling and his followers (see, e.g., Gunderson & Holling, 2002), first in the Resilience Network and later in the highly influential Resilience Alliance (Walker & Cooper, 2011), the concept has garnered great appeal within sustainability science for at least two reasons. First, it is alleged to have "integrative" and "discipline bridging" capabilities (Holling et al. 2002). The fact that sustainability science has to be an inter- and trans-disciplinary venture is ubiquitously accepted among practitioners in the field and crossing disciplinary (and other) boundaries is essential to this aim (Kates et al. 2001; Jerneck et al. 2011; Ziegler & Ott, 2011; Thorén & Breian, 2015). The second reason is that the notion of sustainability itself can be construed in terms of resilience, or rather that resilience can be used as a foundation for understanding (or realizing) sustainability (Ludwig et al. 1997; Perrings, 2006; Anderies et al. 2013).[1] We focus in this article mainly on the concept of resilience and its discipline-connecting capabilities.

In academic publications pertaining to the concept of resilience, the discussion to date has generally been on differences in the content of various definitions of this key term. Brand & Jax (2007), for example, consider resilience as a boundary object that serves as a flexible concept with different meanings for various users, but at the same time allows for interdisciplinary communication. Strunz (2012) suggests that the concept is "polysemous," meaning that it has many similar, though difficult to disentangle, meanings, and argues that this conceptual fluidity is not problematic in all contexts. Strunz mentions research that is "in touch with societal stakeholders" as a candidate where less rigid concepts may be beneficial.

We seek to focus here on another aspect of resilience, one that has thus far been overlooked, namely how and with what aim the concept is defined. We begin by establishing the distinction between concepts defined ostensively and concepts defined stipulatively. The definitions associated with the former serve to identify something in the world and focus, for example, on a particular phenomenon. The latter type of definition, by contrast, is often used to highlight a distinction, or conceptual joint. We then argue that psychologists define the term ostensively while ecologists often define resilience stipulatively. This distinction arises despite the fact that the different usages share a conceptual core that transcends disciplinary boundaries.

[1] It has been contested whether this is indeed a good way of construing resilience. See Derissen et al. (2011).

We continue from this observation to note that in sustainability science, where it is expected that the notion of resilience can bridge disciplines, debates on different understandings of resilience have focused exclusively on the content of the definitions. Nonetheless, we argue that the distinction proposed here matters. An ostensively defined concept and a stipulatively defined concept point toward different interdisciplinary relations. Specifically, in the former case conceptual coherence is secondary to ontological overlaps while in the latter case conceptual coherence is more important. An ontological overlap here signifies the sharing of an interest in the same phenomenon.

A caveat is in order before we proceed. We offer what is first and foremost a philosophical argument and aim to make a philosophical point. Accordingly, we do not provide thoroughgoing reviews of the relevant literature from psychology, ecology, or sustainability science that would allow for robust generalizations concerning these fields. Such a study would indeed be interesting and is perhaps a natural continuation of the present discussion, but it remains outside the scope of this particular article. We instead use the disciplines of psychology and ecology as examples—perhaps even idealized examples—to point to differences in the way terms are defined given a certain context and specific aims. With respect to ecology, we focus primarily on the work of Holling because his writings are typical of a specific usage that we would like to highlight and because his 1973 article entitled "Resilience and stability in ecological systems" has been distinctly important for how sustainability researchers conceive of resilience. The application of resilience in psychology seems more widespread and the concept has been intensely discussed in the field (see, e.g., Rutter, 1985; Olsson et al. 2003; Bonanno et al. 2007; Herrman et al. 2011).

Of further preliminary interest is that while the concept of resilience has been broadly considered among sustainability researchers (Gunderson & Holling, 2002; Jerneck & Olsson, 2008; Davidson, 2010; Andries et al. 2013; Hornborg, 2013), philosophers have not taken much notice, with some exceptions. For instance, related notions such as stability have been analyzed before in the philosophical literature. Hansson & Helgesson (2003) develop a formal framework that distinguishes three main kinds of stability, one of which they label resilience. Their focus, however, is on the *content* of definitions rather than the *way in which* concepts are defined. More relevant for current purposes is Thorén (2014) who points out that the different definitions of resilience tend to converge on two core understandings and further argues that the concepts used are often highly abstract. The consequence is that these ideas become context insensitive and applicable to many rather different disciplines. However (and conversely), they rarely form a substantive interdisciplinary connection. This prior work by Thorén also focuses mainly on the content of definitions. The current contribution, by contrast, should be seen as an alternative way of looking at resilience and how it can connect disciplines.

The article is structured as follows. In the second section we introduce the distinction between ostensive and stipulative definitions. The third section discusses the implications of this difference for how conceptual connections among disciplines may be established. The fourth section contains the two main cases—resilience as used in ecology and psychology—as well as an analysis of them. In the fifth section we develop the discussion to include sustainability science and the final section contains our conclusions.

Ostensive and Stipulative Definitions

There are many ways of defining concepts and how they are to be understood has been a central philosophical concern since antiquity. These debates have persisted within philosophy in general, the philosophy of science, and the philosophy of specific disciplines (such as psychology) and have often centered on how concepts *should* be defined. The logical positivists, for example, believed that all meaningful concepts could be operationalized completely. That is to say for a concept to be meaningful, it should be possible to provide a process, test, or set of operations, through which whatever the concept is intended to capture can be observed or brought about. Defining a concept, in this view, simply is to provide such a set of operations.[2] Although Rudolf Carnap (1936, 1937) helped to discredit this thesis (called operationism), it survived at least through the 1970s within psychology (Wallach, 1971). This is not unimportant in this particular context as psychology is one case that we highlight. However, we will not engage with the underlying philosophical question of what concepts ultimately *are*. Instead, we focus on a specific distinction between two ways of defining concepts: those that aim to point out a phenomenon to be studied and those meant to highlight a conceptual joint. We distinguish between the former concepts which are defined ostensively and the latter concepts which are defined stipulatively. The dis-

[2] For example, the concept of an electron here would be defined in terms of the way through which electrons are detected. Such a definition, thus, would be a complex construct involving references to, for instance, cathode ray tubes.

tinction is important because only ostensive definitions prompt empirical investigation.

Concepts defined ostensively are common, both in science and everyday life. Often the process only involves pointing, and we hold up for display an instance of the extension of the term. We say "that is red" and point to a red piece of paper. In science, something similar is going on in cases where we cannot—at least not presently—understand the referents of our terms by relying on scientific language alone. Psychologists often talk about *construct validity* (Cronbach & Meehl, 1955; Campbell, 1960), and one very simplified way to understand this complicated notion is in terms of the relationship between what we observe (or measure) and the theoretical construct we employ (typically an attribute, proficiency, ability, or skill that happens in the human brain) and claim to be observing or measuring it. As Cronbach & Meehl (1955) explain, "A construct is some postulated attribute of people, assumed to be reflected in test performance." Constructing an ostensive definition is one way to establish a first link between the world of theory and the world that we observe:

> Although ostensive definitions are the starting point for construct validity, the existence of *bricolage* or know-how merely points to where it may be observed.[3] The intuitive certainty of a construct such as *bricolage*, and indeed our everyday observations of it in action, does not provide evidence for its precise relationship to other forms of intellectual activity (Berry & Irvine, 1986).

Saul Kripke (1980) famously asserted that some definitions—in particular those associated with so-called *natural kind terms*—do not give the real essence of that which is defined. Instead, the descriptions that make up such definitions function merely to fix the reference.[4] For example, the concept tiger might be "defined" as "large, striped cats that live in India." This helps us find tigers; its function is roughly equivalent to saying "that is a tiger" while pointing at a tiger.[5] In this sense the concept is defined ostensively. An interesting feature of this kind of process is that the resulting definition can be extremely parsimonious, partial, and even downright false, and still succeed. Tigers are by all means large cats that live in India, but they also live elsewhere. Living in India is obviously not *essential* to tigers. Importantly, it could also have turned out to be the case that tigers were not striped, or even cats at all. Suppose that zoologists examining tigers found them not to be felines but canines uncannily similar to cats (perhaps due to convergent evolution). Outrageous as this counterfactual consideration may sound, similar discoveries have occurred.[6] What would such a finding prompt? In all probability, the definition of the concept would be amended and tigers would be considered to be large, striped dogs that live in India. The point we wish to make here is that the content of the concept is determined—in the end—by how the world is, and the definition that is associated with the concept is subject to revision.

While the purpose of ostensively defining a concept is usually to point toward something to be investigated, stipulative definitions are often introduced to, for example, draw attention to some particular conceptual joint (Belnap, 1993). Mathematical and formal concepts are often stipulatively defined. But there are mundane examples as well. The concept *engine* may be defined in terms of its function: an engine is a device, or mechanism, that converts one form of energy into another (typically thermal energy into mechanical energy). That engines perform this function is *stipulated in the definition*; it is the very meaning of the term and we cannot, for trivial reasons, find that we were somehow mistaken about engines.

Concepts that are stipulatively defined differ from ostensively defined concepts in that they are not subject to revision in light of empirical findings—not

[3] The term *bricolage* comes from the French and was first used in a technical sense by the anthropologist Claude Lévi-Strauss. He identifies the "bricoleur" as someone "adept at performing a large number of diverse tasks; but, unlike the engineer, he does not subordinate each of them to the availability of raw materials and tools conceived and procured for the purpose of the project" (Levi-Strauss, 1966). What Lévi-Strauss sought to do was to make the reader aware of the difference between two types of thinking or approaching problems (cf. Berry & Irvine, 1986). Bricolage, then, involves using whatever is at hand to solve a problem, merely on the merit that it is actually available. A scientific approach, according to Lévi-Strauss, contrasts against this as the tools available are no constraint on the problem-solving process. Once the problem has been given its adequate form, the appropriate tools will be procured or invented (Berry & Irvine, 1986).

[4] To fix the reference, means in this context to attach the term in question to that which it is meant to refer. Kripke (1980) compares this to the way in which a name is attached to a newborn baby.

[5] Biologists use several different ways to determine the boundaries of, and membership in, a species. DNA sequencing is, to the surprise of some people, not a particularly prominent one. Instead, species are considered in evolutionary terms as parts of clades, or as groups of individuals that actually, or potentially, interbreed (for philosophical discussions of these rather intricate matters, see, e.g., Dupré, 1991; LaPorte, 2004). Species are also determined with respect to phenotype and other superficial features, so although the tiger example above is highly idealized in one sense, it is not completely off the mark.

[6] Consider, for example, whales that were long thought to be a kind of fish. So a definition along the lines of "whales are the largest living fish" may literally fail since whales are not fish, but may, nonetheless, succeed in pointing whales out. When it was discovered that whales were not fish but mammals, it was not then concluded that there are no whales.

in the same sense anyway. Ostensively defined concepts are inherently provisional; their meaning is connected to the structure of the world. This does not mean that stipulatively defined concepts are never replaced. The length of a meter is stipulated but it has changed over the course of history. These revisions, however, are not a result of the discovery that a meter was, in fact, shorter or longer than we initially thought but rather result because humans have highly valued standardized measures and have strived for robust definitions.

It is important to note that this distinction neither orders all scientific concepts neatly into two mutually exclusive categories nor is exhaustive on that domain. Our definitions can serve multiple purposes. This is an important point in this article, as it shows that focusing on the content of definitions is not always informative. Moreover, in scientific inquiry, it is often the case that one may switch between these (and other) ways of defining a concept, as well as having concepts that are partially stipulative and partially ostensive. Sometimes we begin by defining a concept ostensively, but aim to replace it, permanently or temporarily, with another type at some point in the future.[7] Furthermore, considerable additional detail can be added to ostensive definitions that improve them. The example with the definition of tigers above may succeed in picking out tigers, but it could be considerably improved. Biological species are often first defined by reference only to phenotype. Later on, however, one may shift to give other kinds of definitions, for example in terms of a species' evolutionary relationship to other species.

At other times, we begin by defining a concept stipulatively only to subsequently turn to an ostensive definition. Regarding the former point—that a single definition can be understood as either ostensive or stipulative—the concept of resilience is a case in point, but there are many others, such as the gene concept used in Mendelian genetics. The concept of the gene was originally defined stipulatively as that which carries a trait from parent to offspring. It was only after the passage of time that cytologists and biochemists began to consider this definition to be ostensive and thus proceeded to empirically investigate the material basis for the gene.[8] These developments have led us to abandon this definition despite the fact that it was initially a stipulation. Not everything that carries a trait from parent to offspring is a gene and neither do genes always carry traits this way. Similarly, if we reconsider the definition of the concept "tiger" proposed above, it may, of course, be taken as stipulative, in which case, Siberian tigers would not really count as tigers.

Conceptual Connections and Interdisciplinary Collaboration

A central issue here concerns the role of these two types of definitions with respect to how disciplines can be connected conceptually and how that relates to interdisciplinarity. If we limit ourselves to only this binary approach to defining concepts, there are two ways in which conceptual connections can be formed.

Suppose that two disciplines are said to be conceptually unified if they use identical concepts. Then we might observe that identity is determined in different ways depending on whether a concept is defined ostensively or stipulatively. Two ostensively defined concepts are identical if, and only if, their respective definitions select the same object or objects in the world. It is of no consequence if the expressions themselves are not identical; their identity can be said to be *extensionally determined*.[9] If we now consider identity between stipulatively defined concepts we find the situation to be exactly the opposite. For such concepts, identity depends on the definitions themselves and instead centers on the *intension* of the concept. If two stipulatively defined concepts have the same extension, but not the same intension, they should be considered different concepts. Hence we can say that the identity between stipulatively defined concepts is *intensionally determined*.

What does this mean for conceptual connections among disciplines? For one, it seems that with respect to ostensively defined concepts it is natural to consider two disciplines as being conceptually unified, or perhaps more appropriately, having a conceptual connection, if there is an ontological overlap in what the respective definitions pick out in the world. Indeed, such ontological interconnections have been emphasized as central in interdisciplinary

[7] An analogous dynamic can be found between operational and theoretical definitions. In parts of psychology, for instance, operational definitions have been considered especially important (Wallach, 1971). An operational definition gives the meaning of a concept by reference to a process or test through which something can be observed or brought about. One purpose of an operational definition is control. Operationalizing definitions narrow the scope of a concept to cover a few measurable parameters. To overtly emphasize the importance of operationalized definitions, however, tends to exclude relevant parameters, in particular those that cannot be easily, or well, measured (Campbell, 1970). Sometimes there are benefits to control, and sometimes not.

[8] For an account of this development, although using a different terminology, see Darden (1991).

[9] It is common with respect to concepts to differ between their *extension* and their *intension* (with an s). The former denotes the entities to which the concept applies while the latter is the meaning of the concept. The extension of the concept *bachelor* is simply all bachelors, whereas the intension of the concept is "unmarried man."

exchanges by, for example, Darden & Maull (1977). Indeed, they can form the basis of what these authors call *interfield theories* that connect one scientific field to another on the basis of different types of ontological relations such as, for instance, part-whole relations or causal relations. The chromosome theory of the location of genes is an example of interfield theory as it connects classical transmission genetics with cytology. From this perspective, the definitions of the concepts used in the respective disciplines are much less important than overlap in what they isolate in the world. That is to say, as long as the expressions do, in fact, pick out the same phenomena, we have what is needed for an interfield connection.

Conceptual connections established on the basis of stipulatively defined concepts, by contrast, are based on the intension of the concept. Here ontological overlaps are much less important; what is central is instead that the concepts used are defined in the same way. Such connections are often substantially weaker. Many disciplines share stipulatively defined concepts such as, for example, mathematical and statistical ideas (or other highly abstract notions), without this necessarily being perceived of as a reason to engage with one another.

The most interesting situation, however, concerns instances where concepts are developed through a scientific process where one shifts between different ways of understanding a definition. One might expect members within a discipline to have, for example, a heightened sense of when a definition is used stipulatively and when it is used ostensively. Between disciplines, however, this appears to be precisely the kind of subtlety that may be lost.

In summation, whether a concept is defined ostensively or stipulatively matters for the kind of conceptual connection that can be formed among disciplines based on that concept. Sometimes it is important to reconcile the definitions of the involved concepts, but sometimes this is not so.

Resilience in Psychology and Ecology

The notion of resilience begins to occur in the title of academic publications from about 1910 onwards. Early articles that use the concept are strongly focused on materials science, in particular in textiles research, where resilience was so frequently used that it prompted specific conceptual discussion and disambiguation. An example comes from Hoffman (1948), who complains that "resilience means different things to different people." A physicist observes that "[t]he behavior of a quartz ball dropped on a quartz plate provides a good example of resilience; it will bounce many times, showing a small loss of energy through dissipation as heat. In other words, it has a high work recovery." But a carpet manufacturer says that "[t]he resilience or 'luxury' factor of a carpet is proportional to the reciprocal of the modulus. I want a low modulus. A quartz plate takes a 'zero' on my resilience scale because it won't absorb any work in compression" (Hoffman, 1948).

Hoffman (1948) goes on to argue for a generalized concept of resilience and finds the most common understanding to be the ability of something to return to a reference state following a disturbance. The issue of concern seems to have been how to operationalize the notion. For instance, the ability of a piece of yarn to return to its previous length after being stretched can be measured as the speed of return or the difference in the length of the yarn before and after being stretched. In more recent times, and prior to the establishment of sustainability science, two disciplines in particular stand out as users of the concept: psychology and ecology. They are interesting examples not only because resilience has been an important concept in both fields but also because they appear to differ in their respective approaches.

Psychological Resilience

While some children who grow up under adverse conditions become normally functioning adults, others succumb to their predicaments and remain marked for most of their lives. What accounts for the difference in outcomes? For a long time, the apparently unharmed individuals were called "invulnerable children." This notion, however, was abandoned in the 1980s as it was perceived to have false, or inappropriate, connotations.[10] In the 1980s, resilience was gaining ground as a preferable, and less problematic, alternative (cf. Rutter, 1985). In current psychological literature, the concept has been broadened and is used not only within pediatric psychology, but also, for example, with respect to how adults deal with psychological stress and trauma (see, e.g., Bonanno et al. 2007; Herrman et al. 2011). In the current literature, one finds several versions of the concept. Here are three examples of how resilience is typically applied:[11]

1. Meeting developmental goals in spite of adversities.
2. Sustained competence under stress.
3. Ability to recover following trauma.

[10] Rutter (1985) points to three ways in which the concept of invulnerability was "wrongheaded." The concept implies that resistance to stress is absolute, that it is only constitutional (and not also dependent on environmental factors) and that degree of resistance is a "fixed quantity" (Rutter, 1985).

[11] See, e.g., Fonagy et al. (1994), Dyer & McGuinness (1996), and Bonanno et al. (2007).

The two first forms are similar in the sense that both denote the maintenance of some property during stress. The latter concerns the ability to return to a pre-existing state following a disturbance, a form that relates more readily to many uses in both material science and, as we shall see, ecology.

There is nothing about these definitions themselves that indicates whether they should be taken as ostensive or stipulative. However, the general context may give a better indication. Psychologists have an interest in resilience as far as it is a way of talking about a behavior that can be observed in individuals. Some people appear to function during, or recover from, psychological trauma better than others and they are deemed to be more resilient. The question, then, is "why and how some individuals maintain high self-esteem and self-efficacy in spite of facing the same adversities that lead other people to give up and lose hope" (Rutter, 1987). Do they have certain protective mechanisms or processes, as some have suggested, and what are those capabilities (Rutter, 1987; Olsson et al. 2003; Herrman et al. 2011)?

The aims of such research are often deeply empirical—to find what it is that makes people resilient. Although definitions are important and psychologists sometimes complain about conceptual disorder, the discussion often differs quite radically from many ecological articles on the topic. The objective is to eventually find a definition that captures the phenomenon and the process to get there is dynamically open.

Ecological Resilience

Within ecology, the use of resilience became established in the early 1970s, especially following publication of Holling's (1973) article.[12] To understand how the notion of resilience is used in ecology, one has to appreciate the context in which stability in general has been discussed within the field. During the 1950s and 1960s, the received view among ecologists was that stability and diversity (or complexity) were positively covariant.[13] This view, called the *stability-diversity thesis*, was endorsed by influential ecologists such as Charles Elton (1958) and Robert MacArthur (1955). An immediate problem with this thesis, however, was that both notions of stability and diversity turned out to be notoriously ambiguous. Diversity and complexity are both related to a number of other concepts such as richness (the number of species in a community) and evenness (their distribution) (cf. Justus, 2008). For instance, one may understand diversity in an ecosystem as the number of species it contains, that is, in terms of richness. In this interpretation, an ecosystem with many species, but where one is overwhelmingly dominant, is more diverse than one with fewer species, but with perhaps a more balanced distribution. If we take evenness into account, we may be inclined to revise the appraisal, but it raises the question, which kind of diversity is linked to stability? And stability in what sense? Stability, too, can be understood in many different ways, which has prompted considerable discussion, and sometimes confusion, among ecologists. Grimm & Wissel (1997), in a survey of stability concepts, found 163 definitions and 70 different terms relating to stability in one way or another.

As Thorén (2014) explains, two versions of resilience are more common in ecology than others—again resilience as the ability to return to some reference state (Pimm, 1984) and resilience as the ability to withstand (or absorb) a disturbance (Holling, 1973). However, it is notable that ecologists are comparatively relaxed with the terminology pertaining to different stability concepts. The distinction we just made with respect to the two main uses of resilience has been recurring in the ecological literature since at least the end of the 1960s and onwards, although it is not always associated with the term "resilience." Holling (1973) makes precisely this distinction and calls ability to withstand disturbance and ability to return to a reference state, respectively, "resilience" and "stability."[14] Schrader-Frechette & McCoy (1993) make the same distinction but prefer the terms "dynamic balance" and "persistence," and the further proliferation of terms continues in the literature.[15]

The disambiguation of the general concept of stability has been a central topic for theoretical ecologists at least since the late 1960s. Grimm & Wissel's (1997) article is one example among many that take up this task. For ecologists, these conceptual issues appear much more important than for psychologists. This is perhaps not surprising given that, within ecology, these notions are often operationalized and deployed within an entirely formal setting, as is the case for Holling (1973), in which a central aim is to articulate a resilience concept that is measurable in predator-prey models.

[12] Holling has himself been of central importance in bringing the concept of resilience from the context of ecology to sustainability research. He has continually developed and broadened the notion (see Holling, 1987, 1996; Ludwig et al. 1997; Gunderson & Holling, 2002). For a more historical perspective on resilience theory, see Walker & Cooper (2011) and Parker & Hackett (2013).

[13] Already in the late 1960s, this point was being questioned, but the thesis was not widely abandoned until later. See Redfearn & Pimm (2000), Justus (2008), and DeLaplante & Picasso (2011).

[14] In later publications, Holling changes the terminology and prefers the terms "engineering resilience" and "ecological resilience" (see, e.g., Holling 1996).

[15] For further examples, see Orians (1975) and Grimm & Wissel (1997).

An Analysis

There are apparent parallels between the concepts of resilience used in ecology and psychology, in both of which it is possible to discern two main versions (see above). Resilience is sometimes seen as the ability of a system *to return to some reference state* after a disturbance and at other times as the ability of a system to *remain unchanged*, or close to unchanged, as it is disturbed (cf. Hansson & Helgesson, 2003).

But there are also subtle differences. Ecologists have developed their concept of resilience in the context of a larger conceptual debate on stability. For present purposes, the ecological discussion about stability and that regarding resilience are indiscernible. One salient feature of this debate concerns the context in which it is carried out. Resilience and stability have often been discussed in a highly formal setting; namely, the resilience of particular models, or classes of models, is at stake. Holling (1973) is a case in point. The core of his discussion surrounds classical Lotka-Volterra based predator-prey models and how resilience may be operationalized with respect to them (see also Ludwig et al. 1997). His aim, as for most ecologists who have engaged with this problem, has been to disambiguate the concept of *stability*, in essence, to pinpoint fine conceptual variations among different ways in which a system can be said to be stable (see, e.g., Grimm & Wissel, 1997). This aim coincides well with Belnap's (1993) observations about stipulative definitions. Our claim is not that ecologists always define resilience stipulatively, but rather, that this is at least sometimes the case, in particular with ecological publications that actually influenced sustainability research.[16] The salient features of the formal context in which the concept often appears, and the explicit aim of conceptual disambiguation, both support our perspective.

Among psychologists, by contrast, it seems more common to define resilience ostensively. This is admittedly difficult to show definitively, but several negative analogies between the two disciplines suggest it is indeed so. First, there is no parallel to the stability debate in psychology and no stability-diversity thesis causing conceptual problems. Instead, psychologists have proceeded from the observation that some individuals handle psychological stress better than others (Olsson et al. 2003). Second, while most of the ecological debate is carried out within a context of mathematical models, psychologists discuss resilience in the context of their subject matter, namely individuals. Finally, relatively speaking, psychologists appear more interested in the underlying mechanisms and processes that realize resilience than in dwelling over conceptual points (see, e.g., Rutter, 1987; Olsson et al. 2003). An early observation by psychologist Donald Campbell (1960) is relevant here. In discussing the conception of construct validity presented in Cronbach & Meehl (1955), he remarks:

> It may be wise to distinguish two types of construct validity. The first of these…is applicable at that level of development still typical of most test development efforts, in which theory, if any, goes no farther than indicating a hypothetical syndrome, trait, or personality dimension. The second type could be called *nomological validity* and would represent…the possibility of validating tests by using the scores from a test as interpretations of a certain term in a formal theoretical network.

It might be that at times, depending on the status of the nomological network (i.e., "the interlocking system of laws which constitute a theory" (Cronbach & Meehl, 1955)), definitions are relatively unimportant; it is the phenomenon, and not the definition, that is central. In contrast, the conceptual discussions within ecology have often aimed to draw up some distinction where both sides are useful. Furthermore, whereas resilience has not *replaced* any other concept in ecology—it is just one kind of stability that sometimes interests researchers—psychologists did abandon the concept of "invulnerability" in favor of resilience because the former carried with it empirically unsubstantiated connotations (see, e.g., Rutter, 1993).

In many ways, this difference in how resilience is defined makes sense. An important objective for many ecologists has been to point out a conceptual joint and this has been instrumental to understanding the stability-diversity thesis. For example, Holling (1973) proposes that it is resilience (ability to persist through a disturbance) and not stability (ability to return to some reference state) that is positively covariant with diversity. Accordingly, interest in stability and resilience was, at least to begin with, purely conceptual. Psychologists, by contrast, have departed from an observation—a difference in the behavior of individuals under similarly difficult circumstances.

It is not our intention to suggest that the ostensive/stipulative distinction cuts across these disciplinary boundaries precisely. On closer inspection it is not surprising to find that both disciplines define resilience both stipulatively and ostensively depending on the particular context. The above exposition, rather, is aimed to illustrate how changes in the con-

[16] For example, it is interesting to note that a candidate for a concept that is used ostensively in ecology is stability in its broadest sense.

text in which a concept is used may make one type of definition more suitable than another.

Resilience and Sustainability Science

To recap, we wish to draw attention to three points. First, there is a difference between ostensively and stipulatively defining a concept. This is fairly straightforward. Second, the distinction between ostensive and stipulative definitions can have a disciplinary dimension, at least with respect to a specific concept, as the above two examples suggest. Stipulative definitions may be more common in certain disciplines or fields and ostensive definitions in others.[17] Finally, and crucially, the distinction between stipulative and ostensive definitions is not always discernible through an examination of the content of a set of definitions.

Now let us consider our second point. The disciplinary dimension of preferred modes of definition is of particular interest if we consider cases in which the concept in question is expected to bridge disciplines. One such context in which resilience has frequently been charged with precisely this expectation is sustainability science. Within this field, many scholars have emphasized the need for a deeply integrative effort involving both natural and social sciences (Kates et al. 2001; Jerneck et al. 2011). The concept of resilience has been proposed as a possible bridge (Gunderson & Pritchard, 2002), not least because it offers a potential way of construing sustainability itself (Common & Perrings, 1992; Ludwig et al. 1997).[18] Unsurprisingly, resilience has thus been an object of some controversy (Davidson, 2010; Hornborg, 2013) and repeated efforts have focused on mapping and accounting for the apparent state of conceptual confusion (Brand & Jax, 2007; Strunz, 2012). These efforts, however, are strongly focused on the content of the definitions proposed within the field and do not take into account the mode of definition. How a concept is defined also matters in interdisciplinary contexts because the interdisciplinary connection that is emphasized when using ostensively defined concepts is "in the world." As long as two disciplines, through the concept, obtain an ontological connection there is no real need to harmonize definitions. It is secondary, or at least not a prerequisite of collaboration and conceptual harmony may be the outcome of scientific investigation. For stipulatively defined concepts, however, this does not appear to be the case. When concepts are defined in such a way the definitions themselves become much more important.

Given the disciplinary dimension of the mode of definition, researchers involved in interdisciplinary pursuits, such as sustainability scientists, should be sensitive to the difference between ostensive and stipulative definitions. One reason for this attentiveness is, as we have shown, that resilience in particular is subject to these differences. However, an argument may be made here that the concept of resilience deployed in sustainability science draws so strongly from its ecological background that it is not a matter of reconciling resilience concepts from different disciplines with one another (see Walker & Cooper, 2011; Parker & Hackett, 2012). Instead, resilience as used within a particular context is imposed on a broader field. This does not necessarily exclude confusion between the modes of definitions but makes such confusion somewhat less plausible.

There is, however, a further reason why sustainability science may be susceptible to this form of confusion, which relates directly to the ecological roots of the concept of resilience deployed in the field. One central use of resilience for sustainability scientists is in the evaluation of particular systems or classes of system—resilience is used to tell us something about how, for example, social-ecological systems will respond to disturbances. Resilience assessment, in this sense, is in many instances analogous to the kind of assessment of individuals that interests psychologists. The aim is evaluation of some target system in order to produce predictions, prognoses, and prescriptions. Specific underlying mechanisms and causes are central not only to the evaluation of current "systems," but also to, as sustainability scientists often put it, "building resilience" (Berkes & Folke, 1998). This might be taken to suggest that the concept of resilience *should* be defined ostensively in sustainability science. Notably, many of the most prominent defenders of resilience in the field have a background in theoretical ecology where arguments that define the concept stipulatively have been legion.

There is then reason to suspect that the stage is set for some confusion regarding how exactly the concept of resilience is meant to bridge, or connect, different disciplines. Does such uncertainty, in fact, exist? And how would we know? As already mentioned, it does not always help to look at the definitions themselves, as a single definition can be taken as either stipulative or ostensive. We may, however, get an idea of the situation by examining what the concept of resilience is taken to convey. First, let us consider this simple, but uncontroversial, definition of resilience:

[17] It is probably the case that disciplines that work with formal mathematical models are more prone to stipulative definitions whereas empirically oriented disciplines are more likely to adopt ostensive definitions.

[18] This idea is somewhat contentious. See Derissen et al. (2011) and Léet (1998). The fact that there is a discussion, however, is sufficient for the argument we present here.

> ***Resilience*:** The capacity to sustain a shock and continue to function (Anderies et al. 2013).

We can understand this definition either as ostensive or stipulative. Let us consider it in that order. Taken as ostensive, components of this definition are clearly tacit. Anderies et al. (2013) are not discussing resilience in just any context, but rather a quite specific one, namely the resilience of social-ecological systems. We can understand this definition as pointing, by way of a certain behavior, to the realizers of that behavior, that is to say, whatever it is that makes a social-ecological system resilient.[19] Defining the concept as such may or may not involve further hypotheses regarding the unity of those mechanisms, that is whether social-ecological systems are homogeneous with respect to this feature. If we understand the definition as stipulative, we would think of it as silent about underlying mechanisms and placed strictly at the level of the behavior itself. Under such circumstances, it is not limited to some specific class of systems but is just a general feature that can occur in any number of different settings.

Under the supposition that the first alternative is indeed the correct way to read the definition advanced by Andries and colleagues (2013) then the concept would transfer to different contexts—say one that involves another type of system—if this other type also exhibits the same mechanisms.[20] If we take the second option to be the correct interpretation, the conceptual transfer does not at all rely on the presence of some particular class (or classes) of realizers. The definition is understood as more or less exhaustive and explicit and can be carried over to any domain where the behavior it describes occurs.

Confounding the two alternatives would thus result in confusing exactly what type of information comes along with the transfer of the concept. In sustainability science, it is often a matter of whether social systems, broadly speaking, are essentially similar to ecosystems. Here, it either involves, at least hypothetically, claims about underlying structures and mechanisms of social entities or it amounts merely to surface phenomena. This matters for whether we are to think of the transfer of the concept of resilience from ecology to sustainability science, and ultimately the social sciences, as controversial. Let us consider the following example. The Ottoman Empire can be said to have been resilient or not resilient with respect to different kinds of calamities that it faced throughout its history. Given that this history extended over a period of considerable length, we might hypothesize that the empire was highly resilient. We might even want to explain the demise of the Ottoman Empire in terms of a successive hollowing out of that resilience. World War I finally sealed the Empire's fate, but if that event had not happened, something else likely would have done so. This appears to us to be a rather uncontroversial use of the notion of resilience, one that is quite in line with many definitions used within ecology, in particular, with the one that Anderies et al. (2013) propose. *That is, if we take the definition as stipulative.* To say that the Ottoman Empire is resilient *in exactly the same way* as an ecosystem, however, obviously involves something further. This something might, for example, be claims concerning the inner structure of the Empire, or empires, or perhaps social systems in general.

Among both critics and defenders of the concept of resilience in sustainability science there seems to be a genuine uncertainty with respect to precisely this issue. Some scholars take the concept to commit its users to very particular views of social systems and social-ecological systems, while others presume it to be an abstract, and largely neutral, concept that is virtually boundless in its application. Hornborg (2013) is an example of the former, arguing that resilience fails to take power relations into account and hence falls well short of providing a basis for any type of framework suitable within the social sciences. Holling & Gunderson (2002), ardent defenders of the resilience framework, repeatedly return to the social system/ecosystem analogy and suggest that deeply seated connections obtain between the two:

> Competitive processes lead to a few species becoming dominant, with diversity retained in residual pockets preserved in a patchy landscape. While the accumulated capital is sequestered for the growing, maturing ecosystem, it also represents a gradual increase in the potential for other kinds of ecosystem futures. For an economic or social system, the accumulating potential could as well be from the skills, networks of human relationships, and mutual trust that are incrementally developed and tested during the progression from r to K (Holling & Gunderson, 2002).

[19] The term "realizer" is a philosophical term that denotes that which realizes something. It can be a useful concept when discussing properties or kinds that have many different realizers (this is called multiple realizability in philosophical terminology).

[20] Another possibility here is that the resilience of one type of system is causally linked to the resilience of another type. This would indeed provide reason for discussion, albeit not a transfer of the ostensively defined concept. Some attempts at this carrying over have indeed been made. Adger (2000) has argued that such a connection obtains between ecological and social resilience.

Although concerns have been raised as to the normative implications involved in applying the resilience concept to social systems (cf. Jerneck & Olsson, 2008), many ecologists assume the notion to be largely descriptive and highly abstract (see, e.g., Derissen et al. 2011). The example with the Ottoman Empire, we think, shows how unproblematic a conclusion this is, given that we take resilience to be defined stipulatively.

An important point here is the risk of confusing the two forms of definitions as the concept is transferred. On one hand, the stipulatively defined version of the concept carries little with it in terms of ontological implications and can therefore be used in many different contexts and with reference to many different kinds of systems. The ostensively defined version, on the other hand, because it targets underlying mechanisms, is less transferable and its applicability depends on the presence of these mechanisms. The risk, thus, is that one mistakes the applicability of the stipulatively defined version of the concept with the applicability of the ostensively defined version and takes the former to indicate the presence of the mechanisms that serve as the basis for the latter.

Conclusion

Discussions of the concept of resilience have almost exclusively focused on the content of the definitions and have thus overlooked how it has been defined (Brand & Jax, 2007; Strunz, 2012). The difference between formulating stipulative and ostensive definitions, however, is important, especially in interdisciplinary contexts such as sustainability science where it matters how different disciplines are linked to one another. An interdisciplinary connection that is merely established on the basis of an abstract notion of resilience—one that we here have associated with defining stipulatively—is barely more substantial than one based on the concept of stability (Thorén, 2014). However, in case this is what sustainability scientists in fact mean to do, there is reason for concern regarding the many different definitions in the literature. A wide spectrum of definitions exists, and although it is easy enough to locate a few core concepts, it is much harder to rigorously establish the connections between resilience and many of the other notions with which it is frequently associated, such as self-organization, learning, and adaptation (cf. Brand & Jax, 2007; Thorén, 2014). If, by contrast, we are to take the definitions of resilience to be more like those proposed by psychologists, that is, as ostensive, the resulting interdisciplinary research program becomes entirely different. Conceptual rigor in the form of defining resilience in the same way across disciplines is then a secondary consideration. The basis for such a collaborative effort is the hypothesis that deeply rooted ontological overlaps, or connections, exist. More precise definitions, even ones shared across disciplines, may be the outcome of such a research program, but are certainly not a prerequisite.

What we are then calling for is a kind of interdisciplinary integration that is less concerned with definitional details and more sensitive to subtle differences across disciplines. This kind of sensitivity should speak to anyone interested in integrative scientific efforts.

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