

Individualisation and individualised science across disciplinary perspectives

Marie I. Kaiser*, Anton Killin*, Anja-Kristin Abendroth, Mitja D. Back, Bernhard T. Baune, Nicola Bilstein, Yves Breitmoser, Barbara A. Caspers, Jürgen Gadau, Toni I. Gossmann, Sylvia Kaiser, Oliver Krüger, Joachim Kurtz, Diana Lengersdorf, Annette K. F. Malsch, Caroline Müller, John F. Rauthmann, Klaus Reinhold, S. Helene Richter, Christian Stummer, Rose Trappes, Claudia Voelcker-Rehage, Meike J. Wittmann

*joint first-authorship

Marie I. Kaiser (corresponding author)

ORCID: 0000-0002-9307-7474

Department of Philosophy, Bielefeld University, Postfach 100131, 33501 Bielefeld, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Bielefeld, Germany.

+49 521 106-4605

kaiser.m@uni-bielefeld.de

Anton Killin

Department of Philosophy, Bielefeld University, Bielefeld, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Bielefeld, Germany.

Anja-Kristin Abendroth

Faculty of Sociology, Bielefeld University, Bielefeld, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Bielefeld, Germany.

Mitja D. Back

Department of Psychology, University of Münster, Münster, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Münster, Germany.

Bernhard T. Baune

Department of Psychiatry, University Hospital Münster, Münster, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Münster, Germany; Department of Psychiatry, Melbourne Medical School, University of Melbourne, Melbourne VIC, Australia; The Florey Institute of Neuroscience and Mental Health, University of Melbourne, Parkville VIC, Australia.

Nicola Bilstein

Chair of Marketing and Service Management, Faculty of Law, Business and Economics, University of Bayreuth, Bayreuth, Germany.

Yves Breitmoser

Faculty of Business and Economics, Bielefeld University, Bielefeld, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Bielefeld, Germany.

Barbara A. Caspers

Behavioural Ecology, Faculty of Biology, Bielefeld University, Bielefeld, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Bielefeld, Germany.

Jürgen Gadau

Institute for Evolution and Biodiversity, University of Münster, Münster, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Münster, Germany.

Toni I. Gossmann

Faculty of Biochemical and Chemical Engineering, TU Dortmund University, Dortmund, Germany.

Sylvia Kaiser

Department of Behavioural Biology, University of Münster, Münster, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Münster, Germany.

Oliver Krüger

Animal Behaviour, Faculty of Biology, Bielefeld University, Bielefeld, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Bielefeld, Germany.

Joachim Kurtz

Institute for Evolution and Biodiversity, University of Münster, Münster, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Münster, Germany.

Diana Lengersdorf

Faculty of Sociology, Bielefeld University, Bielefeld, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Bielefeld, Germany.

Annette K. F. Malsch

Faculty of Health Sciences, Bielefeld University, Bielefeld, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Bielefeld, Germany.

Caroline Müller

Chemical Ecology, Faculty of Biology, Bielefeld University, Bielefeld, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Bielefeld, Germany.

John F. Rauthmann

Department of Psychology, Ludwig-Maximilians-University, Munich, Germany.

Klaus Reinhold

Evolutionary Biology, Faculty of Biology, Bielefeld University, Bielefeld, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Bielefeld, Germany.

S. Helene Richter

Department of Behavioural Biology, University of Münster, Münster, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Münster, Germany.

Christian Stummer

Faculty of Business and Economics, Bielefeld University, Bielefeld, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Bielefeld, Germany.

Rose Trappes

Egenis Centre for the Study of the Life Sciences, University of Exeter, Exeter, UK.

Claudia Voelcker-Rehage

Institute of Sport and Exercise Sciences, University of Münster, Münster, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Münster, Germany.

Meike J. Wittmann

Theoretical Biology, Faculty of Biology, Bielefeld University, Bielefeld, Germany; Joint Institute for Individualisation in a Changing Environment (JICE), University of Münster and Bielefeld University, Bielefeld, Germany.

Manuscript preprint, July 2024

Published version appears in *European Journal for Philosophy of Science*

<https://doi.org/10.1007/s13194-024-00602-8>

Individualisation and individualised science across disciplinary perspectives

Kaiser MI, Killin A, Abendroth A-K, Back MD, Baune BT, Bilstein N, Breitmoser Y, Caspers BA, Gadau J, Gossmann TI, Kaiser S, Krüger O, Kurtz J, Lengersdorf D, Malsch AKF, Müller C, Rauthmann JF, Reinhold K, Richter SH, Stummer C, Trappes R, Voelcker-Rehage C, Wittmann MJ

Abstract

Recent efforts in a range of scientific fields have emphasised research and methods concerning individual differences and individualisation. This article brings together various scientific disciplines—ecology, evolution, and animal behaviour; medicine and psychiatry; public health and sport/exercise science; sociology; psychology; economics and management science—and presents their research on individualisation. We then clarify the concept of individualisation as it appears in the disciplinary casework by distinguishing three kinds of individualisation studied in and across these disciplines: Individualisation_{ONE} as creating/changing individual differences (the process that generates differences between individuals: intrapopulation or intraspecific variation/heterogeneity); Individualisation_{TWO} as individualising applications (the tailoring or customising of something—information, treatment, a product or service, etc.—for an individual or specific group of individuals); and Individualisation_{THREE} as social changes influencing autonomy, risk, and responsibilities (the process discussed under the rubric of sociological individualisation theory). Moreover, we analyse conceptual links between individualisation and individuality, and characterise different sorts of individuality that the disciplines study. This paper aims to promote interdisciplinary research concerning individualisation by establishing a common conceptual-theoretical basis, while leaving room for disciplinary differences.

Keywords

Individualisation; individualised science; individuality; individual differences; philosophy in science

1. Introduction

Individuals of the same population or species differ from one another. This is true for all sorts of organisms, including plants, non-human animals, and humans (Müller et al. 2020; Müller and Junker 2022). For example, animals differ morphologically, physiologically, behaviourally, even in terms of their ‘personality’ (for instance, whether the animal is disposed to act in a bold or shy manner in a risky scenario; see Kaiser and Müller 2021). Animals differ in the way they get ill and react to the same treatment; differ in how they interact with other individuals, how they are seen by other individuals, and in the case of humans at least, are socially recognised as autonomous subjects; differ in how they execute certain tasks and in terms of their preferences and in the decisions that they make (e.g., purchase decisions, mate choices, educational and occupational choices).

For many scientific purposes, especially in biological fields, it is becoming increasingly clear that population- or species-level average values for individual traits—the standard measure of much analysis—are insufficient (e.g., Wolf and Weissing 2012; Schwarz et al. 2021). These values obscure the differences between individuals—the variation/heterogeneity present in the population, species, or study group—stymying efforts to understand and predict, *inter alia*, population processes, interactions with other species, and response to environmental change. The situation is similar in other fields such as personality psychology (Kuper et al. 2022a) and personalised medicine (Brittain et al. 2017; Baune 2020a). Perhaps unsurprisingly, then, the perspective of intrapopulation or intraspecific trait variation as noise around an optimum value is waning (Moran et al. 2021).

The scientists in these fields aim at understanding not only that individuals differ but also how, and why, and what the consequences are. This has ignited a research agenda: *individualisation*. This agenda, as we see it, is at least two-pronged. On the one hand, scientists investigate *how* individual differences¹ develop (i.e., the causes, mechanisms, or processes of individualisation; how individual differences arise, change, stabilise, and persist), as well as *why* individual differences arise and change. On the other hand, scientists are interested in the consequences of individualisation (e.g., in terms of ecological-evolutionary or social consequences) and in the implications of individual differences for a very wide range of contexts of application, including designing nature reserves, improving animal welfare, medical or psychiatric treatment, health/nutrition recommendations, marketing strategies, and pedagogy (e.g., internally differentiated

¹ It would be more precise to always speak of *inter-individual* differences since we mean differences *between* individuals (and not, e.g., differences between earlier and later stages of the same individual—its caterpillar stage and its butterfly stage, for instance). For reasons of simplicity and because it is an established term, we will, however, use the term ‘individual differences’.

teaching). This gives rise to what is often called *individualised (or personalised) science*, for example, personalised medicine (e.g., Abettan 2016).

Many disciplines are concerned with individualisation, understood in terms of individual differences.² This provides the opportunity for fruitful, collaborative exchange between the disciplines (an example being the research project “Individualisation in Changing Environments (InChangE)”, conducted by members of the Joint Institution for Individualisation in a Changing Environment at the Universities of Bielefeld and Münster, Germany. In our experience, however, successful interdisciplinary collaboration requires developing at least a minimal common conceptual-theoretical basis to avoid misunderstandings and to emphasise points of contact (and convergence) between the disciplines (see, e.g., Andersen 2016). This is what this article does and its contribution can thus be characterised as ‘philosophy *in science*’ (Pradeu et al. 2024). The common conceptual-theoretical basis that we develop is minimal because it concerns only a few, very central concepts: ‘individualisation’, ‘individual differences’, and ‘individuality’. It is practice-centred (e.g., Waters 2019), for its conceptual divisions follow those identified in or inferred from the various disciplinary summary outlines that we present. This is a feature of our account, as we aim to take seriously how the concepts are understood and used in scientific practice.

Our philosophical analysis is intended to be scientifically and philosophically relevant. First, we seek to support the interdisciplinary integration of studies of individualisation and individualised science by presenting disciplinary summary outlines and then drawing from these cases the concepts that comprise our minimal common framework. Moreover, we draw connections between the research questions of different disciplines, and identify theoretical-conceptual questions that are priorities for future research. Second, while there has been much philosophical discussion about topics such as biological individuality (e.g., Godfrey-Smith 2009; Clarke 2010; Pradeu 2012, 2016; Lidgard and Nyhart 2017), personalised medicine (e.g., Abettan 2016; Maughan 2017), and methodological individualism in the social sciences (e.g., Epstein 2009; Zahle and Kincaid 2019; Heath 2020), recent efforts in various disciplines to study individual differences and individualisation has not yet been brought together and philosophically analysed. We thus seek to draw philosophical attention to the scientific study of individualisation and to provide some first steps towards using this case to make novel contributions to existing philosophical debates about individuality, individualisation, and individuals.

² ‘Individualisation’ as an established theoretical term in sociology is not best elucidated in terms of individual differences, as we will clarify in Sections 2.4 and 3.1. However, we also show that individual differences are nevertheless an important target of sociological research, whether or not those research efforts and their discourses are framed by sociological individualisation theory.

This paper proceeds as follows. Section 2 presents six summary outlines of individualisation from within several different (clusters of) disciplines: ecology, evolution, and animal behaviour; medicine and psychiatry; public health and sport/exercise science; sociology; psychology; and economics and management science. Each disciplinary perspective is written by at least two of this paper’s co-authors; together we span the full range of disciplines represented. Attention is given to the general state of play within a discipline. Of course, within many disciplines there is a diversity of methods and practices that occur across different subareas and even with the same subareas, necessitating some amount of selectivity: we focus on areas related to individualisation, but make no claim of exhaustiveness. Sections 3 and 4 present our philosophical analysis. Here we draw together threads from the disciplinary summary outlines, establishing a common conceptual-theoretical basis for the interdisciplinary study of individualisation that leaves room for disciplinary differences. In Section 3 we clarify what individualisation is by providing a programmatic analysis, and by clarifying how individualisation is connected to individual differences and how it is informed by investigating individual-environment interactions. We identify three kinds of individualisation processes, based on the disciplinary outlines. We first distinguish Individualisation_{ONE} (a process giving rise to or changing *individual differences*—intrapopulation or intraspecific variation/heterogeneity) from Individualisation_{TWO} (the tailoring of interventions, services and products for an individual or specific group of individuals, given their differences from others). We focus on these two senses of ‘individualisation’ due to our focus on individual differences, as discussed earlier. We identify a third kind of individualisation process studied in the social sciences: social processes effecting a reorientation from traditional collectives to individuals, influencing autonomy, risk, and responsibility. This is ‘individualisation’ in the sense of sociological individualisation theory, which we label Individualisation_{THREE}. Our discussion of this concept, however, primarily serves to distinguish it from the others. Because this already is a well-established theoretical notion, and because it is not best explicated in terms of individual differences, we subsequently set it aside for our purposes. This does not mean, however, that we assume sociologists do not investigate individual differences. On the contrary, Individualisation_{ONE} is often at stake in sociological discourses, as we establish in Section 2.4. Section 4 then offers more general insights into the relation between individualisation, individual differences, and individuality. Our main claim in this section is that, in general, being different from others is one way of expressing individuality; we conceptualise this as *individual-difference individuality* and show how differing conceptions of it are implicated in various disciplines. Section 5 concludes, identifying some prospects for future philosophical analysis.

2. Individualisation Across Disciplines

2.1 Individualisation in Ecology, Evolution, and Animal Behaviour

Individuals of the same species, population, and even family/group differ in many respects, for example, in behaviour, morphology, and physiology (Müller et al. 2020; Müller and Junker 2022; Kaiser and Müller 2021). Determining *how* (proximate questions), *when* (e.g., at which life stages) and *why* (ultimate questions) differences between individuals arise is a major focus of past and current research in ecology, evolution, and animal behaviour. However, even this type of research has mostly been satisfied with mean values of difference/individual-level traits in a population (or species) for the purposes of analysis, and has ignored remaining individual differences. This perspective conceives of intrapopulation and intraspecific variation as noise around an optimum value.

A relatively recent paradigm shift has refocused much biological research squarely on individual differences (Wolf and Weissing 2012; Bolnick et al. 2003), now considered in animal personality research (Dall et al. 2012; Kaiser and Müller 2021), conservation biology (Smith and Blumstein 2013; Powell and Gartner 2011), the study of individualised niches (Krüger et al. 2021, Müller et al. 2020), animal welfare science (Richter and Hintze 2019; Carere and Maestripiéri 2013) and elsewhere.

While individuality is considered in terms of individual differences, individualisation is the process during which individual differences initialise and change over time by way of the development of an individual's traits or phenotype. Sometimes the differences between individuals are easily detectable by studying prominent phenotypes, for example, by investigating variation/heterogeneity with respect to size, shape, or colouration within the group of individuals under study. However, many individual phenotypic differences are less obvious and need to be studied by way of more intricate methods—for example, by examining body odours, gut microbiota composition, individual immune systems, or behaviour. How individual differences in perceptual capacity gives rise to task specialisation/division of labour in eusocial insects (Beshers and Fewell 2001), and how individual differences in sensory apparatus give rise to variation in temporal foraging patterns and speed/accuracy trade-offs in bees (Chittka 2022) are two examples of individualisation research programs.

Besides analysing phenotypic differences, a common way to pinpoint individuals (and their differences) is by genetic markers (e.g., parts of the genomes that are highly polymorphic and considered selectively neutral, such as microsatellites, that are also used to establish relatedness and population structure in animals including humans). While the genome of an individual remains largely stable over its lifetime, many traits develop only

during a specific life stage in interaction with environmental factors. Consider the unique colour patterns of individual fire salamanders, which develop during their late larval stage. Although unique, an individual fire salamander's colour pattern is highly influenced by food availability during that stage (Caspers et al. 2020), but once individuals metamorph and leave the water, their colour pattern remains constant throughout life. While the amount of yellow in the patterns of post-metamorphic fire salamanders is probably under selective pressure, with more yellow leading to reduced predation risk (Caspers et al. 2020), the pattern itself is most likely not under selection, similar to the patterns of human fingerprints. Other traits are highly plastic and change due to different environmental conditions, seasons, and social contexts. For example, the behavioural and hormonal phenotype of a male guinea pig is shaped by his social environment during adolescence, but can be reshaped if the social environment changes later in life (Mutwill et al. 2020).

These examples show how the environment of an individual plays an important role and that individualisation is a result of the interaction between an individual, its genes and internal states, and its biotic and abiotic environment. Methods and concepts in biology, such as reaction norms, take into account and measure how phenotypes and traits differ across an environmental gradient. In contrast, other concepts gleaned from developmental biology emphasise how canalisation suppresses the expression of alternative phenotypes or traits during ontogeny in different environments, reducing environmental influence on a trait, which has the potential to lead to reduced individual differences (Gonzales et al. 2018).

Overall, individual differences, their causes, and their consequences are becoming more central in biological research. Moreover, with the development of the concept of an individualised niche, the focus of how and why individuality originates, develops, and becomes evolutionarily stable has become central. Indeed, the interaction between the individualised phenotype and the environment results in individualised niches via three processes/mechanisms of adjustment that potentially increase the fitness of an individual: niche choice, niche conformance and niche construction (Trappes et al. 2022). The concept of the individualised niche represents an integrative framework to study the causes and consequences of individualisation (Krüger et al. 2021).

This subsection provided a disciplinary summary outline of individualisation, in terms of individual differences, from the perspective of biological disciplines. Here, 'individualisation' refers to processes, occurring throughout the lifetime of individuals, that generate or modify *differences between individuals*—that is, intrapopulation or intraspecies *variation/heterogeneity*.

2.2 Individualisation in Medicine and Psychiatry

There is a long-standing tradition, historically associated with the Hippocratic Oath, according to which medical practitioners commit to the medical interests of individual patients and thereby to dealing with the illnesses of individual patients. Yet with the introduction of a modern scientific approach to medicine and psychiatry in the 19th century, these fields aimed to establish scientifically rigorous standards and norms, requiring something of a shift. Quantification underlies the modern scientific conception of medicine and psychiatry, generating tension with the historic idea of an experienced, expert doctor dealing with their patients as individuals in a more ‘holistic’ way. But that historic, holistic approach is not the only conception of individualising medicine. Indeed, modern individualised approaches to medical treatment (and prevention) are currently gaining traction.

First, the term ‘personalised medicine’ has become increasingly popular, referring to an increasingly sought-after approach in practice, which is to tailor (that is, ‘individualise’) medical treatment or intervention. Despite the name ‘personalised medicine’, this does not entail an ‘individual-level’ approach, in the sense of an individually bespoke, exclusively designed, person-specific medical treatment. Rather, practitioners of personalised medicine individualise treatment and prevention by taking into account the specific characteristics of individual patients and relating them to *strata*—that is, narrower subsets of the more general samples of the population that make up the cohorts of standard randomised control trials—rather than comparing individual patients to the general mean (the ‘one-size-fits-all’ approach; see Brittain et al. 2017; Baune 2020a). Different strata comprise individuals from the larger sample that match in terms of particular genetic characteristics or other determining factors (from subjective data, objective medical test and experimental data, to blood-based biomarkers, digital mental health markers, brain imaging markers, and so on). The reasoning is as follows. Given that individuals differ from one another, individuals sharing a diagnostic label may well have a variety of clinical presentations and respond in a heterogeneous fashion to therapeutic interventions or lifestyle recommendations. Actual responses in a clinical trial can range from no response to dramatic response, given individual variation. Particular individual characteristics may covary with response level, enabling stratification. Thus, knowing certain characteristics of a patient in a clinical encounter and comparing them to (a sufficiently large sample of) individuals that share those characteristics gives that patient a better chance of optimal treatment—say, via response to a specific drug instead of another, or a specific preventative strategy—and still in an evidence-based way (Baune 2020a, b). The stratification approach, then, allows a focus on medically relevant similarities, reducing the influence of variation compared to

use of the larger sample. Whenever strata comprise large enough sample sizes, personalised medicine aims to better capture and relate the patient at hand vis-à-vis the medical or psychiatric matter at hand, compared to the one-size-fits-all approach.

Many HIV patients are prescribed the relatively safe drug Abacavir, for example; however, there is a small chance of a toxic reaction to the drug in hypersensitive patients, correlated with a single genetic variant (see Abettan 2016). Screening HIV patients for this genetic variant (i.e., to see whether they would belong to this genetically classified stratum) and subsequently prescribing the appropriate drug is thus an example of the personalised approach; indeed, one that has become a routine step in prescribing HIV treatment. Likewise, individuals with certain psychiatric risk profiles can be said to belong to ‘risk strata’. Psychiatry researchers examine, *inter alia*, immune function deviations in patients with psychiatric illnesses compared to healthy controls (e.g., Wingo and Gibson 2015). Following this, stratification could be based on genetic risk profiles for the disposition to develop the immune dysfunction that causally contributes to the development of the psychiatric illness. An individual patient in a clinical encounter with a certain genetic risk profile could then be compared to the relevant strata and treated (or provided with preventative measures) accordingly.

Second, personalised medicine often goes in hand with ‘precision medicine’, the aim to describe an individual’s specific case of an illness or disease at a higher level of resolution than previously possible, enabled by new advances in genomics, medical technologies, bioinformatics, and algorithms for analysis. These new advances allow for distinguishing ‘precise’ subcategories of disease, of which each might call for distinct therapies. The broad categories of cancer and cystic fibrosis are examples (Ashley 2016). Indeed, the precision approach has proven especially fruitful in oncology, for example, where pathology is often finely circumscribed and thus diagnosis can be precise. This then may facilitate personalised oncological treatment, tailored to a particular instance of tissue damage/change.³ In contrast, in psychiatry, pathology is generally circumscribed more coarsely, making precision medicine challenging to implement.

In short, individualised approaches to medicine and psychiatry (both personalised and precision) aim to reduce noise. Firstly, the inference that a treatment will work well for a patient is stronger when it comes from a better understanding of the individual’s characteristics (again, providing that there is still comparison against a large enough sample; this necessitates the huge sample sizes that medical researchers work with). This

³ One example is the case of CAR T-cell therapy treatment. Treatments are customised for individual patients via the collection and re-engineering of a patient’s T-cells to produce CARs (chimeric antigen receptors), proteins that recognise and bind to particular proteins or antigens on the surface of cancer cells (see, e.g., Jackson et al. 2016).

enables a structured/stratified assessment and modelling of a range of determining factors to predict risks and treatment responses—and, secondly, in combination with precision medicine, enables the identification of the precise subtype of an individual's disease. Perhaps unsurprisingly, then, there is an increasing number of scientific publications and themed conferences on this topic, which supports the impression of rising importance of the personalised and precision concepts in medicine and psychiatry. Despite the potential promise (Abettan 2016; Baune 2020a; McCarthy 2017), little work has been undertaken to precisely define the concepts and systematically translate individualised medicine into clinical practice. Most work in this regard is piecemeal, aiming to show how an individualised approach can play out clinically in reference to a particular disease or illness (see, e.g., McCarthy 2017, for an individualised approach to type 2 diabetes).

Generally, however, individualised approaches in medicine/psychiatry are still largely at the conceptual stage and are not yet adequately developed or empirically established for clinical practice. There are also legitimate concerns over the hype surrounding individualised approaches: there are many successful cases, but also failed attempts to individualise treatment of more complex illnesses, and these failures receive far less air time (Maughan 2017). That said, bolstered by its successes, individualised approaches are very likely to be something that we will see further explored by medical and psychiatric researchers in the years to come (Baune 2020b).

This subsection provided a disciplinary summary outline of individualisation in medicine and psychiatry. Here, 'individualisation' relates to personalised medicine and psychiatry. In clinical settings, information about individual differences guides the medical professional, enabling them to individualise medical advice, intervention or treatment so that it is better tailored to the individual patient.

2.3 Individualisation in Public Health and Sport/Exercise Science

The public health sciences aim to prevent disease, prolong life, and encourage healthy lifestyles through organised social efforts and policy recommendations. Public health's initiatives promote the making of informed choices at all levels of society, including private and public organisations, communities, families, and individuals (Winslow 1920; Wanless 2004; Griffith et al. 2005). Examples include the World Health Organisation's poster campaign foregrounding individual responsibility in handwashing and personal hygiene in order to reduce the use of antibiotics and prevent communities from developing antimicrobial resistances (Chandler 2020), and the World Health Organisation's global action plan on physical activity, providing recommendations to help

countries increase levels of physical activity within their populations (WHO 2022). Worldwide improvements in health have seen public health initiatives increasingly focus on new epidemics of non-communicable diseases, for example, cardiovascular diseases, musculoskeletal disorders, diabetes and mental disorders (Lopez et al. 2008; WHO 2020).

Health promotion generally targets not only the societal level but individual behaviour and resources, lifestyle risk factors, and the wider determinants of health, such as poverty and education (Wanless 2004; WHO 2022). These targets of analysis shift public health's focus towards individual health, emphasising the role of an individual's circumstances with respect to their health maintenance and disease pathogenesis (Arah 2009). Developments in molecular genetics and genomics support this refocus, for they have elucidated ways in which the human genome interacts with diverse environments and individual health-related behaviour (Ilklic et al 2007). As a new field, public health genetics is striving for the integration of (epi)genetic information into strategies for disease prevention as well as the development of novel tools and technologies, rendering the field a highly-relevant interface between individuals and societies. Dumit et al. (2021) predict that public health initiatives will benefit from the personalisation of public health genetics. This vision is, however, currently controversial among public health scholars, as the causes of non-communicable diseases are complex on the one hand, and only a few risk factors are responsible for many diseases and deaths on the other (Jahn and Probst-Hensch 2018).

One important aim of public health initiatives is to strengthen individual health literacy and influence individual behaviour towards healthier lifestyles. Personalised services for both individuals and communities result in more health opportunities as well as the “empowerment of communities, their ownership and control of their own endeavours and destinies” (WHO 1986). Cunningham et al. (2000), for example, report a pilot internet questionnaire that asks individuals about their drinking habits, and then provides personalised assessments—advice tailored to the answers of a person. In general, the more precisely information is adapted to the particular case of an individual, the better the advice from a human expert or algorithm, facilitating, on balance, more efficient individual health promotion (Caspari and Bös 2006).

Such information can also be derived by more objective measures such as physiological assessment. Within sport/exercise science, the development of tailored exercise recommendations is an important topic. Training studies consistently report wide variation in the effects of regular exercise training, including individuals who demonstrate an adverse response to specific training interventions and other individuals showing the expected (and desired) responses. Based on such variation in response to exercise, it has been suggested that individuals can be divided into ‘responders’ and ‘non-

responders' (Mattioni et al. 2021). Being a responder or non-responder to exercise training, however, depends on training principles such as exercise modality, intensity, duration, and frequency, strongly implying the need for the tailoring of recommendations. Current approaches go one step further showing that certain individual characteristics such as fitness level or sex (and within sexes, the fluctuating levels of sex hormones) directly impact responses to exercise. That is, the same absolute dosage of exercise induces different physiological responses depending on the fitness or hormonal state of a person (Julian and Sargent 2020). This calls not only for individualised approaches to health advice in general, and exercise advice specifically. It also indicates the variety of research questions. Similarly, sport/exercise science aims to explain individual differences in motor performance and learning (Hübner et al. 2019) to derive appropriate therapeutical approaches, design training programs (Mack et al. 2023), or to support developmental processes whether in children or older adults.

Another important aim is the design of health-promoting human environments; the full range of environmental features play significant roles in health-relevant individual development (Gebhard 2020). The socio-political environment is also key: state intervention to empower citizens proves fundamentally difficult in Western societies and can have a negative impact on individual self-esteem, especially when the target group called to self-care finds itself confronted with structural or material problems that are beyond their influence but under state control (Berg et al. 2019). This problem is exacerbated when local health authorities conceptualise health inequalities and their social determinants as personal matters and thus the responsibility of individuals (Mead et al. 2020).

Even when public health initiatives are aimed at target groups, the intention is to reach every single individual within the group. Hence, individualisation in public health can be described as personalised health-related services or products, or information tailored for a certain target group—this is reminiscent of individualisation in medicine and psychiatry, discussed in the previous subsection. In relation to health literacy, individualisation has been defined as “adapting or tailoring services and information to the needs of individuals. The aim is to provide a person with the maximum amount of information that is important to them from their perspective” (Caspari and Bös 2006, our translation). Sport/exercise science has a long tradition of developing such tailored recommendations; nevertheless, there are still many unsolved questions with respect to the ‘fine-tuning’ of individualised approaches. Finally, in a de-traditionalised and individualised modern society, in which thinking has shifted from being oriented on traditional collectives to individuals, individualisation of health implies greater individual responsibility for one’s own health (Berg et al. 2019; Berger 2020; Bolam et al. 2004). This

is in line with how individualisation is discussed in sociological individualisation theory, considered next.

2.4 Individualisation in Sociology

The distinction between ‘individual’ and ‘society’ is a central justification of sociology as a discipline. Within their reflections on the individual, early sociologists discussed the variety of individual options on the one hand, and social expectations on the other, that opened up in the 19th century, for example, with respect to dissolving estates of the realm. For Georg Simmel, Max Weber, and Emile Durkheim, increasing reference to the ‘I’ was not good news, but “a disease of an anti-social individualism” (Rammstedt 1985, p. 494, our translation; see also Mead 1934).

More recently, a particular concept of individualisation has become particularly important in sociology, alongside increased efforts to conceptualise and analyse empirically observable social change, especially with respect to both industrial production and changing gender relations. The society-level individualisation processes identified here (e.g., Beck and Beck-Gernsheim 1994, 2002) affect individuals in a specific way, in that they detach from traditional and hitherto predominant social forms (‘de-traditionalisation’) and become more individually oriented, autonomous, and responsible (‘individualisation’). Such individualisation processes occur in many social domains, such as the workplace: “individuals take on a new role as coordinators of their personal work biographies: they become actors who actively shape their individualised work orientations and commitment patterns, which a few decades ago used to be shaped much more on a collective basis” (Kirpal et al. 2007, p. 285).

This concept of individualisation was used in part to critique then mainstream postmodernist theorising. Postmodernists of the 1970s emphasised the positive aspects of the recent and ongoing breakdown of various traditional social norms and structures, especially those occurring in so-called ‘WEIRD’ societies—breakdowns that resulted in increased individual autonomy, rights, and freedom of choice. Individualisation theorists aimed to show the limits of this perspective by arguing that it overstates the extent to which individuals are free (Beck 1992; Beck and Beck-Gernsheim 1994, 2002; Giddens 1991, 1994). The greater autonomy found in Western society today compared to even 60 years ago—just two generations—naturally may be liberating for many individuals, perhaps especially women and other marginalised groups. But, the idea goes, greater personal freedom does not erase risks and responsibilities. How these change in an individualised society became the target of a research agenda within sociology (Beck and Lau 2005). ‘Individualisation’ in this sense, then, refers to the process whereby increased social

change (and increased future uncertainties due in particular to the shift away from traditional norms and structures) force each individual to dedicate more effort and time to their daily life choices—forcing individuals to accept an increased level of risk and responsibility for the consequences of those choices. Since greater autonomy must be exercised in societies undergoing individualisation than in previous generations, knock-on effects are inevitable: chief among these is the increasing extent to which individuals are required to construct and be held accountable for their own lives, which has significant implications for responsibilities.

Sociological individualisation theory has its critics (see, for review, Dawson 2012). Plausibly, in distinguishing their framework from postmodernism, individualisation theorists have in turn overstated the extent to which individuals have become ‘disembedded’ in an individualised society—especially in so widely projecting a particular *experience* of modern societies—necessitating an ‘embedded’ conception of individualisation (Dawson 2012). For a start, individuals socially integrate in new ways (e.g., networks, scenes). Rather than throw the baby out with the bath water, sociologists now see individualisation as socially situated (Adams 2003; Ødegårda and Berglund 2008). This has reignited sociological interest in poststructuralist approaches (for example, processes of subjectivation; see Foucault 1975), and praxeological approaches (such as production and reproduction of habitus; see Bourdieu 1987), two starting points for much contemporary sociological epistemological inquiry (e.g., Adkins 2004; Lehmann 2009; McNay 1999).

These debates have also found expression in social structure analysis, in particular in the sociology of the life course, as well as sociological gender studies. Social structure analysts examine changes in social structures on the basis of individual decisions and behaviour, in conjunction with cultural, institutional, and structural framework conditions. ‘Individualisation’ in this context of inquiry means the process whereby “markets and welfare states address the individual *as an individual* rather than as a group member”, especially given that “individualism has become accepted as a cultural model, especially in the sense of responsibility for one’s own actions” (Diewald 2013, p. 554, our translation and emphasis). In other words, the explanatory targets of this individualisation research are individuals (who differ from one another) and their social environments.

We see this also in sociological gender studies. Buschmeyer and Lengersdorf (2016), for example, distinguish ‘hegemonic masculinity’, the predominant masculinity concept in sociological gender studies, from non-hegemonic formations. Gender expression is increasingly heterogeneous, and individual variation in the expression of masculinity, for example, may challenge inferences that rely on a unitary concept of it.

New social norms have reshaped a range of other social concepts and constructions, such as ‘fatherhood’, resulting in a variety of socially legitimate ways of being fathers (Lengersdorf 2013, 2014). This calls for the study of individuals in order to better understand how individual fathers differ qua fatherhood. Finally, although one can speak of the social de-institutionalisation of gender-specific normal life courses in many regions of the world, which has resulted in more individualised decision-making opportunities and autonomy, one must also speak of novelties that arise. Individuals face new opportunities and new challenges for integrating gainful employment with family and other commitments in everyday life and over one’s life course, largely determined by one’s position in social, organisational, and familial structures (Kirpal et al. 2007).

In this subsection, we characterised the theoretical notion of individualisation as it is conceived within sociological individualisation theory. We distinguished this notion of individualisation from research in sociology that emphasises individuals given their differences from one another, as well as the processes that generate or change such differences between individuals—reminiscent of the concept of individualisation in the biological sciences, discussed earlier.

2.5 Individualisation in Psychology

Although ‘individuality’ and ‘individualisation’ are currently not mainstream terms in psychology, psychological science has an established focus on both the description of individuality (how individuals are psychologically *different* from others, or even unique) and the process of individualisation (how it comes to be that individuals differ from one another). In addition, ‘individualisation’ is often used in contemporary psychology when referring to individualised services (e.g., psychotherapy, an intervention) that are tailored to individuals or specific groups. For example, personality psychology research on variation in psychological dynamics considers contingencies that can be directly related to application, working better for some individuals because of differences in reaction to circumscribed situations (Kuper et al. 2022b; Mota et al. 2023).

The field of psychology most concerned with individualisation is personality psychology. Personality psychology is deeply concerned with individual differences, and has been, since its inception (McAdams 1997; see also Corr and Matthews 2020). It integrates insights and methods from cognitive psychology (commonly interested in, *inter alia*, rules of cognition, affect, motivation, and behavioural regulation), social psychology (commonly interested in normative effects of contexts and social interactions), developmental psychology (commonly interested in normal developmental trajectories across the lifespan), and quantitative psychology (concerned with

psychological research methods and statistics including longitudinal and multi-method data, adding a different perspective that focuses on how people differ). Thus, personality psychology aims to understand more fully how individuals function psychologically, whether in certain respects like all other persons (i.e., generalities), like some other persons (i.e., due to individual differences), or like no other persons (i.e., due to uniqueness), following the terminology of Kluckhohn and Murray (1953).

The study of individuality and individualisation in personality psychology has quite some history. An early concept, coined by Carl Jung (1934/1950), was *individuation*—the process of becoming an individual with a self and identity (Schlamm 2014). Historically, this concept did not take hold much because psychoanalytic concepts and thinking were eschewed once behaviourism became the dominant psychological paradigm. Other paradigms followed behaviourism, but Jung’s individuation concept, with its psychoanalytic roots, was not revived in mainstream psychology. However, the contemporary self and identity literature (which has some ties to personality and social psychology) is indeed concerned with processes of self and identity formation that may capture key aspects of becoming an individual—different from others—in one’s society (e.g., Cote and Levine 2002). Differential approaches, originating from Stern (1911), have been more influential (e.g., Allport 1937; Cattell 1946). These are concerned with quantitative analyses of individual differences and distinguish nomothetic, variable-oriented approaches (i.e., describing how individuals differ in terms of specific variables and how these differences co-vary) from idiographic, person-oriented approaches (i.e., describing the similarities and differences of given individuals across variables).

Following this differential approach, contemporary personality psychology is quantitatively oriented. Most research follows a nomothetic, variable-oriented approach (Kuper et al. 2022a), but there is an emerging trend for more idiographic, person-oriented analyses as well (e.g., Beck and Jackson, 2020). Further, modern comprehensive analyses of individual differences include descriptive, predictive, and explanatory foci (Möttus et al., 2020). With regard to description and prediction, there is evidence for (a) ubiquitous and strong differences between individuals regarding all sorts of psychological phenomena (including behaviours, motivations, emotions, cognitions, social perceptions, and life narratives), and (b) robust effects of these differences on life outcomes such as well-being, social relationships, occupational success, and longevity (e.g., Beck and Jackson 2022; Soto 2019; Roberts et al. 2007).

Explanatory approaches especially in personality development and personality dynamics contribute to understanding the emergence of individual differences and are thus key for understanding individualisation. Firstly, research on personality development (for overviews, see Bleidorn et al, 2020, 2021) assesses people’s individuality across time

(e.g., assessments of individuals' self-concept, biological and behavioural regularities, and reputations across yearly assessments) and, thus, sheds light on the process of individualisation. It has shown that: (a) personality is remarkably stable over time but also susceptible to change across the whole life-span (particularly in certain life phases such as young adulthood); (b) personality development is influenced by both genetic and environmental sources, with so-called shared environmental sources such as parental style and sociodemographic background being of less importance than non-shared sources such as peer-groups, romantic relationships, and job experiences (contradicting classic socialisation theories); and (c) individuals select into and experience social role transitions and life events differently leading to differential developmental trajectories and, thus, an increase in individual differences (i.e., individualisation).

The resulting changes in how much individuals differ from each other can be described and sorted in different ways and there is not yet an agreed upon taxonomy of individualisation processes (viz., changes of variables) in psychology. Table 1 summarises five exemplary 'types' of individualisation that might be of particular interest for other disciplines as well. For example, individualisation can refer to changes in a given variable (variable-oriented; see Types 1-3), to changes in the configuration of many different variables (person-oriented; see Type 4). Variables can be of any kind, including physiological, behavioural, motivational, cognitive or affective modalities. In addition, individualisation can refer to differential developments in the complex ways in which individuals construe their self-identity (see Type 5).

Secondly, research on personality dynamics has contributed to unravelling the processes that might drive these differential developments (e.g., Back 2021; Geukes et al. 2018; Wrzus and Roberts 2017). It has shown that individuals do not only differ in typical momentary behavioural and experiential state levels, but also in the degree to which there is intra-individual variation in behaviour across time and situational characteristics (e.g., Geukes et al. 2017) and in how individuals react to circumscribed situations (e.g., Kuper et al. 2022b). Changes in these state parameters may precede lasting trait changes (Roberts and Jackson 2008). Personality dynamics research has also shown that a range of motivational, behavioural, affective, and self-reflective processes underlies these state and trait changes, with one particularly important domain of processes being social in nature (e.g., self-esteem boosts when feeling valued: Hutteman et al. 2015; affective reactions to status perceptions: Kroencke 2023; behavioural co-regulation in peers: van Zalk et al. 2020).

Table 1: Five exemplary types of individualisation

	Variable Investigated	Operationalisation of 'Individualisation'	Increase in Individuality
1.	Change in distribution of levels of a variable	The (difference in) density distributions (especially standard deviation) of a variable	If the standard deviation on a variable increases, individuality increases
2.	Change in rare, 'exotic' or 'special' variable	The (difference in) frequency, valence, or normativity of a variable that is rare or deemed 'exotic' or 'special' in a given society/culture	If an individual develops more or stronger rare/exotic/special tendencies, individuality increases
3.	Change in extreme level of a regularly occurring variable	The (difference in) extremity of a variable that is deemed 'normal' in a given society/culture	If an individual develops extreme levels of otherwise regular tendencies, individuality increases
4.	Change in configuration or combination of many different variables	The (difference in) profile of several variables (with their respective levels)	When changes in unique patterning of variables and their levels (as well as their deviations from the norm) occur, individuality increases
5.	Change in subjectivity, self-awareness, self-representations, self-identity, etc.	(Differences in) self-related (perceptual and cognitive) processes	If certain self-related processes increase, individuality increases

While many of these dynamic processes that might trigger differential changes in individuals are currently explored, psychological research has just started to explore how they overlap, influence each other, and relate empirically to individuality and individualisation, understood in terms of individual differences. This subsection has shown how in psychology, individualisation is conceived in terms of the process that initialises and changes (oftentimes, increases) differences between individuals; it also notes the field's use of 'individualisation' in terms of tailoring or customising.

2.6 Individualisation in Economics and Management Science

Research in economics and management science traditionally adheres to methodological individualism (Weber 1922). Accordingly, "social phenomena must be explained by showing how they result from individual actions, which in turn must be explained through reference to the intentional states that motivate the individual actors" (Heath 2020).⁴

⁴ Although many scientists do operate with such a view, we note that methodological individualism (understood as the view that social phenomena must be explained by the actions of individuals) is a controversial theoretical commitment that has received much philosophical attention (e.g., Zahle and Kincaid 2019; Heath 2020). Our impression is that no such commitment is necessary for epistemic success in

Modern research in these fields not only indexes actions to preferences, but also considers endowment, prior information, information processing, and capacity to make economic choices (see Davis 2003, pp. 47-49).

The general approach in economic modelling (1) defines ‘decision makers’, that is, agents, which may represent a range of entities including firms, consumers, parliaments, countries, etc.; (2) defines the sets of actions available to the decision makers and their implications for the state of the world (i.e., who is affected and in which ways); and (3) defines the epistemic scope of the decision makers. This is in order to predict their choices, given their action sets and their beliefs about the choices of others. Steps 1 and 2 describe the context of the interaction—that is, the ‘environment’—while step 3 describes the decision makers. The definitions in step 3 generally comprise preferences regarding states of the world, or functional representations thereof, such as utility, profit, or welfare functions, and, depending on the context of inquiry, also endowment, information, and choice procedure. Admittedly, the distinction between environment and decision makers as described may not be immediately obvious in all cases. A decision maker’s skill set might be represented in their action set (‘environment’) or in their preference ordering over the possible outcomes of their actions (‘individuality’). The standard approach in economics is to define different skill sets of agents as different ‘types’ of agents, where type is an individual trait. All agents’ preferences are tightly connected with their types, implying that preferences can express differences in skill set while being defined independently of the environment (action sets), maintaining methodological individualism.

Current research further emphasises that analysing individual actions of decision makers in ‘modern’ markets with a large number of interactions between decision makers (e.g., word-of-mouth communication events and through social influence taking place) may entail a complex system displaying behaviour difficult to foresee, due to it being mathematically intractable and potentially chaotic (Foote 2007). This research utilises agent-based modelling and simulation instead of equilibrium analysis (for overviews, see Macal 2016; Rand and Stummer 2021) in accounting for heterogeneity, the decision makers’ individual traits (e.g., their preferences), and their individual embeddedness in a social network of peers. All the while, these methods track individual experiences made during the course of the interaction (e.g., an individual’s decisions and the observation of the reaction of others in response to these decisions). Frequently, this research observes that the combination of prior heterogeneity and individual experience drives the decision

individualisation/individualised science in general, regardless of the role it plays in the specific case of economics and management science. However, this claim needs to be worked out in detail and defended in a different paper.

makers' individuality, understood as the motives behind their decisions, their preferences, information, choice procedure, and funds (endowment).

Indeed, in relation to research in economics and management science, *individuality* amounts to the aggregate of qualities and characteristics of an individual relevant to decision making. For example, Davis (2015, p. 76) states that “individuality ... is the utility function representation of the individual” (and similarly in Davis 2003, 2010). Approaches that are more general would also allow for endowment, information, and choice procedure to contribute to a decision maker's individuality (Davis 2003).

Since ‘individualisation’ is not a theoretical term in economics and management science, we offer two operationalisations. According to the first of these notions, individualisation is the process by which an economic agent develops their own individual motives or qualities/characteristics relevant to decision making (e.g., by changing preferences or learning Bayesian updating), or perhaps the development of a specific or unique distinguishing feature relevant to their decision making. These describe a change of a decision maker's economic individuality that, along with experiences (including, for example, changing environments), has the potential to change the agent's decision-making behaviour.

According to the second notion of individualisation, a third person treats a decision maker depending on their individuality, tailoring a specific action or material resource to their individual profile. Since individuality here is the aggregate of features relevant to decision making, most notably preferences, the decision maker is therefore treated explicitly in a way that is related to their individual preferences (wishes or needs). Consumers are heterogeneous in their behaviour and preferences; for example, how willing or reluctant a consumer is to try a new product greatly varies. This fact has pushed research away from the traditional abstraction of an average consumer who represents all. For bringing more realistic features and behaviours to modelling, individual differences make a difference.

Examples of individualisation in this second sense abound, specifically in marketing and business practice, as consumers frequently seek to find their individual needs and desires addressed by appropriately tailored or customised goods or services. An insurance firm, for example, might try to understand the differences between their consumers and offer a wider range of insurance premiums/contracts, intending to cater for various groups of individuals more competitively than other firms. While such tendencies were addressed early on with strategies such as product differentiation and market segmentation (Smith 1956), more recent developments—especially in information and communication technology—enable companies to offer even more individualised products and services to single customers or groups of customers (Franke

and Schreier 2010). In the literature, different terms are used to refer to this phenomenon, such as ‘personalisation’, ‘customisation’, or ‘one-to-one marketing’, which are often used synonymously with this sense of individualisation (Sunikka and Bragga 2008).

3. The Targets of Studies of Individualisation

The preceding disciplinary perspectives reveal that scientists study quite diverse phenomena under the label of ‘individualisation’ and cognate terms, or when they characterise their field as individualised science (or as taking an individualised approach). However, the disciplinary perspectives also reveal that there are similarities across the disciplines in terms of the general kinds of processes at stake with reference to ‘individualisation’. In Section 3.1 we ask ‘What is individualisation?’ and we provide an account that clarifies what the targets of these studies are, in quite general terms. Since studies of individualisation frequently refer to differences between individuals, in Section 3.2 we clarify what individual differences are and what kinds of individual differences various disciplines study. We also explain why individual-environment interactions are central to understanding how differences between individuals arise and change over time.

3.1 Three Kinds of Individualisation

One major kind of individualisation identified in the disciplinary outlines is the process that gives rise to or changes individual differences in a population, species, or other group—that is, gives rise to or changes intrapopulation, intraspecific, or intragroup variation/heterogeneity. We call this sort of individualisation process *Individualisation_{ONE}* (in short, ‘individualisation as *producing/changing differences between individuals*’). *Individualisation_{ONE}* takes place over the developmental timescale, and can occur at any life stage or even throughout the lifetime of an individual. Examples include the process that leads to the unique colour patterns of fire salamanders, the process by which individual men develop different expressions of masculinity or fatherhood, or the process by which individual humans, qua consumers in a market, develop distinct preference sets. An abstract example of *Individualisation_{ONE}* is represented in Figure 1.

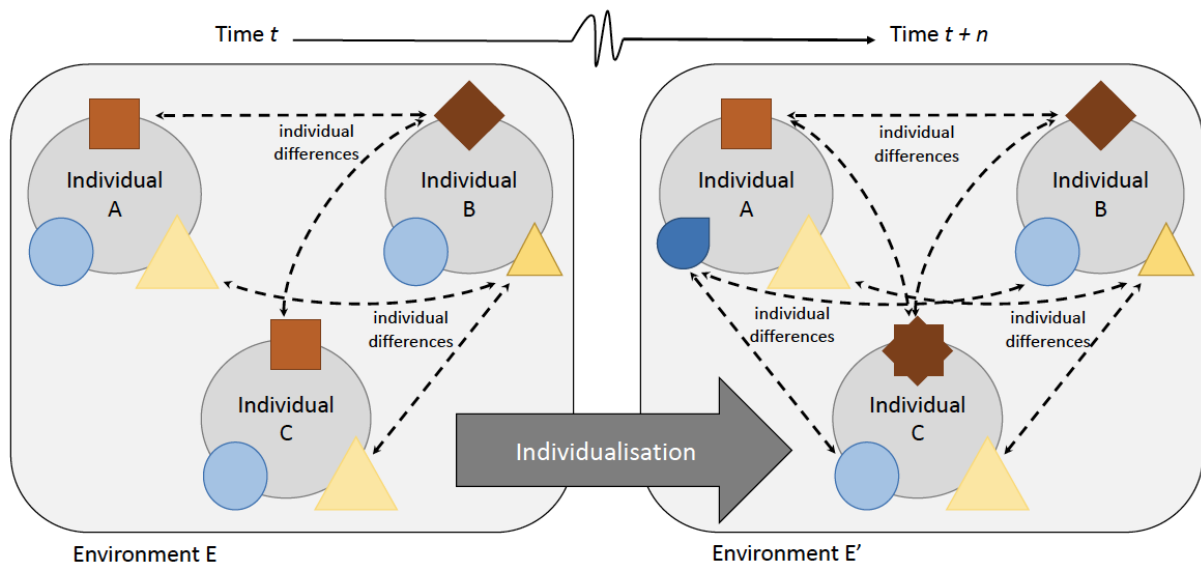


Figure 1. Individualisation_{ONE}, the process that gives rise to or changes individual differences ('individualisation as creating/changing individuals differences'). The individuals A, B, C of a group are represented by light grey circles; their traits/characters are represented by red squares, rhomb or stars, by blue circles and drops, and by yellow triangles of two different sizes. The dashed arrows highlight differences between individuals in their traits. The temporal process between the left box and the right box represents the individualisation process. In this example, individual A underwent a change in one of its traits (light blue circle turned into dark blue drop) and individual C underwent a change in a different trait (red square tuned into dark red star). Both changes increase the number and kinds of individual differences present in the group. Individualisation occurs in environments ($E \rightarrow E'$), although specific environmental features and relations with individuals are not represented for simplicity's sake.

Oftentimes, Individualisation_{ONE} leads to an *increase* of individual differences, that is, one or more individuals in a group (or species) becoming more different from others (more on the quantification and operationalisation of individual differences in Section 3.2). Not all individualisation processes, to be sure, involve an increase in the total number of extant individual differences; some only change the ways in which individuals differ from each other, without raising the amount of differences. The traits in which individuals differ from each other can be of many various sorts (more in Section 3.2).

Individualisation_{ONE} is the focus of individualisation research in disciplines such as biology and psychology, but it also plays a role in sociology (e.g., in social structure analysis and gender studies), economics (e.g., when studying how economic individuals develop distinguishing features relevant to them being decision makers), and even medicine/psychiatry (e.g., when investigating individual differences in the courses of a disease). Further examples of Individualisation_{ONE} include how the behavioural and hormonal phenotype of a male guinea pig is shaped by his social environment during adolescence, resulting in behavioural and hormonal differences between male guinea

pigs. Psychological examples include how individual psychological/personality differences arise from and give rise to differential reaction to circumscribed situations. Sociological examples include how changing social norms and heterogenous family structures give rise, for example, to different individual expressions of gender and social identities—ways in which individuals differ from one another.

Other research inquiries are not concerned directly with the processes that give rise to or influence individual differences, but rather consider the phenomenon of individual differences explicitly in proffering individualised medical/psychiatric treatments, health recommendations, commercial products, marketing strategies, and the like. We characterise this second kind of individualisation, *Individualisation_{TWO}*, as the process of tailoring or adjusting interventions, goods, and services to the individual at hand (or to a specific group of individuals), taking into account their salient, distinguishing features (in short, ‘individualisation as *individualising applications*’). *Individualisation_{TWO}* is prominent in fields such as medicine and psychiatry, public health and sport/exercise science, psychology, and management science. Evidence-based *Individualisation_{TWO}* builds on empirical *information about individual differences*.⁵ Whereas *Individualisation_{ONE}* is the process leading to individual differences (by creating or changing them), *Individualisation_{TWO}* often starts from empirical information about existing individual differences and makes epistemic use of it in contexts of application—by creating interventions, goods, and services that are individualised in the sense of being tailored to those traits of individuals that distinguish them from others. Disciplines such as medicine and psychiatry, public health and sport/exercise science, and management science are thus typically more concerned with *Individualisation_{TWO}* than they are with *Individualisation_{ONE}*. The primary interest of individualisation research in these fields is to gain and use empirical information about individual differences in order to design personalised treatments of diseases, develop individualised nutrition recommendations, address the individual needs and desires of consumers by way of individualised offerings, and so on—or to study how others undertake such individualising approaches, such as profit-driven firms, and the consequences.

Examples from marketing and business practice of *Individualisation_{TWO}* include the tailoring of insurance premiums/contracts to individual risks and preferences, and the tailoring of online advertising and search results to the search history, characteristics, and preferences of individuals. Medical/health examples include the tailoring of HIV treatment

⁵ However, the evidence-based tailoring of applications is not a necessary requirement for *Individualisation_{TWO}*. In the profit-driven business and marketing world—studied by economists and management scientists—a firm’s perception of heterogeneity of a certain sort, and an economic motivation to cater for that, might suffice for a firm to undertake the tailoring of products and services.

(viz., the screening of HIV patients for the genetic variant associated with a toxic reaction to Abacavir), the tailoring of exercise training regimes to the fitness level, sex, or hormone level of individuals, and the tailoring of advice pertaining to alcohol consumption to the needs of individuals. Moreover, Individualisation_{TWO} is also discussed in more applied areas of other disciplines, such as in psychology (e.g., individualised psychotherapy) and even biology (e.g., individualised animal welfare; Richter and Hintze 2019). An abstract example of Individualisation_{TWO} is represented in Figure 2, illustrating how empirical information about differences between individuals guides the tailoring of an application in order to account for the salient differences between the individuals.

Given that Individualisation_{ONE} and Individualisation_{TWO} may sometimes both be at stake in a discussion, it is useful for clarity's sake to explicitly distinguish these. As mentioned above, the evidence-based Individualisation_{TWO} of applications builds upon empirical information about individual differences. One might go further and argue that it is likely to be more accurate or efficient when it also incorporates knowledge about the process of how individual differences arise and change over time, that is, knowledge about Individualisation_{ONE}. This is plausible in many cases. For instance, knowledge about how the specific social environment of a person influences their drinking habits and makes them different from others is crucial for developing personalised assessments and health recommendations, as well as policy recommendations (public health). Likewise, the successful development of individualised treatments for type 2 diabetes requires knowledge about individual differences on several levels (e.g., molecular, pathophysiological, etc.; see, e.g., McCarthy 2017), but it might also be important to understand how these individual differences emerge and which roles (for instance) certain genes or environmental factors play. Hence, knowledge about Individualisation_{ONE} stands to influence Individualisation_{TWO}.

In turn, Individualisation_{TWO} also stands to influence Individualisation_{ONE}. For instance, individualised medical treatment or psychotherapy could in principle decrease or increase differences between individuals or qualitatively change the ways in which individuals differ from each other. Likewise, creating goods that are tailored to salient distinguishing features of individuals (e.g., devices that are individualised by the set of apps that they have pre-installed, given the interests of different groups of people) may lead to a greater diversification of people's device usage behaviour, to a greater homogenisation, or to a change in the ways that people differ from each other. By taking up this research prospect in an experimental setting, researchers may also come to better understand the development of these differences.

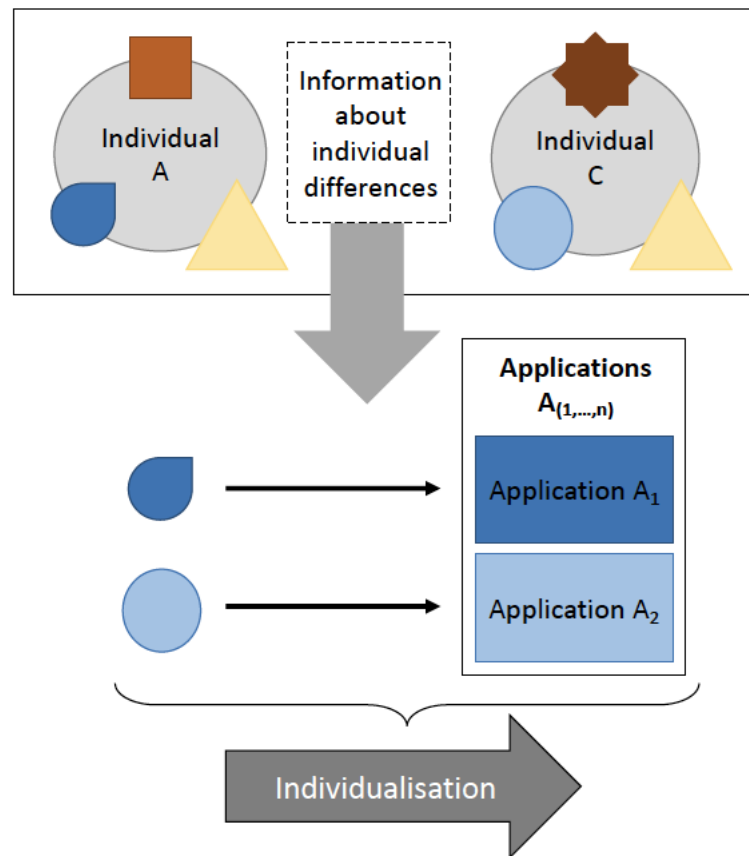


Figure 2. Individualisation_{TWO}, the tailoring of interventions, goods, or services. The upper box picks out two individuals from Figure 1, illustrating an example of empirical information about salient differences between individuals. The lighter grey arrow in the middle represents that some of this information guides the tailoring of applications, with the result that individuals with the dark blue drop trait are better suited to application A₁ and individuals with the light blue circle trait are better suited to application A₂. This process of tailoring applications to suit different individuals is the individualisation process, indicated by the dark grey arrow at the bottom: due to the fact that individuals differ, different applications are then tailored to suit these differences.

There is a third kind of process that is also conceptualised as individualisation. However, although it may implicate individual differences, these are not central to this concept. Rather, sociological individualisation theorists utilise ‘individualisation’ as a term of art, to pick out the ways in which societal shifts from traditional ways of living to modern, more individual-focused ways of living affect autonomy, risk, and responsibility (Beck and Beck-Gernsheim 1994, 2002). There is an established literature on this concept in sociology and related fields (such as public health), and while much of this literature is constructive, much is also critical of the validity of the concept—so a fair examination of sociological individualisation theory requires its own paper (see, e.g., Dawson 2012). In contrast, our purpose here is to briefly characterise the concept and distinguish it from Individualisation_{ONE} and Individualisation_{TWO}.

This third kind of individualisation is a process of social change: since the mid-twentieth century, modern society has ‘de-traditionalised’—that is, seen the breaking away of the modern individual from the bonds of closer, traditional groups, as well as the replacement of old traditional values with newer, individually oriented values. As a result, individuals are now more dependent on more distant or even anonymous social forces, leading to a greater range of individual freedoms but also new risks and greater individual responsibility. We call this *Individualisation*_{THREE} (in short, ‘social changes influencing autonomy, risk, and responsibilities’). The following quotation is illustrative:

According to leading sociological theorists... we have now entered a ‘late modern’ epoch of ‘de-traditionalisation’ and ‘individualisation’. Economic prosperity, education and the welfare state have freed us from externally imposed constraints, moral codes and traditional customs. The social structures of class, gender, religion and family are withering away, so that people no longer have pre-given life trajectories. Instead individuals are compelled to reflexively make their own choices and hence create their own biographies. At the same time, the ‘project of self’, with an emphasis on individual self-fulfilment and personal development, comes to replace relational, social aims. (Duncan and Smith 2006, p. 167.)

Even though *Individualisation*_{THREE} represents an important and influential concept in sociological discourses, it is less relevant to recent efforts across scientific fields to study individualisation specifically in terms of individual differences, our focus and core motivation in this paper (see Section 1). The reason for this is that, in theory, *Individualisation*_{THREE} could occur in a group or society without implicating individual differences among the group members. Of course, as *Individualisation*_{THREE} makes it possible for individuals to ‘create their own biographies’, these new narratives may result in the occurrence of *Individualisation*_{ONE}, generating increases in individual differences. Sociologists study such individual differences, but not necessarily under the rubric of sociological individualisation theory. For the latter discourse, it is the ‘de-traditionalisation’ of modern society and the resultant (or, for critics, the alleged) new freedoms, new risks, and new responsibilities of life in modern ‘individualised’ society that are at stake, not variation/heterogeneity per se. Indeed, *Individualisation*_{THREE} is to be contrasted with a more constrained, more traditional sense of individual autonomy/freedom/risk, rather than with homogeneity. In the remaining sections of this article, we opt to focus on the first two senses of individualisation. This does not imply, however, that we ignore sociology. Section 2.4 clearly shows that sociologists are interested in individuality in terms of individual differences (e.g., with respect to gender

and life course), and are indeed often studying Individualisation_{ONE}, independently of whether or not their work is couched in the framework of sociological individualisation theory (Individualisation_{THREE}).

3.2 Individual Differences and Individual-Environment Interactions

Individual differences range over any characteristic or trait of an individual that varies in a species, population, or group. This is why ‘individual differences’ are also referred to as intrapopulation, intraspecific, or intragroup ‘variation’, or ‘heterogeneity’. These varying traits can be genetic, morphological, or physiological traits (biology, medicine); personality traits, including behavioural and experiential—motivational, affective, cognitive—traits (psychology); preferences (economics); expression of socially recognised constructions, e.g., masculinity/fatherhood (sociology); health determining factors (public health and sport/exercise science); disease traits (medicine); and so on. Different disciplines focus on different aspects of the individual and on different kinds of traits or characteristics given their varied research questions, methods, and goals.

Thus, there is a diversity of kinds of traits of an individual that are studied, across disciplines. In addition, one kind of trait may also be operationalised and measured differently even within a single discipline. In Section 2.5, five different operationalisations of Individualisation_{ONE} processes are distinguished (psychology). They specify different ways in which psychological differences can increase: the differences in one trait among individuals increase, an individual develops a rare or more ‘exotic’ trait, an individual develops an extreme level of a normal trait, individuals develop unique combinations of traits (and of levels of traits), and individuals develop particular self-related processes. Except for the last one, when investigated purely qualitatively, these operationalisations allow scientists to quantify Individualisation_{ONE} (at least in principle) and thereby make claims about whether individual differences have increased or decreased, and to circumscribe these claims as about individual differences of a particular nature. These quite general ways to operationalise and quantify psychological Individualisation_{ONE} may be fruitfully applied, *mutatis mutandis*, in other disciplines, for instance biology (more on this in Section 4).

When seeking to understand the process that gives rise to or changes individual differences in a group or population (i.e., Individualisation_{ONE}), scientists investigate how the traits of individuals (including their internal aspects, such as hormones, epigenetics, or immune system) change through individuals’ interactions with the environment (Figure 3). Biologists, for example, investigate how the behavioural and hormonal phenotype of a male guinea pig is shaped by his interactions with other individuals that

constitute his social environment. Psychologists study how much and by means of which processes the motives, interpersonal styles, and self-concepts of individuals change and stabilise in response to different life events, role transitions, occupational and relationship choices, and aging. Likewise, sociologists study how (conceptualisations of) gender differences are shaped by, for instance, the behavioural expectations of other individuals. Economists investigate how decision makers interact with each other and thereby influence their beliefs and constrain their available actions and the decisions they make.

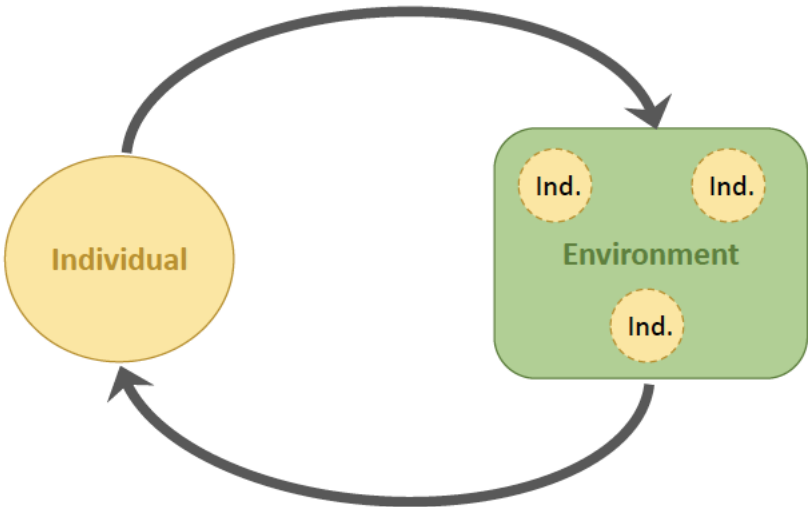


Figure 3. Individual-Environment Interactions. The focal individual, represented by the bigger yellow circle on the left, acts on the environment (e.g., niche construction) and the environment, represented by the green box on the right, influences the individual. (See, e.g., Levins and Lewontin 1985.) An environment can include other individuals (‘Ind.’), represented by the dashed yellow circles in the green box.

Even though all disciplines studying Individualisation_{ONE} examine individual-environment interactions, only a few of them might often explicitly use the term ‘environment’.⁶ It is more common in some disciplines to speak of studying individuals in situations (psychology), while others focus on individuals as being socially integrated/situated and embedded in society (sociology). Some disciplines take into account only specific environmental factors, such as other decision makers, the actions

⁶ Here we must pass over a pressing issue that has been extensively discussed in the philosophy of science: the question of what counts as ‘environment’ (e.g., where do individuals end and their environments begin, what are different types of environments, etc.; see, e.g., Brandon 1990, Chapter 2, for a discussion of the concept of environment in biology, and Malsch et al. 2024 for a discussion of the concept of environment in public health). We refer in a general way to individual-environment interactions, as is often done in scientific discourses (e.g., Trappes et al. 2022), and we set aside the task of individual/environment demarcation for another paper. We thank an anonymous referee for probing us on this issue.

available to them, and the like (economics) or health/disease determining factors (public health/medicine). Still, on a general level, all disciplines seek to understand how individual differences result from the interactions of individuals with features of their environments.

4. Relating Individual Differences to Individuality

In the previous section, we argued that recent studies of individualisation, in terms of individual differences, focus on two distinct kinds of individualisation. Individualisation_{ONE} is the process that gives rise to or changes differences between individuals, whereas Individualisation_{TWO} typically uses empirical information about differences between individuals to tailor interventions, services, or products to individuals or specific groups of individuals.

Moreover, we argued that the kinds of individual differences studied vary widely from discipline to discipline. Biology investigates a wide spectrum of traits (and ecological relations or interactions with the environment), ranging from genetic, physiological (hormonal and immunological) traits, morphological features, to behavioural traits; even animal personality traits. Any kind of trait or ecological relation that influences the fitness of an individual is in principle of interest to biologists. Other disciplines are interested in other traits or aspects of individuals and foreground other interactions with other parts of the environment.⁷ Public health, for example, focuses on the health of individuals and health-determining factors, especially of the built-material and social environments. Medicine/psychiatry focuses on diseases of individuals and disease-determining intrinsic and environmental factors. Economics focuses on economic agents—decision makers—and on the actions that are available to them and the rational decisions that they make. Personality psychology focuses on psychological traits and factors influencing them. Sociology focuses on social structures and the individuals within that are socially recognised as autonomous subjects. Of course, our claims here are not exhaustive: many research efforts in these fields will have different goals or foci.

Section 2, however, indicates that in several disciplines the term ‘individuality’ is used alongside ‘individualisation’ (and ‘individual differences’, ‘variation/heterogeneity’). This raises the question of how individualisation and individual differences are related to individuality. To address this question, we begin with the case of biology and then take a wider, multi-disciplinary perspective. Kaiser and Trappes (2021) argue that studies of

⁷ Outside of biology it seems more adequate to speak of individual-environment interactions or relations, rather than of ecological relations of the individual. The reason is that ‘ecological’ seems to refer only to a subset of the diverse environments, situations, or contexts that are studied in the different scientific disciplines.

individual differences and individualisation in ecology, evolution, and animal behaviour reveal a kind of biological individuality that is distinct from other notions of individuality in biology that focus on evolutionary, immunological, or metabolic criteria (for an overview of different types of biological individuality see, e.g., Godfrey-Smith 2009; Clarke 2010; Pradeu 2012, 2016; Lidgard and Nyhart 2017). Kaiser and Trappes' notion of biological individuality concerns the ways that individuals differ from one another and are unique in their phenotype (including behaviour) and ecological relations (i.e., interactions with their environment). Here, 'unique' means that each individual possesses a distinct set of phenotypic traits and ecological relations, not necessarily that it has exclusive traits/relations that it shares with no other individual. The main claim is that 'being unique' (i.e., having a unique set of phenotypic traits and ecological relations) and 'being different from other individuals' are ways to exhibit (a kind of) biological individuality and thus of being a biological individual. They call this kind of biological individuality *phenotypic-ecological individuality* (Kaiser and Trappes 2021; Trappes 2021, 2022).

Based on this claim, we can infer that Individualisation_{ONE} processes that create or change differences between individuals of a group or population also change the phenotypic-ecological individuality of those individuals. An increase in individual differences increases phenotypic-ecological individuality. It does so either by increasing the extent to which individuals differ from one another in their phenotype and ecological relations or by adding to the ways in which individuals differ. Both sorts of increases might be difficult to measure—quantifying many different phenotypic traits and ecological relations and weighing them against each other presents a challenge—but the conceptual point stands.

Moreover, we think that the strategy of conceptualising individuality in terms of individual differences can be generalised and applied in the other disciplines, beyond biology. That is, exhibiting intrapopulation or intraspecific variation/heterogeneity—being different in particular ways from other individuals—is one way of exhibiting individuality and of being an individual (see also Pradeu 2012). We refer to this sort of individuality, generally, as '*individual-differences individuality*'. It is this kind of individuality that the different disciplines are concerned with when they study how individual differences arise or change (Individualisation_{ONE}) or when they practice individualised science (Individualisation_{TWO}). The concept of individual-differences individuality contrasts with other concepts of individuality that distinguish individuals on other grounds, for example, according to evolutionary, immunological, or metabolic criteria (Kaiser and Trappes 2021). Such criteria need not relate to intrapopulation or intraspecific variation/heterogeneity, and their use may result in identifying different individuals.

Even though the concept of individual-differences individuality applies across various disciplines, different fields adopt different conceptions of it;⁸ that is, they focus on different sorts of individual differences (whether those are individual traits, states, or individual-environment interactions). Biology focuses on differences in phenotypic traits and ecological relations and thus is concerned with phenotypic-ecological individuality, as we have outlined above; public health and sport/exercise science study the health of humans and health-determining factors and thus are concerned with health-related individuality; medicine and psychiatry focus on medical/psychiatric diseases and disease-determining factors and thus are concerned with disease-related individuality; economics focuses on the agency, rational decision making and action sets of individuals and thus conceives of decision-making individuality; psychology investigates psychological personality traits and, for instance, how individuals react to situations, and thus are concerned with what can be called personality individuality; sociology is interested in the autonomy of individuals and in the process of socially recognising subjectivity and thus is concerned with social individuality (Figure 4). We should emphasize that we are making no claim of exhaustiveness. Similar to biology, which studies a plurality of kinds or dimensions of biological individuality, including evolutionary, immunological, and metabolic individuality, other disciplines might also study different kinds of individuality (see also McConwell 2023). Figure 4 thus represents only a partial conceptual landscape for individuality. As explained above, biologists often conceive of individuality in terms of unique sets of phenotypic traits and ecological relations of individuals (Kaiser and Trappes 2021; Trappes 2021, 2022). This is close to the fourth personality psychological operationalisation of individualisation in terms of unique configurations or combinations of traits.⁹ For other disciplines, such as biology, it might be fruitful to apply these different operationalisations/conceptions of personality individuality (see also Table 1 in Section 2.5) to extend or enrich their studies of individual differences. For example, biologists could conceive of individual differences and phenotypic-ecological individuality not only in terms of unique sets of traits but also focus on the rareness of traits or distinctive levels of traits. This outlines a promising avenue for future research and it is only one example that shows how explicating and linking different disciplinary conceptions of individuality may enrich disciplinary studies of individualisation and individuality.

⁸ We adopt the concept/conception distinction commonly mentioned in discussions of conceptual pluralism (e.g., Currie and Killin 2017) and in moral and political philosophy (e.g., Rawls 1971). For example, two theorists might agree on the concept of (say) moral flourishing, yet have different conceptions of what it amounts to: one might think it is in maximising happiness, another in virtuous action.

⁹ Still, some psychologists might not agree to the notion of phenotypic-ecological uniqueness if they have a narrower understanding of ‘uniqueness’ as referring only to the characteristics of a person that are shared with no other person (see Section 2.5).

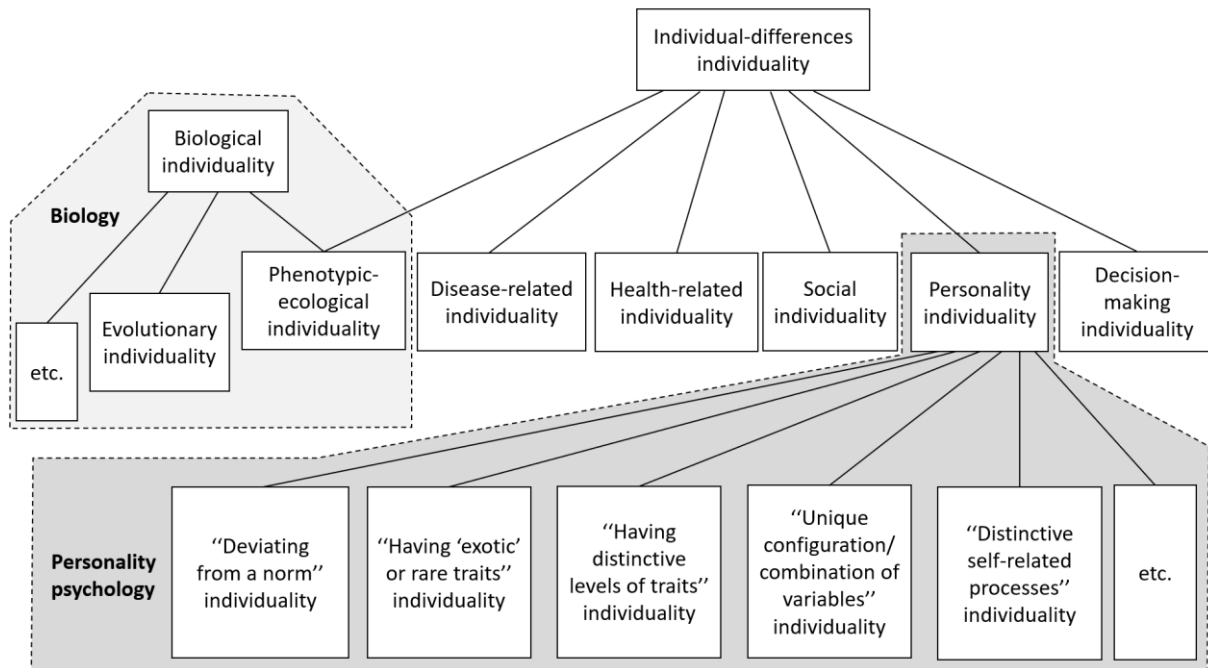


Figure 4. Partial conceptual landscape for individuality. The category of biological individuality reflects several concepts relevant to biologists and philosophers of biology, of which one is evolutionary individuality (Godfrey-Smith 2009; Clarke 2016), another one is phenotypic-ecological individuality (Kaiser and Trappes 2021). The latter concept also belongs to the category of individual-differences individuality, alongside disease-related individuality (medicine/psychiatry), health-related individuality (public health and sport/exercise science), social individuality (sociology), personality individuality (personality psychology) and decision-making individuality (economics and management science). Each of these concepts is capable of reflecting distinct conceptions. Personality psychology provides an illustrative example, with its multiple conceptions of personality individuality (in terms of norm deviation, possession of ‘exotic’ or rare traits, and so on).

In this section, we have related individualisation to individual differences and individuality. Our conceptual framework allows for disciplinary differences concerning the sorts of individual differences investigated, yet brings together these as conceptions of individual-difference individuality. That is, they all contribute to our understanding of individuality in terms of individuals being unique and being different from one another. Individual difference is one way that individuals express individuality.¹⁰

¹⁰ The general claims made are not essentialist and intentionally not framed that way. We thank an anonymous referee for suggesting this clarification.

5. Conclusion and Prospects for Future Research

This paper provides a conceptual-theoretical basis for the interdisciplinary study of individualisation. We present disciplinary summary outlines for a range of fields, and from these we identify three kinds of individualisation processes under investigation in these fields. Individualisation_{ONE} is the process giving rise to or changing individual differences, understood as intrapopulation, intraspecific, or intragroup variation/heterogeneity; Individualisation_{TWO} is the tailoring of interventions, services, and products given individual differences (and often utilising information about those differences); and Individualisation_{THREE} is a kind of social change that modifies autonomy and results in increases in responsibilities and risks. Given our focus in this paper on individual differences, we focus on the first two of these kinds of individualisation processes. We reveal the interrelations between Individualisation_{ONE} and Individualisation_{TWO}, and we explain the importance of studying individual-environment interactions when trying to understand how individual differences emerge and change (viz., Individualisation_{ONE}). We argue that there is, in general, a close connection between individual differences and individuality because ‘being different from others’ (viz., intrapopulation or intraspecific variation/heterogeneity) is one way that individuals express individuality. Finally, we identify a plurality of individuality concepts/conceptions on different levels, within disciplines and across disciplines.

This paper presents only a first step in the philosophical analysis of interdisciplinary studies of individualisation. The disciplinary summary outlines in Section 2 raise more philosophical questions than the ones addressed in this paper. This is why we would like to conclude also by highlighting additional philosophical issues that are left open for future philosophical research.

First, discussion of individualisation and individualised science provides a new context for the philosophical investigation of methodological individualism and other explanatory norms. Methodological individualism in the social sciences is characterised as the assertion that higher-level phenomena (e.g., social phenomena) must be explained in terms of the actions of individuals (Zahle and Kincaid 2019; Heath 2020). At first sight, this assertion may seem at odds with the explanatory practices in studies of individualisation (or at least a red herring). The phenomena to be explained by way of individualisation research (e.g., how individual differences arise or change) are rarely higher-level phenomena. Still, the study of individual differences often requires studying groups of individuals or types of traits. Accordingly, explanations of individual differences may also be pitched at the level of groups of individuals or types of traits, and the assertion of methodological individualism might be reformulated to account for, or

challenge, this. The extent to which individualisation/individualised science presupposes (or is hindered by) methodological individualism is an open philosophical question.

Second, individualisation is a promising concept for ongoing and future research in philosophy of science in practice. Such work could draw on existing distinctions and positions found within a discipline or research agenda—for example, within the debate over biological individuality—and use the methods and tools of philosophy of science to contribute. Discussions of metabolic individualisation, for instance, may help to make sense of transitions in individuality in mammalian pregnancy, and a concept of phenotypic-ecological individualisation might be useful for understanding how ecological associations arise and change over time. Recognising questions about individualisation thus broadens the problem agenda of (biological) individuality (Kaiser and Trappes 2021). Moreover, individualisation provides an excellent test case for theoretical discussions about the nature of interdisciplinarity, interdisciplinary integration, and so on. We have only touched upon these topics in this article; further development of this line of inquiry is an important prospect for future philosophical research.

Third, in Section 3.2 we argue that the biological concept of individual-environment interactions can be used also in other disciplines to investigate Individualisation_{ONE} processes. However, what the environment is, what the individual is, and which of its traits are most relevant (recall Section 4) differs from discipline to discipline. The different concepts of environment as well as how the disciplines demarcate the individual from its environment (e.g., biology and psychology assign behaviour to the individual, whereas economics characterise sets of available actions as parts of the environment) are further interesting philosophical questions left for future research.

Finally, as Individualisation_{TWO} takes effect, we see shifts in the patterns underlying many domains. Take the provision of social health care and support, for example, which several years ago became highly individualised in various countries. In the case of Australia, this resulted in a poorly regulated, market-based ‘cash for care’ gig economy facilitated by the digital app environment, and understandably drew criticism (MacDonald 2021; Killin 2022). Or take the stratification methods of individualised medicine and psychiatry, which, in an individual insurance-based healthcare system, may lead to increased inequalities especially when stratification of, say, drug response, strongly correlates with ethnic categories (Kalow 2001; Johnson 2008; Abettan 2016). Philosophical analysis and critique of the consequences of individualisation (in its different guises) is a largely untapped priority for future research, and clearly has the potential for practical and political uptake.

Acknowledgements

For discussion of initial ideas, MIK and AKFM thank participants of the InChangE workshop on “The Concept of Individualisation in Changing Environments”, Bielefeld, Germany (January 2022); MIK, AK, and AKFM thank participants of the InChangE Individualisation Symposium, Bielefeld, Germany (April 2022); MIK thanks participants of the Retreat 2022 of the TRR-SFB 212, Hoherodskopf, Germany (August 2022); and AK thanks an audience at the Philosophy in Interdisciplinary Research Conference at KU Leuven, Belgium (December 2022) as well as Niels Boissonnet, Olena Orlova, and Marisol Herrera-Rivero. Finally, MIK and AK are grateful to Alkistis Elliot-Graves, Philipp Haueis, Katie H. Morrow, and two anonymous referees for the *EJPS* for their constructive critical comments on previous versions of the manuscript, as well as Patrick Hoare and Farees Moazzam for proofreading assistance.

Statement of Author Contributions

Lead organisation and joint first authorship: MIK, AK. Initial article idea: MIK, AK, AKFM. Article writing: MIK, AK (sections 1, 3, 5); BAC, JG, TIG, SK, OK, JK, CM, KR, SHR, MJW (section 2.1); BTB, AK (section 2.2); AKFM, CV-R (section 2.3); AKA, DL, AK (section 2.4); MDB, JFR (section 2.5); NB, YB, CS (section 2.6); MIK, AK, RT (section 4). Figures: MIK, AK. Additional contributions to the penultimate draft manuscript (any sections): MIK, AK, MDB, BTB, NB, YB, JG, TIG, SK, JK, DL, CM, JFR, KR, SHR, CS, RT, CV-R, MJW. Final article preparation and revisions: MIK, AK. All authors approved article submission.

Funding Statement

This paper is a result of the research project “Individualisation in Changing Environments (InChangE)” funded as a part of the programme “Profilbildung 2020”, an initiative of the Ministry of Culture and Science of the State of North-Rhine Westphalia. Research for this paper also profited from the Collaborative Research Centre “A Novel Synthesis of Individualisation across Behaviour, Ecology and Evolution: Niche Choice, Niche Conformance, Niche Construction (NC³)” (TRR-SFB 212), funded by the German Research Foundation (DFG). Rose Trappes has received funding from the European Research Council (ERC) under the European Union’s Horizon 2020 research and innovation programme (grant agreement No. 101001145). This paper reflects only the authors’ views—these funding bodies are not responsible for any use that may be made of the information it contains. The sole responsibility for the content of this publication lies with the authors. The authors declare no conflicts of interest.

Statements of compliance with ethical standards

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

Conflict of interest: The authors declare that they have no conflict of interest.

References

- Abettan C (2016) "Between hype and hope: what is really at stake with personalized medicine?" *Medicine, Health Care & Philosophy* 19:423-430.
- Adams M (2003) "The reflexive self and culture: A critique." *British Journal of Sociology* 54(2):221-238.
- Adkins L (2004) "Reflexivity: Freedom or habit of gender?" *Sociological Review* 20(6):21-42.
- Allport GW (1937) *Personality: a psychological interpretation*. New York: Holt.
- Andersen H (2016) "Collaboration, interdisciplinarity, and the epistemology of contemporary science." *Studies in History and Philosophy of Science Part A* 56:1-10.
- Arah OA (2009) "On the relationship between individual and population health." *Medicine, Health Care and Philosophy* 12(3):235-244.
- Ashley EA (2016) "Towards precision medicine." *Nature Reviews Genetics* 17:507-522.
- Back MD (2021) "Social interaction processes and personality." in: Rauthmann J (ed), *The handbook of personality dynamics and processes*, pp. 183-226. Elsevier.
- Baune BT (2020a) "What is personalised psychiatry and why is it necessary?" in: Baune BT (ed), *Personalised psychiatry*, pp. 1-2. London: Academic Press/Elsevier.
- Baune BT (2020b) "The future of personalized psychiatry." in: Baune BT (ed), *Personalized psychiatry*, p. 557. London: Academic Press/Elsevier.
- Beck ED, Jackson JJ (2020) "Idiographic traits: a return to Allportian approaches to personality." *Current Directions in Psychological Science* 29(3):301-308.
- Beck ED, Jackson JJ (2022) "A mega-analysis of personality prediction: robustness and boundary conditions." *Journal of Personality and Social Psychology* 122(3):523-553.
- Beck U (1992) *Risk society: towards a new modernity*. London: Sage.
- Beck U, Beck-Gernsheim E (1994) *Riskante Freiheiten: Individualisierung in modernen Gesellschaften*. Frankfurt: Suhrkamp.
- Beck U, Beck-Gernsheim E (2002) *Individualization*. London: Sage.
- Beck U, Lau C (2005) "Second modernity as a research agenda: theoretical and empirical explorations in the 'meta-change' of modern society." *British Journal of Sociology* 56(4):525-557.
- Berg J, Harting J, Stronks K (2019) "Individualisation in public health: Reflections from life narratives in a disadvantaged neighbourhood." *Critical Public Health* 31(1):101-112.
- Berger P (2020) "Individualisierung als Integration." in: Poferl A, Sznaider N (eds), *Ulrich Becks kosmopolitisches Projekt: Auf dem Weg in eine andere Soziologie*, pp. 106-122. Nomos Verlagsgesellschaft. <https://doi.org/10.5771/9783845291727-106>
- Beshers SN, Fewell JH (2001) "Models of division of labor in social insects." *Annual Review of Entomology* 46:413-440.
- Bleidorn W, Hopwood CJ, Back MD, Denissen JJA, Hennecke M, Jokela M, Kandler C, Lucas RE, Luhmann M, Orth U, Roberts BW, Wagner J, Wrzus C, Zimmermann J (2020) "Longitudinal experience-wide association studies—a framework for studying personality change." *European Journal of*

Personality 34:285–300

- Bleidorn W, Hopwood CJ, Back MD, Denissen JJA, Hennecke M, Hill PL, Jokela M, Kandler C, Lucas RE, Luhmann M, Orth U, Roberts BW, Wagner J, Wrzus C, Zimmermann J (2021) "Personality trait stability and change." *Personality Science* 2:e6009. <https://doi.org/10.5964/ps.6009>
- Bolam B, Murphy S, Gleeson K (2004) "Individualisation and inequalities in health: a qualitative study of class identity and health." *Social Science & Medicine* 59:1355-1365.
- Bolnick DI, Svanbäck R, Fordyce JA, Yang LH, Davis JM, Hulseley CD, Forister ML (2003) "The ecology of individuals: incidence and implications of individual specialization." *American Naturalist* 161(1):1-28.
- Bourdieu P (1987) *Distinction: a social critique of the judgement of taste*. Routledge.
- Brandon RN (1990) *Adaptation and environment*. Princeton: Princeton University Press.
- Brittain HK, Scott R, Thomas E (2017) "The rise of the genome and personalised medicine." *Clinical Medicine (London)* 17(6):545-551.
- Buschmeyer A, Lengersdorf D (2016) "The differentiation of masculinity as a challenge for the concept of hegemonic masculinity." *Norma* 11(3):190-207.
- Carere C, Maestriperi D (2013) "Introduction: animal personalities: who cares and why?" in: Carere C, Maestriperi D (eds), *Animal personalities: behavior, physiology, and evolution*, pp. 1-9. Chicago: University of Chicago Press.
- Caspari F, Bös K (2006) "Individualisierung von Informationen im Rahmen der Gesundheitsförderung." *Bewegungstherapie und Gesundheitssport* 22(1):13-17. <https://doi.org/10.1055/s-2006-921394>
- Caspers BA, Krause ET, Hermanski I, Wiesbrock C, Kastrup FW, Steinfartz S (2020) "Developmental costs of yellow colouration in fire salamanders and experiments to test the efficiency of yellow as a warning colouration." *Amphibia-Reptilia* 41(3):373-385.
- Cattell RB (1946) *The description and measurement of personality*. Yonkers, NY: World.
- Chandler CIR (2020) "Current accounts of antimicrobial resistance: stabilisation, individualisation, and antibiotics as infrastructure", *Palgrave Communications* 5:53. <https://doi.org/10.1057/s41599-019-0263-4>
- Chittka L (2022) *The mind of a bee*. Princeton, New Jersey: Princeton University Press.
- Clarke E (2010) "The problem of biological individuality." *Biological Theory* 5 (4):312-325.
- Clarke E (2016) "A levels-of-selection approach to evolutionary individuality." *Biology & Philosophy* 31(6):893-911.
- Corr PJ, Matthews G (eds) (2020) *The Cambridge handbook of personality psychology*. Cambridge: Cambridge University Press.
- Cote JE, Levine CG (2002) *Identity, formation, agency and culture: a social psychological synthesis*. New York: Psychology Press.
- Cunningham JA, Humphreys K, Koski-Jännes A (2000) "Providing personalised assessment feedback for problem drinking on the internet: a pilot project." *Journal of Studies on Alcohol* 61:794-798.

- Currie A, Killin A (2017) "Not music, but musics: a case for conceptual pluralism in aesthetics." *Estetika: Central European Journal of Aesthetics* 54(2):151-174.
- Dall SR, Bell AM, Bolnick DI, Ratnieks FL (2012) "An evolutionary ecology of individual differences." *Ecology Letters* 15(10):1189-1198.
- Davis JB (2003) *The theory of the individual in economics: identity and value*. Routledge.
- Davis JB (2010) *Individuals and identity in economics*. Cambridge University Press.
- Davis JB (2015) "Bounded rationality and bounded individuality." *A Research Annual: Research in the History of Economic Thought and Methodology* 33:75-93.
- Dawson M (2012) "Reviewing the critique of individualization: the disembodied and embedded theses." *Acta Sociologica* 55(4):305-319.
- Diewald M (2013) "Lebensverlauf." in: Mau S, Schöneck N (eds), *Handwörterbuch zur Gesellschaft Deutschlands*, pp. 552-564. Springer.
- Dumit EM, Suboh A, Sawhney R (2021) "The future of public health." Deloitte, Spring 2021. <https://www2.deloitte.com/xs/en/pages/about-deloitte/articles/back-to-work/the-future-of-public-health.html>
- Duncan S, Smith D (2006) "Individualisation versus the geography of 'new' families". *Twenty-First Century Society* 1:167-189.
- Epstein B (2009) "Ontological individualism reconsidered." *Synthese* 166(1):187-213.
- Foot R (2007) "Mathematics and complex systems." *Science* 318(5849):410-412.
- Franke N, Schreier M (2010) "Why customers value self-designed products: the importance of process effort and enjoyment." *Journal of Product Innovation Management* 27(7):1020-1031.
- Foucault M (1977) *Discipline and punish: the birth of the prison*. Pantheon Books
- Gebhard U (2020) *Kind und Natur: Bedeutung der Natur für die psychische Entwicklung*. Cham, Switzerland: Springer.
- Geukes K, Nestler S, Hutteman R, Küfner ACP, Back MD (2017) "Trait personality and state variability: predicting individual differences in within- and cross-context fluctuations in affect, self-evaluations, and behavior in everyday life." *Journal of Research in Personality* 69:124-138.
- Geukes K, van Zalk MHW, Back MD (2018) "Understanding personality development: an integrative state process model." *International Journal of Behavioral Development* 42:43-51.
- Giddens A (1991) *Modernity and self-identity*. Cambridge: Polity Press.
- Giddens A (1994) "Living in a post-traditional society." in: Beck U, Giddens A, Lash S (eds), *Reflexive modernisation: politics, tradition and aesthetics*, pp. 56-109. Cambridge: Polity Press.
- Godfrey-Smith P (2009) *Darwinian populations and natural selection*. Oxford: Oxford University Press.
- Gonzalez PN, Barbeito-Andrés J (2018) "Canalization: a central but controversial concept in evo-devo." in: Nuño de la Rosa L, Müller GB (eds), *Evolutionary developmental biology: a reference guide*, pp. 1061-1072. Cham: Springer.
- Griffiths S, Jewell T, Donnelly P (2005) "Public health in practice: the three domains of public health."

- Public Health* 119(10):907-913.
- Heath J (2020) "Methodological individualism." in: Zalta EN (ed), *Stanford Encyclopedia of Philosophy (Summer 2020 Edition)*. <https://plato.stanford.edu/archives/sum2020/entries/methodological-individualism/> Hübner L, Vieluf S, Godde B, Voelcker-Rehage C (2019) "Explaining individual differences in fine motor performance and learning in older adults: the contribution of muscle strength and cardiovascular fitness." *Journal of Aging and Physical Activity* 27(5):1-48.
- Ilkilic I, Wolf M, Paul N (2007) "Schöne neue Welt der Prävention? Zu Voraussetzungen und Reichweite von Public Health Genetics." *Das Gesundheitswesen* 69(2):53-62.
- Jackson HJ, Rafiq S, Brentjens RJ (2016) "Driving CAR T-cells forward." *Nature Reviews Clinical Oncology* 13: 370-383.
- Jahn L, Probst-Hensch N (2018) "Public health genomics." in: Egger M, Razum O, Rieder A (eds), *Public Health Kompakt*, pp. 27-30. De Gruyter. <https://doi.org/10.1515/9783110466867-005>
- Johnson JA (2008) "Ethnic differences in cardiovascular drug response: potential contribution of pharmacogenetics." *Circulation* 118(13):1383-1393.
- Julian R, Sargent D (2020) "Periodisation: tailoring training based on the menstrual cycle may work in theory but can they be used in practice?" *Science and Medicine in Football* 4(4):253-254.
- Jung CG (1934/1950) "A study in the process of individuation." in: CG Jung, *The archetypes and the collective unconscious, CW 9i*, pp. 290-354. London: Routledge/Kegan Paul 1959.
- Kaiser MI, Müller C (2021) "What is an animal personality?" *Biology & Philosophy* 36:1. <https://doi.org/10.1007/s10539-020-09776-w>
- Kaiser MI, Trappes R (2021) "Broadening the problem agenda of biological individuality: individual differences, uniqueness, and temporality." *Biology & Philosophy* 36:15. <https://doi.org/10.1007/s10539-021-09791-5>
- Kalow W (2001) "Interethnic differences in drug response." *Drugs and the Pharmaceutical Sciences* 113:109-134.
- Killin A (2022) "Social care and individualised risk in a changing environment." *Metascience* 31:383-386.
- Kirpal S, Brown A, Dif M (2007) "The individualisation of identification with work in a European perspective." in: Brown A, Kirpal S, Rauner F (eds), *Identities at work*, pp. 285-314. Dordrecht: Springer.
- Kluckhohn C, Murray HA (1953) "Personality formation: the determinants." in: Kluckhohn C, Murray HA, & Schneider DA (eds), *Personality in nature, society, and culture: second edition*, pp. 53-69. New York: AA Knopf.
- Kroencke L, Kuper N, Mota S, Geukes K, Zeigler-Hill V, Back MD (2023) "Narcissistic status pursuit in everyday social life: a within-person process approach to the behavioral and emotional dynamics of narcissism." *Journal of Personality and Social Psychology* 125(6):1519-1541.

- Krüger O, Caspers B, Chakarov N, Elliott-Graves A, Kaiser MI, Korsten P, et al. (2021) "Individualised niches: an integrative conceptual framework across behaviour, ecology, and evolution." *EcoEvoRxiv*. <https://doi.org/10.32942/osf.io/7h5xq>
- Kuper N, Modersitzki N, Phan LV, Rauthmann JF (2022a) "The dynamics, processes, mechanisms, and functioning of personality: an overview of the field." *British Journal of Psychology* 112:1-51.
- Kuper N, Breil SM, Horstmann KT, Roemer L, Lischetzke T, Sherman RA, Back MD, Denissen JJA, Rauthmann JF (2022b) "Individual differences in contingencies between situation characteristics and personality states." *Journal of Personality and Social Psychology* 123(5):1166-1198.
- Lehmann W (2009) "Becoming middle class: how working-class university students draw and transgress moral boundaries." *Sociology* 43(4):631-647.
- Lengersdorf D (2013) " 'That is my way of raising the child!': the (non)acceptance of paternal engagement in domestic sphere." in: Kis K, Ranjitsingh AN (eds), *Violent and vulnerable: challenging the gender boundaries of masculinities and femininities*, pp. 121-130. Brill.
- Lengersdorf D (2014) "Stabilizing masculinities." *Culture, Society & Masculinities* 6(2):150-162.
- Lewins R, Lewontin R (1985) *The dialectical biologist*. Cambridge, MA: Harvard University Press.
- Lidgard S, Nyhart LK (eds) (2017) *Biological individuality: integrating scientific, philosophical, and historical perspectives*. University of Chicago Press.
- Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray CJL (2006) *Global burden of disease and risk factors*. New York: The World Bank Group/Oxford University Press. https://ncdalliance.org/sites/default/files/resource_files/Global%20Burden%20of%20Disease.pdf
- Macal MC (2016). "Everything you need to know about agent-based modelling and simulation." *Journal of Simulation* 10(2):144-156.
- MacDonald F (2021) *Individualising risk*. Singapore: Palgrave Macmillan.
- Mack M, Stojan, R, Bock O, Voelcker-Rehage C (2022) "Cognitive-motor multitasking in older adults: a randomized controlled study on the effects of individual differences on training success." *BMC Geriatrics* 22:581. <https://doi.org/10.1186/s12877-022-03201-5>
- Malsch AKF, Killin A, Kaiser MI (2024) "Health-oriented environmental categories, individual health environments, and the concept of environment in public health." *Health Care Analysis* 32: 141-164.
- Mattioni MF, Soares RN, Murias JM, Schellhorn P, Erz G, Burgstahler C, Widmann M, Munz B, Thiel A, Nieß AM (2022) "Responders and non-responders to aerobic exercise training: beyond the evaluation of $VO_{2\text{ max}}$." *Physiological Reports* 9(16):e14951.
- Maughan T (2017) "The promise and the hype of 'personalised medicine'." *The New Bioethics* 23(1):13-20.
- McAdams DP (1997) "A conceptual history of personality psychology." in: Hogan R, Johnson J, Briggs S (eds), *Handbook of personality psychology*, pp. 3-39. San Diego: Academic Press.
- McCarthy MI (2017) "Painting a new picture of personalised medicine for diabetes." *Diabetologia* 60:793-799.

- McConwell AK (2023) *Biological individuality*. Cambridge: Cambridge University Press.
- McNay L (1999) "Gender, habitus and the field." *Theory, Culture and Society* 16(1) 95-117.
- Mead GH (1934) *Mind, self and society*. Chicago: University of Chicago Press.
- Mead R, Thurston M, Bloyce D (2022) "From public issues to personal troubles: individualising social inequalities in health within local public health partnerships." *Critical Public Health* 32(2):168-180.
- Moran NP, Caspers BA, Chakarov N, Ernst UR, Fricke C, Kurtz J, Lilie ND, et al. (2022) "Shifts between cooperation and antagonism driven by individual variation: a systematic synthesis review." *Oikos*. <https://doi.org/10.1111/oik.08201>
- Mota S, Mielke I, Kroencke L, Geukes K, Nestler S, Back MD (2023) "Daily dynamics of grandiose narcissism: distribution, stability, and trait relations of admiration and rivalry states and state contingencies." *European Journal of Personality* 37(2):207-222.
- Möttus R, Wood D, Condon DM, Back MD, Baumert A, Costantini G, Epskamp S, Greiff S, Johnson W, Lukaszewski A, Murray A, Revelle W, Wright A, Yarkoni T, Ziegler M, Zimmermann J (2020) "Descriptive, predictive and explanatory personality research: different goals, different approaches, but a shared need to move beyond the Big Five traits." *European Journal of Personality* 34:1175-1201.
- Müller C, Caspers BA, Gadau J, Kaiser S. (2020). "The power of infochemicals in mediating individualized niches." *Trends in Ecology & Evolution* 35(11):981-989.
- Müller C, Junker RR (2022) "Chemical phenotypes as important and dynamic niche dimension of plants." *New Phytologist* 234:1168-1174.
- Mutwill AM, Zimmermann TD, Hennicke A, Richter SH, Kaiser S, Sachser N (2020) "Adaptive reshaping of the hormonal phenotype after social niche transition in adulthood." *Proceedings of the Royal Society B: Biological Sciences*. <https://doi.org/10.1098/rspb.2020.0667>
- Ødegårda G, Berglund F (2008) "Political participation in late modernity among Norwegian youth: an individual choice or a statement of social class?" *Journal of Youth Studies* 11(6):593-610.
- Powell DM, Gartner MC (2011) "Applications of personality to the management and conservation of nonhuman animals." in: Inoue-Murayama M, Kawamura S, Weiss A (eds), *From genes to animal behavior: social structures, personalities, communication by color*, pp. 185-199. Tokyo: Springer.
- Pradeu T (2012) *The limits of the self: immunology and biological identity*. Oxford: Oxford University Press.
- Pradeu T (2016) "The many faces of biological individuality." *Biology & Philosophy* 31(6):761-773.
- Pradeu T, Lemoine M, Khelifaoui M, Gingras Y (2024) "Philosophy in science: can philosophers of science permeate through science and produce scientific knowledge?" *British Journal for Philosophy of Science* 75(2). <https://doi.org/10.1086/715518>
- Rammstedt O (1985) "Zweifel am Fortschritt und Hoffen aufs Individuum: Zur Konstitution der modernen Soziologie im ausgehenden 19. Jahrhundert." *Soziale Welt* 36(4):483-502.
- Rand W, Stummer C (2021) "Agent-based modeling of new product market diffusion: An overview of strengths and criticisms." *Annals of Operations Research* 305:425-447.

- Rawls J (1971) *A theory of justice*. Cambridge, MA: Harvard University Press.
- Richter SH, Hintze S (2019) "From the individual to the population—and back again? Emphasising the role of the individual in animal welfare science." *Applied Animal Behaviour Science* 212:1-8.
- Roberts BW, Jackson JJ (2008) "Sociogenomic personality psychology." *Journal of Personality* 76:1523-1544.
- Roberts BW, Kuncel NR, Shiner R, Caspi A, Goldberg LR (2007) "The power of personality: the comparative validity of personality traits, socioeconomic status, and cognitive ability for predicting important life outcomes." *Perspectives on Psychological Science* 2:313-345.
- Schlamm L (2014) "Individuation." in: Leeming DA (ed), *Encyclopedia of Psychology and Religion*. Boston: Springer. https://doi.org/10.1007/978-1-4614-6086-2_329
- Schwarz JFL, Mews S, DeRango EJ, Langrock R, Piedrahita P, Páez-Rosas D, Krüger O (2021) "Individuality counts: a new comprehensive approach to foraging strategies of a tropical marine predator." *Oecologia* 195:313-325.
- Smith BR, Blumstein DT (2013) "Animal personality and conservation biology: the importance of behavioral diversity." in: Carere C, Maestripieri D (eds), *Animal personalities: behavior, physiology, and evolution*, pp. 381-413. Chicago: The University of Chicago Press.
- Smith WR (1956) "Product differentiation and market segmentation as alternative marketing strategies." *Journal of Marketing* 21(1):3-8.
- Soto CJ (2019) "How replicable are links between personality traits and consequential life outcomes? The life outcomes of personality replication project." *Psychological Science* 30(5):711-727.
- Stern W (1911) *Die differentielle Psychologie in ihren methodischen Grundlagen*. Leipzig: Barth.
- Sunikka A, Bragga J (2008) "What, who and where: Insights into personalization." in: *Proceedings of the 41st Hawaii international conference on system sciences*, pp. 283. Institute of Electrical and Electronics Engineers. <https://doi.org/10.1109/HICSS.2008.500>
- Trappes R (2021) *Individuality in behavioural ecology: personality, persistence, and the perplexing uniqueness of biological individuals*. PhD Thesis, Bielefeld University. <https://doi.org/10.4119/unibi/2959077>
- Trappes R (2022) "Individual differences, uniqueness, and individuality in behavioural ecology." *Studies in History and Philosophy of Science* 96:18-26.
- Trappes R, Nematipour B, Kaiser MI, Krohs U, van Benthem KJ, Ernst UR, Gadau J, Korsten P, Kurtz J, Schielzeth H, Schmoll T, Takola E (2022) "How individualized niches arise: defining mechanisms of niche construction, niche choice, and niche conformance." *BioScience* 72:538-548.
- van Zalk MHW, Nestler S, Geukes K, Hutteman R, Back MD (2020) "The codevelopment of extraversion and friendships: bonding and behavioral interaction mechanisms in friendship networks." *Journal of Personality and Social Psychology* 118(6):1269-1290.
- Wanless D (2004) *Securing good health for the whole population: final report*. London: Her Majesty's Treasury/Her Majesty's Stationary Office. <https://www.southampton.gov.uk/moderngov/documents/s19272/prevention-appx%201%20wanless%20summary.pdf>

- Waters CK (2019) "Presidential address, PSA 2016: an epistemology of scientific practice." *Philosophy of Science* 86:585-611.
- Weber M (1922) *Wirtschaft und Gesellschaft*. Mohr.
- WHO (1986) "Ottawa charter for health promotion." World Health Organization. https://www.euro.who.int/_data/assets/pdf_file/0004/129532/Ottawa_Charter.pdf
- WHO (2020) "The top 10 causes of death." World Health Organization. <https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death>
- WHO (2022) *Global status report on physical activity*. Geneva: World Health Organization.
- Wingo AP, Gibson G (2015) "Blood gene expression profiles suggest altered immune function associated with symptoms of generalized anxiety disorder." *Brain, Behavior, and Immunity* 43:184-191.
- Winslow CEA (1920) "The untilled fields of Public Health." *Science* 51(1306):23-33.
- Wolf M, Weissing FJ (2012) "Animal personalities: consequences for ecology and evolution." *Trends in Ecology & Evolution* 27(8):452-461.
- Wrzus C, Roberts BW (2017) "Processes of personality development in adulthood: the TESSERA framework." *Personality and Social Psychology Review* 21:253-277.
- Zahle J, Kincaid H (2019) "Why be a methodological individualist?" *Synthese* 196:655-675.