

Toward an ontology of identity-related constructs in addiction, with examples from nicotine and tobacco research

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Abstract

Background and aims: We aimed to create a basic set of definitions and relationships for identity-related constructs, as part of the Addiction Ontology and E-Cigarette Ontology projects, that could be used by researchers with diverse theoretical positions and so facilitate evidence synthesis and interoperability.

Methods: We reviewed the use of identity-related constructs in psychological and social sciences and how these have been applied to addiction with a focus on nicotine and tobacco research. We, then, used an iterative process of adaptation and review to arrive at a basic set of identity-related classes with labels, definitions and relationships that could provide a common framework for research.

Results: We propose that ‘identity’ be used to refer to ‘a cognitive representation by a person or group of themselves’, with ‘self-identity’ referring to an individual’s identity and ‘group identity’ referring to an identity held by a social group. Identities can then be classified at any level of granularity based on the content of the representations (e.g. ‘tobacco smoker identity’, ‘cigarette smoker identity’ and ‘vaper identity’). We propose distinguishing identity from ‘self-appraisal’ to capture the distinction between the representation of oneself (e.g. as an ‘ex-smoker’) and (i) the importance and (ii) the positive or negative evaluation that we attach to what is represented. We label an identity that is appraised as enduring as a ‘core identity’, related to ‘strong identity’ because of the appraisal as important. Identities that are appraised positively or negatively involve ‘positive self-appraisal’ and ‘negative self-appraisal’ respectively. This allows us to create ‘logically defined classes’ of identity by combining them (e.g. ‘positive core cigarette smoker identity’ to refer to a cigarette smoker self-identity that is both positive and important). We refer to the totality of self-identities of a person as a ‘composite self-identity’.

Conclusions: An ontology of identity constructs may assist in improving clarity when discussing theories and evidence relating to this construct in addiction research.

KEYWORDS

E-cigarette, Identity, nicotine, ontology, vape, vaping device

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INTRODUCTION

The term 'identity' has been used by researchers to refer to a range of constructs in attempting to understand psychological, behavioural and social phenomena such as addiction. This article reviews major theoretical approaches to the concept of identity, summarising how identity is understood and operationalised within different theoretical traditions and how these have been applied in addiction research. We drew on 'patient and public involvement' group discussions to provide examples of lived experience of use of identity-related categories [1]. We propose 'ontological definitions' for key identity-related entities that may have use across theoretical domains.

Ontologies are ways of representing the world in which entities are defined and classified in a standardised way so that they can be used to synthesise data across theoretical orientations, disciplines and domains [2–4]. Ontological definitions differ from dictionary definitions. They do not make claims about the 'correct' definition of a term; rather they describe a class of entity and how it relates to other classes of entity, and then give this class a unique identifier and a label. Consensus can be built around the existence of entities matching a particular class description. The unique identifier can be applied to the entity that, together with a label, makes it easy to refer to it [2]: for example, when coding findings from the literature for evidence syntheses. We develop examples drawn from nicotine and tobacco research. Nicotine and tobacco research is an area in which it is particularly useful to apply ontologies because of confusion caused by imprecise and inconsistent use of terms [5–7].

How identity is construed in the social science literature

Theories of identity all appear to construe identity as a representation that a person or a social group holds about themselves. At its most basic, this representation is of the self as having a continuous existence [8]. Many theories go beyond this and specify characteristics we ascribe to ourselves (e.g. gender and ethnicity), representations of the self that relate to behaviour patterns (e.g. tobacco smoker), appraisals of those characteristics and whether they are referring to representations held by individuals or groups. They also include propositions about how identity develops and changes, and the role it plays in what we think and feel and how we act (e.g. in relation to theories of behaviour) [8, 9].

Social identity theory (SIT) conceptualises 'social identity' as a representation individuals have of themselves as members of social groups. The theory proposes that people have a positive appraisal of groups to which they perceive themselves as belonging (in-groups) and tend to have negative appraisals of those that they do not belong to (out-groups). Social identity is theorised to contribute to positive self-esteem [9, 10] and to influence behaviour [11].

Self-categorization theory (SCT) distinguishes three levels of self-categorisation: self as a person ('human identity'), self as a member of

a group (social identity) and self as a collection of personal characteristics ('personal identity') [12]. Social and personal identity can change over time and with experience.

Ego-identity, as conceptualised in Erikson's stages of psychosocial development [8], combines social identity and personal identity in SCT with a specific emphasis on a sense of continuity with others and development through the life course. The term 'identity crisis' is used to describe a process of transition from one identity to another.

Motivated identity construction theory (MICT) [13] proposes that people across cultures are motivated to construct identities that fulfil important needs for self-esteem, continuity, distinctiveness, meaning, efficacy and belonging.

Social cognitive theories cover a range of different identity-related constructs. One of these construes identity as 'a cognitive structure or self-theory, which provides a personal frame of reference for interpreting self-relevant information, solving problems, and making decisions' [14]. In addition, there are specific representations of the self, relating to competence, agency and empowerment.

In the social constructionist approach, identity is an ever-changing representation that exists in the social world of discourse between people [15, 16]. In this sense, the self is seen as a reflection of society [17]. Structural sociology more generally considers identities as representations held by groups rather than individuals. Groups in this sense need not have members who interact with each other. They may simply have a group label applied to them based on one or more shared characteristics. An example would be gender role identity that can be construed and studied at the level of groups of various kinds, including nationalities and cultural groups [18].

The research literature uses the term 'core identity' to refer to identities that are important to people and judged to endure over time [19]. Core identities may be considered to be the essence of self, the central guiding self-perception encompassing the totality of how one sees oneself (an internal cognitive representation), in turn guiding how one behaves and projects, or 'performs' the conceptualisation of self [20].

Identity-related constructs in research on addiction and nicotine and tobacco

Identity-related constructs are important in understanding pathways into and out of addictive behaviour. Frequently used are 'addict identity', 'ex-addict identity' and 'recovering addict identity' [21, 22]. Separate from this are identities based on behaviour patterns (as represented, not necessarily as actually taking place as behaviours) such as 'occasional substance user identity' and 'regular substance user identity' [23, 24]. These identities frequently have positive or negative appraisals attached to them so that people often report feeling positive or negative about themselves as users of a particular substance or ex-users of one. The identities often relate to other social identities such as being a member of a peer group [25]. Social norms play a role in whether certain self-identities are appraised positively or negatively [25].

Constructs relating to identity have explanatory potential for understanding variation in smoking prevalence across cultures. In China, for example, tobacco smoking is more negatively evaluated for women than men and this is reflected in much lower smoking prevalence among women than men [26]. ‘Self-identity’ categorisations have been postulated as key drivers to explain tobacco consumption behaviours. Positive self-identity as a smoker, for example, correlates with continued tobacco smoking behaviour [27], whereas negative appraisal of tobacco smoking and seeing oneself as a ‘non-smoker’ may be associated with smoking cessation [28]. Perceiving oneself, in a simple way, as a ‘smoker’ or a non-smoker may play a mediating role between dependence and cessation [29]. Perceptions of the self in this way can be seen to have explanatory potential and drive behaviour. Retaining a sense of oneself as a smoker, for example, despite quitting, may be an explanatory factor underpinning smoking relapse [20, 30]. Identity change is thought to be critical to sustained cessation that might be resistant to environmental and social cues to smoke [31].

AIMS

The study aimed to identify a set of definitions, labels and relationships for identity-related constructs that can be used by addiction researchers across a range of theoretical perspectives to increase interoperability and enable evidence synthesis.

METHODS

The development of ontologies involves engagement with a body of literature and consultation with experts and ‘experts by experience’, to arrive at classes of entity about which a consensus can be reached, and how these relate to each other, including their hierarchical relationships. Labels are, then, applied and discussed. Definitions should follow a standard form consisting of the ‘parent’ class (e.g. in Linnaean classification the genus ‘homo’ is the parent class of the species ‘*homo sapiens*’) followed by a description of what distinguishes the class in question from others in the parent class [2]. Labels should aim to distinguish the class as unambiguously as possible without having to refer to additional context. For example, the label ‘dependence’ is problematic in an addiction ontology because it is too broad—there are many different types of dependence, and not all of them relate to addiction; a better label would be ‘substance dependence’. However, ontologies allow for the use of specified synonyms that do not have to be unique and can assist the process of searching. For that purpose, dependence could be included as a synonym for substance dependence.

A key function of ontologies is to promote interoperability across domains, and it is good practice to use entities from existing ontologies where possible. It is also important for interoperability to be able to trace the hierarchy of classes up to a single shared upper-level ontology. The Addiction Ontology links through taxonomic relations

to an upper level ontology called Basic Formal Ontology (BFO) for its uppermost classes [32]. This upper-level ontology is widely used in biological sciences and is increasingly used in social, clinical and behavioural sciences. The Addiction Ontology also makes use of the Mental Functioning Ontology (MFO) and its emotion extension for constructs relating to cognitive and emotional processes [33].

To develop the addiction ontology, we undertook a comprehensive annotation of 100 abstracts published in the journals *Addiction* and *Drug and Alcohol Dependence* (DAAD). We reviewed the first 50 research reports (primary data collection studies) from *Addiction* and the first 50 from DAAD in 2018, identifying all terms that were used to refer to meaningful constructs. This was judged an adequate sample to generate sufficient terms for initial development of ontology constructs, because the number of new terms in each additional abstract beyond that point was small. We, then, sought to classify these into high-level topics to capture all aspects of the field including theories, study methods and findings. To elaborate the part of the ontology relating to nicotine and tobacco, we also identified additional terms from a series of expert group discussions. For the identity-related constructs, we additionally reviewed the literature on identity theories and their application to addiction. This was not a systematic review of the kind that would be used to answer an empirical question, but a scoping review to discover uses of identity-related terms.

The authors of this article comprise the core team who were responsible for curating the entities and seeking agreement on what should be included or edited ready for inclusion. Each team member focused on a specific area to develop, and sought feedback from the team at weekly meetings (held online) over a 2-year period. This process allowed the team to systematically work through the entities and agree on (i) whether the entity should be included, (ii) its position within the ontology, (iii) the label and definition. We sought a majority consensus before including entities. Figure 1 presents the workflow of the ontology from the point of agreed entity inclusion onward.

Informed by ‘patient and public involvement’ feedback [1], the team worked iteratively to propose definitions, labels and relationships, and then test these against our understanding of the field and the literature, until we arrived at consensus for the representation of core classes of entity.

Once a set of definitions, labels and relationships were agreed by the team these were published on an online portal designed specifically for the Addiction Ontology (<https://addictovocab.org/>) and on the open access publishing platform, Qeios (<https://qeios.com>). Qeios has a unique and highly desirable feature of publishing definitions, as well as articles. The definitions have DOI numbers and therefore can be accessed and referenced by any publication that uses ‘crossref’ (<https://www.crossref.org>).

RESULTS

Figure 2 shows labels for a basic set of identity-related constructs for use in addiction and specifically nicotine and tobacco research. Table 1 lists the unique identifiers and labels for classes, their parent

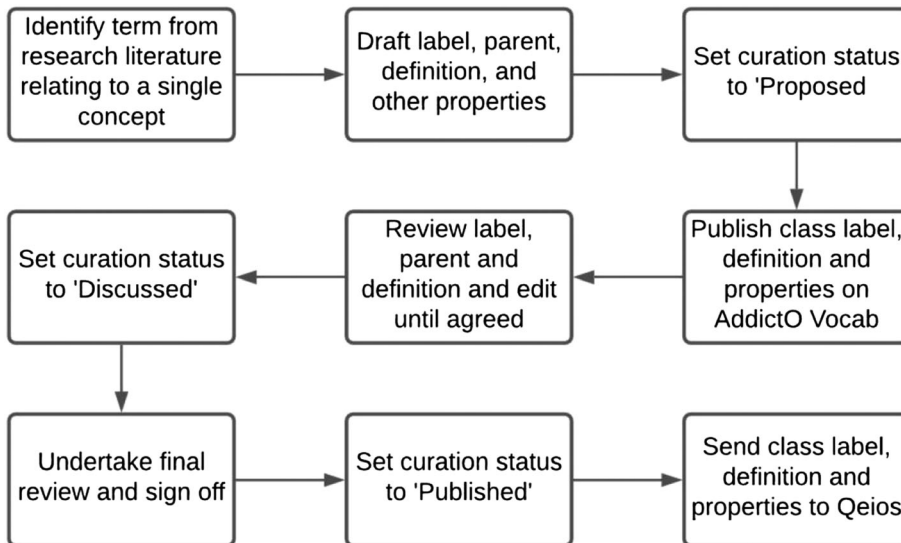


FIGURE 1 Workflow for including classes in the Addiction Ontology

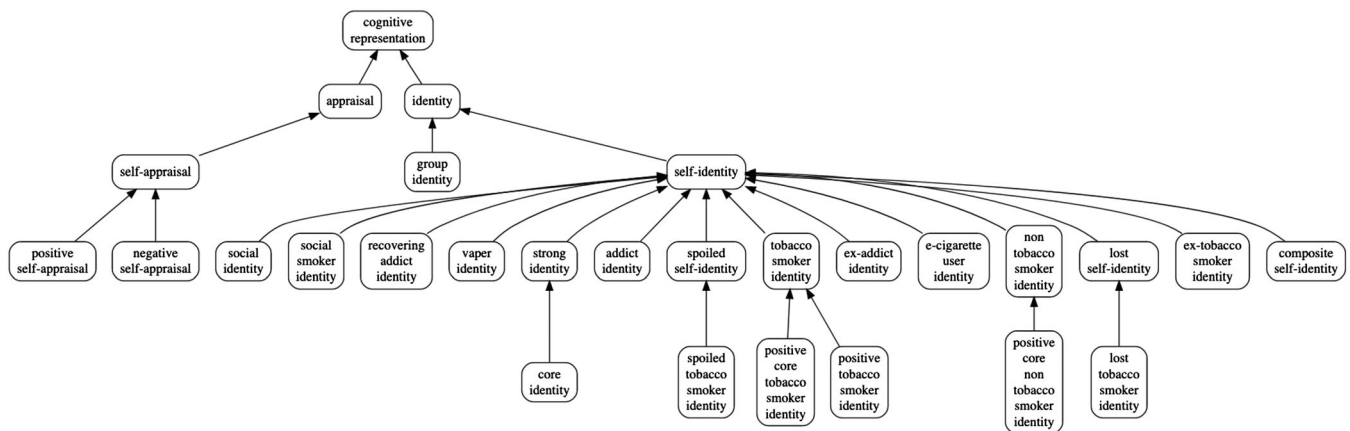


FIGURE 2 Identity-related entities in the Addiction Ontology. Classes are illustrated with rounded rectangles, whereas hierarchical relationships between classes are illustrated with arrows pointing from the more specialised class to the 'parent' or more general class.

classes and definitions. Entities that were created for the Addiction Ontology have identifiers beginning with ADDICTO, whereas those imported from other ontologies use the identifiers from those ontologies.

Identity as cognitive representation

All entities relating to identity come under the single class in the MFO of 'cognitive representation'. Representations are one of several types of entity that BFO refers to as a 'specifically dependent continuant', which in everyday language can be thought of as an 'attribute'. That is, they depend on another, independent entity for their existence. Cognitive representations depend on the cognitive functioning of a human brain. They are 'specifically' dependent, because a specific instance of an identity is always borne by a specific brain.

Cognitive representations can be held by individuals or groups of individuals and so beneath identity is classified self-identity [34], an

identity that a person has about themselves, and 'group identity' [34], an identity that a group holds about itself. Including group identity in the ontology allows us to refer to collective representations that groups may have (e.g. a group of football supporters may collectively view themselves as loyal to their club). Therefore, group identities will be made up of individual identities of group members. We do not elaborate group identity in this article, but in principle, many characteristics of self-identity can also be used to define classes of group identity.

Classes of self-identity

A self-identity [35] may involve some form of self-appraisal [36], which is a subclass of 'appraisal' in the emotion ontology developed beneath the MFO. Therefore, some people may attach no positive or negative value to a particular characteristic of themselves (e.g. as someone who lives in a given street), whereas for others the same

TABLE 1 Identity-related classes of entity and definitions in the Addiction Ontology

ID	Label	Definition	Parent
(a) Addiction Ontology entities			
ADDICTO:0000381	Identity	A cognitive representation by a person or a group about themselves.	Cognitive representation
ADDICTO:0000399	Self-identity	An identity that a person has about themselves.	Identity
ADDICTO:0000715	Group identity	An identity that a group holds about itself.	Identity
ADDICTO:0000398	Self-appraisal	An appraisal by a person about themselves.	Appraisal
ADDICTO:0001163	Positive self-appraisal	A self-appraisal in which what is represented is appraised as good or desirable.	Self-appraisal
ADDICTO:0001164	Negative self-appraisal	A self-appraisal in which what is represented is appraised as bad or undesirable.	Self-appraisal
ADDICTO:0001165	Addict identity	A self-identity in which a person represents themselves as being addicted to something.	Self-identity
ADDICTO:0001166	Ex-addict identity	A self-identity in which a person represents themselves as having been addicted to something but no longer addicted to that thing.	Self-identity
ADDICTO:0000714	Ex-tobacco smoker identity	A self-identity in which a person represents themselves as having previously been a tobacco smoker but currently not being a tobacco smoker.	Self-identity
ADDICTO:0000716	Lost self-identity	A self-identity in which a person represents themselves as no longer having some positively appraised characteristic.	Self-identity
ADDICTO:0000717	Non tobacco smoker identity	A self-identity in which a person represents themselves as not being a tobacco smoker.	Self-identity
ADDICTO:0001167	Recovering addict identity	A self-identity in which a person represents themselves as being in recovery from addiction and vulnerable to relapse to that addiction.	Self-identity
ADDICTO:0001087	Social identity	A self-identity that represents a relation between oneself and another person or group.	Self-identity
ADDICTO:0001168	Social smoker identity	A self-identity in which the person considers themselves to smoke predominantly or exclusively in social situations.	Self-identity
ADDICTO:0000718	Spoiled self-identity	A self-identity representing something as having been positively appraised in the past but is currently negatively appraised.	Self-identity
ADDICTO:0001227	Strong identity	A self-identity in which what is represented is appraised as important.	Self-identity
ADDICTO:0000406	Tobacco smoker identity	A self-identity in which a person represents themselves as a tobacco smoker.	Self-identity
ADDICTO:0000409	Vaper identity	An identity in which a person represents themselves as a vaper.	Self-identity
ADDICTO:0001224	Composite self-identity	An identity that includes all of a person's self-identities.	Self-identity
ADDICTO:0001169	Lost tobacco smoker identity	A lost self-identity in which the positively appraised past characteristic is that of being a tobacco smoker.	Lost self-identity
ADDICTO:0001171	Spoiled tobacco smoker identity	A spoiled identity of oneself as a tobacco smoker.	Spoiled identity

(Continues)

TABLE 1 (Continued)

ID	Label	Definition	Parent
ADDICTO:0000367	Core identity	A strong identity in which what is represented is appraised as important and enduring.	Strong-identity
ADDICTO:0001225	Positive core tobacco smoker identity	A tobacco smoker identity that is a core identity and a positive identity (logically defined class).	Tobacco smoker identity
ADDICTO:0000392	Positive tobacco smoker identity	A tobacco smoker identity that is a positive identity (logically defined class).	Tobacco smoker identity
ADDICTO:0001170	Positive core non tobacco smoker identity	A non tobacco smoker identity that is a core identity and a positive identity (logically defined class).	Non tobacco smoker identity
(b) External entities			
MF:0000030	Representation	A dependent continuant, which is about a portion of reality.	Specifically dependent continuant
MF:0000031	Cognitive representation	A representation, which specifically depends on an anatomical structure in the cognitive system of an organism.	Representation
MFOEM:000005	Appraisal	A cognitive representation, which represents an evaluation of the relevance of some triggering object or event to the organism.	Cognitive representation

Note: Classes of entity are listed under the parent class.

characteristic may be evaluated as either positive or negative. We elaborate self-appraisal as ‘positive self-appraisal’ and ‘negative self-appraisal’. These in turn can be combined with classes based on the content of the identity in what in ontologies are known as logically defined classes [4] to create classes at any detail level that include positive and negative appraisal, such as ‘positive tobacco smoker identity’ or ‘negative vaper identity’.

Similarly, some identities are important to us, whether positive or negative, so we have the class ‘strong identity’ to refer to these. Some strong identities are judged to endure over time and so we have the class core identity [37] to represent identities that are appraised as both enduring and important. Therefore, we can create the logically defined class ‘core tobacco smoker identity’ [38] to refer to an identity that someone has of themselves as a tobacco smoker, this being judged to be an important and enduring characteristic to them and which may influence their actions in the future.

To encompass our representation of ourselves in relation to other people or groups, we propose the class social identity [39]. This is distinguished from group identity [40], which, as noted above, we use to refer to the collective identity of a group. For example, in treatment for substance misuse one might attend recovery support groups and represent oneself as belonging to the ‘recovery’ group. This defines the person as belonging to a group that is attempting to recover from problematic substance use. Social identity may also play an important role in substance use initiation behaviours. Identifying with smokers as a group can influence decisions about whether to start smoking.

Other subclasses that appear to have general applicability in addiction are (i) ‘spoiled self-identity’ [41], which is a self-identity in

which the person has a representation of something about themselves that is negatively appraised having previously been positively appraised, and (ii) ‘lost self-identity’ [42], which is a self-identity in which a person has a representation of a past self that they appraise positively, but which is no longer the case.

We can form additional classes of identity at any level of granularity based on the content of how the self is represented, which can in principle encompass anything. In the field of addiction some identities that are clearly central are the addict identity [43] the ex-addict identity [44] and the recovering addict identity [45]. In this ontology, to facilitate cross-theory compatibility we do not attempt to make strong theoretical claims in the definitions, but simply to note that they involve individuals representing themselves as addicts, former addicts or recovering addicts. This leaves the way open for theorists to make additional substantive claims about these identities that are not built into their definition, but rather are empirically derived and testable.

People also represent themselves in terms of their behaviour patterns, leading to classes of identity such as ‘tobacco smoker identity’ [38]. In recent years, use of electronic vaping devices such as e-cigarettes have become prevalent, and this can lead to identities such as ‘vaper identity’ [46]. Note that these classes refer to how people represent themselves, which may not accurately reflect how they might be more objectively classified. Therefore, one e-cigarette user may have a vaper identity, whereas another may have an ‘e-cigarette-user identity’ [47], in which they make a distinction between e-cigarettes and other vaping devices.

A potential point of confusion exists when people apply a label to themselves that does not accord with the representation they have. In

this ontology, the label given to the identity is based on the content of their representation rather than the label they assign themselves. Therefore, a person may label themselves as a 'vaper', but that is because they identify vaping with e-cigarette use rather than the broader class of behaviours that may involve other forms of vaping. In that case, if the content of their representation were accessible, it would be more appropriate to use the e-cigarette user identity class. Similarly, someone may label themselves as a 'social smoker' [48] and not a tobacco smoker if they see themselves as smoking primarily in social situations, but do not self-identify as a tobacco smoker. This may have consequences for subsequent behaviour, because labelling oneself is important even if the label does not accurately reflect the representation.

People can also represent themselves as non-users of products such as cigarettes or vaping devices so we can have 'non-smoker identity' [49]. Note that there is an important difference between not having an identity as a tobacco smoker and having a non-smoker identity. Our proposed ontology captures this by the former involving no representation and the latter involving a specific representation. Identities can also refer to characterisations of ourselves in the past and the present, as in 'ex-smoker identity' [50]. The same principle can apply to any behaviour pattern that people can engage in and form a representation of, including alcohol consumption, cannabis use and heroin use. Additional identity subclasses can be added as required to the ontology.

Logically defined classes

As noted above, a useful feature of ontologies is the facility to combine classes using logical expressions. We saw this with the ability to combine self-appraisal and core identity with other classes. This can work with many different classes. Therefore, we can combine tobacco smoker identity, positive identity and core identity to create a class 'positive core tobacco smoker identity' [51].

Similarly, we may combine tobacco smoker identity with spoiled self-identity to create a class spoiled tobacco smoker identity [52] to characterise someone who represents their tobacco smoking as something that they appraised positively previously but now appraise negatively.

Therefore, the classes in this ontology can be used to form any number of further classes that can be linked to each other through their components. A person may represent themselves as an ex-smoker after as little as a day of not having smoked, or as a smoker although they have not smoked for several weeks. As was noted earlier, this representation may play a causal role in subsequent behaviour, such as that adopting a positive core non-smoker identity [53] as soon as one has stopped smoking may be protective against relapse [54].

Composite self-identity

What is being represented in self-identities can be anything about ourselves, however simple or complex and however specific or general. We also need to be able to refer to the totality of our representation of ourselves, including all these representations. This is so

that we can characterise this totality in ways that are important for our behaviour and mental health. For example, if our self-identities are inconsistent with each other and do not cohere we may consider our total identity as 'fractured'. We, therefore, propose a class 'composite self-identity' that represents this totality of our identities.

DISCUSSION

This article has attempted to characterise basic identity-related constructs that are relevant to addiction in a way that can be used with diverse theoretical positions, whereas enabling some of the nuances and subtleties of those positions to be expressed in a consistent fashion. The ontology distinguishes between the content of representations and appraisals of these characteristics, which permit us to talk about core identities and positive and negative identities. The class definitions have been developed in a way that allows them to be combined and elaborated to create new classes at any desired degree of specificity. The ontology distinguishes between self-identities that are held by individuals and group identities that are held collectively by groups. It promotes interoperability with other domains of interest by linking with the MFO and at the top level with BFO.

The proposed ontology necessarily has a shallow hierarchical structure with a potentially huge number of classes directly under the self-identity class. At first glance, one might imagine that one could place some classes under others (e.g. social tobacco smoker identity under tobacco smoker identity). However, that is not the case because these are different representations and social tobacco smoker identities do not inherit all the characteristics of tobacco smoker identities in general, which would be the case if they were hierarchically related. The shallow hierarchical structure reflects the large number of possible identity classes. The social smoker identity is distinct from tobacco smoker identity in that on some occasions it may involve denial of being a smoker. In a similar vein, cigarette smoker identity is not a subclass of tobacco smoker identity because a cigarette smoker may not necessarily represent themselves as a tobacco smoker.

Following the BFO, the Addiction Ontology is what is known as a 'realist ontology' [55]. This means that the entities it seeks to represent are believed to exist in the world although the representations will always reflect a particular perspective and conceptual framework.

Ontologies of the kind proposed are continually developed in breadth and depth. The ontology that has been developed so far may in the future be developed in many ways. One is by the process of linking constructs with measures of those constructs. For example, simple measures have been developed of constructs such as positive smoker identity, and these have been found to have predictive and explanatory value for behaviours [27]. The Addiction Ontology will in the future contain a section devoted to measurement of constructs. Once this work is further advanced, researchers should be able to use the ontology to help them choose identity-related measures based on classes of identity that they are investigating.

Another line of development may be in terms of what we may call 'prospective identities'. Although 'lost identity' involves a

representation of ourselves as we were in the past, we also need to be able to classify our representations of ourselves as we could be in the future [56, 57]. These prospective identities might be labelled 'aspirational identities' if the future characteristics are positively appraised or 'feared identities' if they are negatively appraised. They are not in the ontology at present because they have not been through the development process. A further line of development may be to introduce what we could term 'injunctive identities', personal rules that we apply to ourselves. Therefore, for example, 'non-smoker injunctive identity' might not merely represent our non-smoking behaviour, but include a rule that we apply to ourselves that we should not smoke tobacco. We could still hold this identity while occasionally smoking tobacco.

A limitation of the identity branch of the Addiction Ontology presented in this article is that our review of identity constructs and terms commonly used in the field was not exhaustive, although we followed a transparent and systematic approach to the development of entity definitions, as described above. Ontologies need continual development and maintenance. Since our review of terms in 2018 the nicotine and tobacco landscape has evolved, which will likely impact on identity constructs. Entities should largely remain stable, but new entities may also need to be added. At the very least ontologies need oversight to ensure that their online representation can continue to be accessed and used. However, more than this, they need to evolve with a field of interest. This is a challenge that has been met in other domains through evolving communities of practice and community ownership of such shared knowledge resources. It is hoped that it will be possible to build such a community in the field of addiction, preferably with the support of learned societies and journals.

Use of ontologies in the social and behavioural sciences is still in its infancy, although interest is growing [58, 59]. It remains to be seen how far and how rapidly researchers will embrace them, with efforts such as the consensus report of the National Academies of Sciences, engineering and medicine on 'Accelerating Behavioral Science Through Ontology Development and Use' [60], promoting engagement. The next step for the classes in this ontology is for interested parties to comment on the classes proposed using the Qeios publishing platform (www.queios.com), and if they find the classes useful to refer to them in their articles using the appropriate class identifiers. This will greatly facilitate integration by providing common search terms for the same entities, something that currently is challenging. With engagement from researchers on the field, the key contributions of an ontology are to provide a basis for developing detailed operationalisations of entities that are not limited to particular theories. This should reduce ambiguity and greatly facilitate evidence synthesis.

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AUTHOR CONTRIBUTIONS

Caitlin Jade Notley: Conceptualization; data curation; formal analysis; writing-original draft; writing-review and editing. **Robert West:** Conceptualization; data curation; methodology; validation; writing-original draft; writing-review and editing. **Kirstie Soar:** Formal analysis; project administration; writing-original draft; writing-review and editing. **Janna Hastings:** Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; software; validation; visualization; writing-original draft; writing-review and editing. **Sharon Cox:** Conceptualization; data curation; formal analysis; funding acquisition; methodology; writing-original draft; writing-review and editing.

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