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Social Identity Networks: People Holding Attitudes Are a Collective Social Identity Information System and Bipartite Networks Are a Useful way to Represent Them

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Abstract

I operationalize a *social information system* as a bipartite social identity network of *people* holding *attitudes*, where attitudes are coupling points between the individual and the social. This social-symbolic structure binds people into groups (via jointly held attitudes) and attitudes into clusters (when jointly held by people) in which attitude-based groups and group-related attitudes form a recursive (co-constitutive) dynamic structure, and people's attitude expressions position them within a dynamical social field while simultaneously producing it (capturing what has been called *interactionism* in social psychology and *duality* in sociology). In this system, attitudes have social functions: (1) producing affiliation; (2) defining identities and differentiating social groups; and (3) positioning people. *Dynamic fixing* occurs when network structures stabilize to associate certain attitudes and identities, producing a social information system in which identity is a dimension of compression. The ability for people to position each-other by the attitudes they express is a key interface between social identity and individual psychology, and this is a function of the structure of the social identity information system, dynamically and actively produced.

Keywords: attitudes; network; bipartite; social identity; belief system; social information system; social identity information system; social identity network; bipartite social identity network

The phrase “social attitudes” (Allport, 1919; W. I. Thomas & Znaniecki, 1918) captures a deep conundrum at the heart of social psychology: that it tries to simultaneously describe individuals and social groups. This is a difficult problem. Various theoretical movements have emphasized one side or the other; but, in this paper, I present a Social Identity Network approach that does both at once, realizing the special status of attitudes as coupling-points between the individual and the social.

To explain: if two contemporary Americans discover each other’s attitudes on abortion, immigration, gun control or other “hot” topics, they can guess each-other’s political identities with astonishing accuracy (Lüders, Carpentras, et al., 2024). On the other hand, if two Swiss people learn each-other’s attitudes to guns they will be better able to guess each-other’s gender than political identity.

How is this possible? It depends on the synchronization of attitudes in groups such that various combinations of attitudes become most associated with certain identities; thus identities become dimensions of compressibility in the collective social information system, and small amounts of information can be used to make reasonable guesses about other features by exploiting associational redundancy in the system (Durrheim & Quayle, 2025).

In this sense, social polarization is a feature of compressible social information that allows the recognition of an agent’s group identity from a small number of key attitudes, addressing the problem of how people use expressed attitudes to tell “us” from “them” in a system structured to facilitate this social operation. This is important because, once attitudes like “support for electric cars” or “approval of vaccines” become properties of groups, then attitude change becomes an intergroup process. Overlooking the internal cognitive representation of attitudes, the Social Identity Network approach focuses on their social function as linkages between the individual and the social, bridging these levels of analysis. In this view, attitudes are properly social, because expressing them positions the speaker within a system of social identities; and expressing an attitude associated with an outgroup is to risk

misrecognition.

Overall, in this paper, I will argue for (1) a metatheoretical perspective that treats attitudes as a dynamical socially structured information system (or space, or field) in which specific attitude expressions both contribute to producing the socially-structured space and are coordinates positioning individuals and groups within it; and (2) that bipartite networks are useful models for representing this type of complex system. The former is already well established in the social identity and social representations approaches and, in the first part of this review, I return to the work done by Tajfel, Moscovici, and others to develop this metatheoretical perspective, and show how the concept of "attitudes" fits within and between these broader paradigms. However, despite being a core part of the social identity approach, the concept of *interactionism*—that there is a mutually constitutive and dynamically recursive relationship between the individual and the social—has had relatively little consideration and impact compared to other aspects, especially in quantitative work which has had "a continued tendency towards cognitive reductionism" (Reicher, 1997, p. 93). This is not least because conventional quantitative approaches have not provided good scaffolding for imagining or articulating how individual activity is made sensible by its location in a collective system produced by that very activity. Thus, to address the second objective, I review work bubbling up at different times and places, since at least the 70's, showing bipartite networks to conceptually capture what sociologists have called *duality*—how groups are defined by individuals that comprise them, and individuals by the groups they belong to (Breiger, 1974). The concepts of duality and interactionism are closely related.

Combining these two perspectives, both originating more than half a century ago, the Social Identity Network approach synergistically reinvigorates the concept of attitudes in social identity research: the bipartite network provides both a conceptual metaphor and a tractable mathematical model capturing how attitude expressions simultaneously produce social structure and locate individuals within it. I review a body of work systematically testing the

psychological micro-processes underpinning the network model, and demonstrating the utility of the approach for empirical analysis of attitude systems.

This will be useful at multiple levels. First, the approach takes advantage of novel methods that do justice to the original metatheoretical objectives of the social identity framework, providing end-to-end coherence between theoretical and mathematical models (cf. Fried, 2020) consistent with the metatheory of the social identity and social representations approaches. This framework will help researchers to orient research questions, data and analyses to the processes by which individuals and groups are coupled and co-constituted by attitudes. It will be particularly useful for: identifying and visualizing opinion-based groups (Bliuc et al., 2007) and locating individuals within them; identifying attitudes with particular importance for social differentiation; identifying potential faultlines that could result in future schism; or for identifying points of connection that could facilitate cohesion.

Second, a good mathematical model provides scaffolding for the imagination (cf. Olsson & Galesic, 2024) and, at this broader level, the utility of the Social Identity Network approach is to make evident the social information system of which people and attitudes are a part. The bipartite network provides an intuitive model and metaphor for understanding how systems of attitudes become compressible, and thus comprehensible, in social identity terms (Durrheim & Quayle, 2025). Thus, the network model provides a bridge between qualitative and quantitative approaches to social identity.

Metatheoretical Foundation: Attitudes as Positions in a Dynamical Socially Structured Space

To simplify the overarching objective of considering attitudes as an interface between the individual and social levels of analysis, this network approach is agnostic about intra-individual features of cognition or affect and focuses on attitudes as expressed, whether in surveys, conversations, social media or anywhere else. Here, explanation operates at a broader level of analysis, considering the function of attitudes as an interface between people and social

groups. In this perspective, expressed attitudes are simultaneously producing a social information system and locating people within it[i].

Thus, attitudes are defined in the broadest possible terms, following the general consensus that an attitude is an evaluation of a target; and that a target is a representation of anything that can be evaluated, ranging from concrete (people, objects, specific activities, etc.) to abstract (groups, ideas, etc.) (Ajzen, 2001; Albarracin & Shavitt, 2018; Bohner & Dickel, 2011; Howe & Krosnick, 2017). The word "attitude" can therefore be shorthand for a wide range of constructs including opinions, values, beliefs, and so on (cf. Bramson et al., 2016). However, like Sherif and colleagues (C. W. Sherif et al., 1965), I understand attitudes as expressive positions, or "stands" (p. 3), that people can take towards a target; that people have a range of attitudes to draw on depending on the circumstances (cf. Brown et al., 2022); and these may include logically inconsistent (Converse, 2006) or ambivalent ones (Billig, 1996).

Treating attitude expressions as *positions* is nothing new—it is a return to the etymological roots of "attitudes" in social theory. As Danziger explains:

> Technical … uses of 'attitude' first occur in discourses about art, especially visual art and the theatre…. The 'attitude' of the figure was the visible arrangement of its parts into a meaningful pattern…. Here there is no question of a causal link between an inner and an outer aspect. Rather, the 'attitude' of the figures refers to an inherent unity of inner and outer which endows certain physical appearances with expressive meaning (Danziger, 1997, pp. 134–135).

The earliest empirical studies of social attitudes in social psychology aligned with this expressive and relational definition: for Thomas and Znaniecki (1918), attitudes are coordinated in groups, and attitude expressions position individuals in relation to social structures. They argue "an attitude is a psychological process treated as primarily manifested in its reference to the social world and taken first of all in connection with some social value….. the psychological process remains always fundamentally a state of *somebody*; the attitude

remains always fundamentally an attitude toward *something"* (W. I. Thomas & Znaniecki, 1918, pp. 22–23, italics original).

It did not take long, however, for the pendulum to swing firmly towards individualism. Allport's (1924a) asocial position became dominant; that "public opinion is merely the collection of individual opinions. It has no existence except in individual minds…" (p. 396). There were dissenters, such as Sherif who argued, on the other side, that such "cultural products have a reality of their own, independent of this or that individual member of society; and this immediate reality may be verified easily by the resistance one meets when he [*sic*] deviates…" (M. Sherif, 1936, p. 58). However, these counterarguments did not have much impact, at least partly, for methodological reasons. Although even Allport admitted that "speaking in terms of collectivity is alluring" he rightly argued that "no one has [yet] succeeded in formulating a [complexity] science of this sort" (1924b, p. 688; see Durrheim & Quayle, 2025).

By the 60's, Moscovici's (1963) review of attitude research concluded that the strictly individualistic approach had been ascendant for almost half a century, but was proceeding "without defining the real questions to be solved" which, he argued, should explore attitudes in relation to society, groups and individuals; gesturing towards his new ideas for understanding them as features of social representations. At the same time, Tajfel was also grappling with the relation between individual cognition and shared representations in the form of stereotypes, which he defined as commonly shared associational structures that loosely capture "what-goes-with-what," as in, what features go with what identities, providing a socially shared associational structure that can be used to infer characteristics "as a first approximation to the 'sort of person [someone] is'" (Tajfel, 1963, p. 3). Of course, attitudes and stereotypes are closely connected, since what makes an attitude about a group a *stereotype* is the fact that it is socially shared.

In this work Tajfel, Moscovici and others, were setting the foundation for a

reinvigorated social psychology oriented to understanding the complex dynamic relationship between the individual and the social (Elcheroth et al., 2011). While Moscovici worked from the outside in, focusing on the processes of *social representation,* which he described as "a bridge between the individual and the social worlds" (Moscovici, 1988, p. 219), Tajfel worked from the inside out, focusing on processes of *social identity* by which individuals psychologically locate themselves and each-other in relation to collective structures and information (of which social representations such as stereotypes and categories are types). Tajfel describes his own and Moscovici's project jointly as:

> …present[ing] an argument for the transformation of what is being done at present into a genuine *social* psychology which would have as its basis the idea that [people] and society have a reciprocal effect upon the mode of existence and behaviour of each other; thus … call[ing] for the rejection of concepts implying a one-way causation, whatever direction the causation is presumed to take (Tajfel, 1972, p. 5, italics original)

Later, Tajfel and others (Reynolds et al., 2010; Tajfel, 1979; Turner & Oakes, 1986) articulated this more clearly as an *interactionist*[ii] metatheoretical perspective—one "in which social behaviour would be seen as a 'dynamic interaction' between psychological processes and the nature of the social systems inside which this behaviour takes place" (Tajfel, 1979, p. 183). The "dynamic interaction" here is between levels in the system, with individuals' experience being shaped by their position in symbolic social structure and, simultaneously, social structure being dynamically and collectively produced by individuals' attitudes and behaviour—"we must see group phenomena as both *the product and condition* of actions of individuals" (Asch, 1952, p. 251). As Tajfel (1979) put it:

> An 'individualistic' theory contains the (most often) unstated assumption that individuals live and behave in a homogeneous social medium. This medium consists of a collection of undifferentiated individual particles which are assumed to relate to each other inter-individually following the laws of 'basic' psychological processes.

> There is no room in this vision of randomly floating particles for the cognitive and socially shared organization of the system within which the particles float.…. this kind of approach …. will get us no nearer to an adequate social psychology of social conflict, social stability, social change, social movements or social unrest" (p. 187).

Instead, the interactionist perspective holds that social-psychological activity of individuals is coupled and creates a "social field" (Asch, 1952, p. 251; Moscovici, 1953, p. 424; Turner & Oakes, 1986, p. 239) in which each individual is uniquely positioned[iii]. This would be something like a magnetic field, where each component contributes to producing, and is simultaneously influenced by, the system.

Despite the explicit orientation of the social identity approach to interactionism, it was difficult—even at the start—to keep the focus from returning constantly towards individualism in theory and practice. Turner and Oakes (1986) noted that, despite its anti-individualistic aspirations to capture how "individual psychology and society are irreducible emergent properties of each other" (p. 240), research in the social identity tradition seemed to be making little concrete progress in "uncovering of the processes of reciprocal interaction" (p. 240) between the individual and the social. "What seems lacking," they argued, "is cumulative theoretical progress in the specification of the precise mechanisms of social-psychological interaction and emergence—theories that would demonstrate empirically and explain conceptually the concrete features of functional interaction" (*ibid.*, p. 240). Put simply, the social identity approach had the ambition, but lacked models and methods, to quantitatively capture the complex interplay between psychology and symbolic social structure.

Similarly, despite Moscovici's stated intention to study social representations as "a network of concepts and images tied together in various ways according to the interconnections between the persons and media that serve to establish communication" (Moscovici, 1988, p. 222), in general practice, the individuals in the system were overlooked since, by "de-emphasizing each person's distinctive features and internal details, we can bring out the social

characteristics of the total operation" (Moscovici, 1988, p. 220). The main interest was the overall collective symbolic structure rather than individuals' positions within it.

In this way, these two intellectual traditions became the trouser legs of European social psychology, connected at the waist but leading in different directions. *Attitudes* did not fit neatly into either leg, and have not commonly been considered in either tradition[iv]. On the one side, shared attitudes might be described as elements of social representation (Breakwell, 1993; Deaux & Philogène, 2001; Liu & László, 2007; Moscovici, 1963). However, on the other side, attitudes and social representations are usually seen to show "such striking divergences to suggest that a comparison between them is a category mistake…. The former foregrounds individual cognition, while the latter social knowledge" (Gaskell, 2001).

Nevertheless, there have been several calls to synthesize the relations between attitudes and society, for example, from the side of Social Representations, Gaskell (ibid.), goes on to argue that individual attitudes and social representations are related in a figure-ground relationship, each constituting the other. Jaspars and Fraser (1984) argue that attitudes are how social representations find anchor in individuals. From the side of the social identity approach, Smith and Hogg argue that attitudes link individuals to collective symbolic structures (Hogg & Smith, 2007; J. R. Smith & Hogg, 2008). Thus, a reconfigured concept of attitudes might bridge social identity and social representations. However, Howarth concludes that "to date there are no recognized examples of work in the field of 'attitudes' that incorporates the interactive and mutually constitutive relationship between what we understand as the 'individual' and the 'social' that is central to the theory of social representations" (Howarth, 2006, p. 700). Moscovici argues that such an approach would require a "definition of attitudes as (1) socially shared, (2) endowed with a content, and (3) forming a system" (Moscovici, 1988, p. 226). Fortunately, models capable of conceptualising individuals and symbolic social structures as an integrated complex were already in progress.

At around the same time that the social identity and social representations approaches

were being developed (primarily) in Europe, a small group of North American sociologists were tackling similar problems with new methods for describing social structure. In particular, Breiger was developing a bipartite model capturing the "duality of persons and groups" (1974, p. 181), whereby people's identities are defined by their group memberships, and groups are simultaneously and reciprocally defined by the people who form them. This dualistic approach conceives of both individuals and groups as being reciprocally defined by their position in a social field, and thus captures the emergent nature of the social-psychological complex. This provides a conceptual and methodological framework capturing emergent structures at the interface of the psychological and the social in ways consistent with both the social identity and social representations approaches. In the present paper, I describe a network approach to attitudes closely aligned with Breiger's, employing ideas that have been independently proposed by several groups (including: Betz et al., 2018; Breiger et al., 2014; Fuhse et al., 2020; Leifeld, 2020; Moliner, 2023; Quayle, 2017, 2020; Rizzoli et al., 2024).

In the next sections, I synthesize theory from qualitative social science (ethnomethodology; discursive psychology; social constructionism) and network science to define *attitudes* in terms consistent with the social identity and social representation approaches, particularly arguing that attitude expressions have social functions of positioning, social bonding, and group differentiation. I then introduce the Social Identity Network approach and discuss how it is useful. I explain how it provides an operational metaphor for understanding attitudes as an interface, or coupling-point, between individual and social levels and visualizing how attitudes collectively produce a *social field* (Duveen, 2001; Moscovici, 1953; Tajfel, 1979) or *social space* (Clémence, 2001). Loosely following Tajfel (1969)[v], I will refer to this as a *social information system* (Durrheim & Quayle, 2025), in which groups emerge at the collective level and individuals are located within them by the specific combinations of attitudes they express. Then, I review a body of work empirically validating the approach and showing its utility. While noting that there are many possible ways to tackle

these broad metatheoretical objectives, and that that various models from cluster analysis to large language models are capturing aspects of the social information system, I argue that the bipartite network approach has the key advantage of capturing the dynamic-recursive co-constitution of the individual and social (i.e., what social identity theorists called *interactionism,* or sociologists called *duality*) by design, rather than merely by assumption or inference. Modelling similarities as dyadic ties—while computationally expensive—allows individuals to be located in social systems much more precisely than other approaches.

The Social Functions of Attitudes

The first step in developing this perspective is to realize the social functions of attitude expressions in accountable social conduct (Durrheim, 2012). This will make it clearer how attitudes provide a coupling point between individuals and social systems.

Attitude Expressions Are Socially Functional and Contextually Sensitive

Individualistic approaches usually treat attitudes as relatively stable internal representations of some reality. In contrast, the social constructionist perspective on attitudes shifts attention from intra- to inter- individual processes, holding that attitudes are best understood as symbolic resources deployed as people interact (Potter, 1998). This means that attitude expressions are *socially functional* as well as *informational*: they act on the world as much as they describe it (Searle, 1995). As Potter (1998) put it: "attitudes are *performed* rather than *preformed*" (p.246). In other words, an important thing about attitudes is what they achieve when they are expressed. Although a variety of performative outcomes of attitude expression have been described (e.g., Durrheim et al., 2016; Edwards & Potter, 1992; Hogg & Reid, 2006; Potter, 1998), here I will focus on three key functions related to attitude-identity dynamics (Lüders, Quayle, et al., 2024): affiliation, social identity production, and social positioning.

Agreement and Disagreement on Attitudes Produces Affiliation and Disaffiliation

The interactive process of agreement is affiliative (Potter, 1998), in other words,

socially bonding (e.g., Schafer, 2018). This is such a fundamental social mechanism that infants can apparently infer social affiliation from observing agreement on attitudes from at least nine months of age (Liberman et al., 2014). The preference for agreement in ordinary amicable relationships is so normative in most contexts that failure to agree is remarkable; and something for which interlocutors are held to account (Sacks, 1987)[vi].

Of course, there are attitudes people can usually disagree on with little risk, such as matters of taste (Spears et al., 2009), but other topics where disagreement can undermine relationships (e.g., Kobayashi & Tse, 2022) or even end them in estrangement (e.g., Facciani & McKay, 2022). While minor disagreements can be fun (Walkinshaw, 2015), people often keep risky attitudes to themselves to avoid conflict (Cowan & Baldassarri, 2018). In one study, about an eighth of Americans reported having lost friends over disagreements on religion or politics (Gerber et al., 2013). In most contexts, direct disagreement is so profoundly disaffiliative that people usually have to carefully manage it (Conroy, 1999; Pomerantz, 1984). Put simply, interpersonal relations require common ground; and agreement on attitudes is an important way of finding it (Erickson, 1988).

Attitudes Produce Social Identity and Contribute to Group Differentiation

"Opinions and beliefs … function as world-making things" (Elcheroth et al., 2011, p. 746). As Sherif noted already in 1936, attitudes are important markers of collective social identity, and are deployed by people to map out the boundaries of "us" and "them" (Klein et al., 2003, 2007; M. Sherif, 1936). People in a group must coordinate at least some attitudes to produce shared identity; and new identities can emerge based on shared opinions (Bliuc et al., 2007). Producing group differentiation requires people to agree more with ingroup members than outgroup members (at least on core attitudes) (Turner et al., 1987). Group structure is thus inevitably written-in to systems of attitudes; and attitude expressions can be read in identity terms: "before it becomes thematized as a struggle for the individual, an identity is first a social location, a space made available within the representational structures of the social world. It is

this which gives categorizations their power" (Duveen, 2001, p. 268). Groups that cannot coordinate their collective attitudes struggle to establish a strong group identity, lack a basis for collective decision-making, and therefore lack collective agency (Reicher & Haslam, 2006a). Groups can become powerful when they achieve (or maintain) agreement on core attitudes (Bliuc et al., 2007); or otherwise dissolve or schism when they fail to do so (Sani, 2008).

This has profound implications for attitude theory, because attitudes do not exclusively "belong" to individuals but are also properties of groups; and if I am to belong authentically to a group then I am obliged to share at least some core attitudes with other group members (Erickson, 1988; Hogg & Reid, 2006). Conversely, when I express group-relevant attitudes I position myself in the identity-imbued attitude space in recognizable ways.

Social Positioning: Attitude Expressions Tell Other People Who We Are

If attitudes are collective properties of groups, then attitude expressions are shibboleths of identity—socially recognizable indicators that someone belongs to a group and shares a common identity (or not) (Klein et al., 2007; Prost et al., 2023). Even *failure* to express an attitude or enact a norm important to group identity provides identity-revealing information (Moscovici, 1953, p. 426) and singles-out individuals as lacking commitment to collective values (Hogg & Abrams, 2001). Klein and colleagues refer to these socially strategic functions of attitude expression as *social identity performance* (Klein et al., 2007). This approach treats attitudes (1) as *collective properties of groups* and (2) as *socially functional* (since holding and expressing them is an important way of producing and managing social identity).

Since attitudes are woven in to group identities, when we express them we are giving others information by which they can categorize us and make inferences about what kind of person we are (Hogg & Smith, 2007). As Moscovici put it, attitudes express a "relationship between social subject and social stimulus" (Moscovici, 1963, p. 244) and shared knowledge of these social regularities make them readable in identity terms (Elcheroth et al., 2011). The sharing of core attitudes thus allows group members to recognize each-other whilst

differentiating themselves from other groups (Prost et al., 2023); expressing an attitude in an identity-laden social information system is thus an act of *social positioning* (Clémence, 2001; Duveen, 2001; Elejabarrieta, 1994; Staerklé et al., 2011). Everett's (2013) conservatism scale provides a good example: if an American expresses an attitude to gun control they are unavoidably providing information about the political group they might belong to (and this, obviously, is the logic of the scale).

Even when participating in academic research, and trying hard to provide clear and direct information about their cognitions, people are sensitive to how their attitude expressions may be read by others in a context. This is evidenced by the large body of research on socially desirable responding and impression management in attitude research (Crowne & Marlowe, 1960). Reframed as social positioning, social desirability can be understood as people expressing attitudes to produce *situated identity* (Alexander & Lauderdale, 1977), revealing a key social-psychological *function* of attitudes rather than being a measurement artifact. This is the argument of discursive approaches to attitude research (Potter, 1998; Wiggins, 2016). But even expressing an innocuous attitude provides a basis for people to 'get to know each-other.' This is clear in dating profiles, which are often a mix of personal information (e.g., gender; age; height; eye-colour, etc.) and attitudes. For example, this is how Eli (24M) presents himself in his dating website bio:

> Eli, 24.
>
> Sunday fundays > lazy Sundays.
>
> Skiing > snowboarding.
>
> Electric guitar < acoustic guitar (but I play both)
>
> Peanut butter > jelly (Though, they still go together pretty well. Maybe we will too.)
>
> (Murray, 2018).

Only a few attitudes are expressed in this profile, and yet they provide an enormous amount of identity information to potential partners because each expressed attitude links into

larger symbolic networks by which we make sense of people (Hogg & Smith, 2007). I would guess that *reading* would be low on Eli's list of hobbies because it would not fit well with the other attitudes expressed. Of course, Eli might choose to reveal one set of attitudes in a dating context and a different set in a job interview, given their strategic relevance.

In summary, when we express attitudes, we are achieving at least three practical social outcomes: we are producing links of affiliation with those who share our attitudes; we are producing dimensions for group differentiation; and we are positioning ourselves in the social information system in ways readable to others who are familiar with it (Lüders, Carpentras, et al., 2024). These outcomes are achieved concurrently, as attitude expressions simultaneously produce and reinforce our collective social information system, position us within it, and establish (or erode) bonds with those we agree or disagree with. Because attitudes are connected to each-other via networks of associations, and because they are woven-in to group identities, if I express an attitude I am giving you information about my group identities; and conversely if you learn my group identities you have a basis to infer my attitudes. Attitudes therefore produce a distributed social identity information system; and expressing an attitude both positions the speaker in this system and contributes to its creation. Understanding these relational features of attitudes requires theories and methods in which they can be represented. This system has two types of entity, people and attitudes, and to conceptualize it I turn to the bipartite network.

Bipartite Networks to Model Attitudes as Coupling-Points

A bipartite network is a special case with two types of nodes, where each node-type connects only to the other type (McGee et al., 2019)[vii]. This structure is most familiar from co-authorship network analysis, where the nodes are authors and papers, and a link between authors is inferred from their joint authorship on a paper (e.g., Quayle et al., 2020)[viii]. In a bipartite social identity network, the nodes are *people* and *attitudes*, with an edge reflecting that a given person has expressed a given attitude[ix]. This solution to representing attitudes and

identity has been bubbling up across the social sciences in different places and disciplines for at least forty years already. Indeed, all the ingredients for a bipartite network theory of attitudes were present in Wellman and Berkowitz's (1988) edited volume on *Structural Analysis,* described by the authors as a paradigm shift in the social sciences analysing relations between components in a system and, like contemporary social identity theorists, critiquing the "atomization of reductionism (p. ii)"

Republished in Wellman and Berkowitz's (1988) collection was Breiger's (1974) brief paper *The Duality of Persons and Groups.* This was, as far as I am aware, the first clear specification of a bipartite approach to understanding people-in-groups and groups-in-people[x]. In this conception, groups are understood in relation to the people who comprise them; and people are understood in relation to the groups they belong to. People and groups form a single social complex, in which each level defines the other. The levels reciprocally—mutually—constitute each-other (Mützel & Breiger, 2021).

Breiger's (1974) model was not yet considering attitudes as a component of group structure. However, the chapter immediately following in Wellman and Berkowitz's (1988) volume was Bonnie Erickson's (1988) *The Relational Basis of Attitudes* where she argues that attitudes—routinely conceptualized as atomized properties of individuals—are best thought of as properties of groups. Erickson's argument has two key axioms: "(a) the natural units of analysis for attitudes are not isolated individuals but social networks and (b) viable subjects for explanation are not individual attitudes, but degrees of attitude agreement among individuals" (p. 99). Thus, the key organizing principle of the social structure of attitudes is homophily: people in relationships and groups synchronize their attitudes roughly in proportion to the closeness of their relationship and frequency of interaction; and groups become characterised by overlaps in agreement (cf. McPherson & Smith, 2019). Conversely, complex social networks can be divided into meaningful subunits characterised by overlaps in attitude agreement. Erickson notes that "that such attitudinal agreement does not depend on direct ties

nor on direct social comparison between the structurally equivalent people themselves," but can emerge via diffuse processes of social comparison.

Breiger's insight (that people and groups can be parsimoniously modelled as bipartite networks) combined with Erickson's (that similarities in attitudes are a fundamental social bond) leads naturally to the idea of modelling bipartite networks of people holding attitudes to capture emergent group structure. These two papers nestled side-by-side in this obscure 1988 volume, therefore, provided the ingredients for a bipartite network model of attitudes. However, there was a reason that this synergistic leap was not obvious at the time—the structural analysis approach was explicitly trying to move away from "explanations stressing the causal primacy of abstract concepts such as ideas, values" and, presumably, attitudes (Granovetter's preface to Wellman & Berkowitz, 1988, p. ii). Treating attitudes as nodes in a network, and edges as people holding them, would have been antithetical to the paradigm in which these papers were located.

However, in the following years it became increasingly clear in this line of sociology that social structure has symbolic as well as material components. As Breiger argued later, "the material world (the world of action) and the cultural world (the world of symbols) interpenetrate, and are built up through the immediate association of each with the other" (Breiger, 2000, p. 92). Pachucki and Breiger (2010) took this further, critiquing "empirical analysis over the past several decades [that] has tended to treat social networks and culture as discrete realms rather than together" (p. 219). By 2014, Breiger and colleagues were representing people and attitudes as bipartite networks (Breiger et al., 2014). In the present paper, I integrate this idea with the social identity approach and demonstrate that this simple mathematical model provides a useful framework for conceptualizing the social identity functions of attitudes in *social identity networks*.

The Social Identity Network Approach

So far, I have discussed that: (1) attitudes are linked together in meaningful networks;

(2) these collective symbolic structures are characteristic of group identities; (3) attitude expressions are functional, locating individuals' positions in relation to these collective symbolic structures *while also producing those structures*; and (4) bipartite networks are an obvious model for describing *people* holding *attitudes* (figure 1). Although the bipartite network structure only allows explicit links between node types, people are implicitly connected via the attitudes they jointly hold, and attitudes by the people who jointly hold them. Specifically, people become implicitly linked to each-other when they share an attitude; and attitudes are implicitly linked when shared by the same person or people. The implicit links between people or between attitudes can be visualized in *one-mode projections* for each node-type (M. G. Everett & Borgatti, 2013). The dotted lines in figure 1 are the simplest possible one-mode projections of a bipartite network, with one projection showing homophily between pairs of agents (figure 1A) and, the other, symbolic associations between attitudes (figure 1B). Figure 2 shows how people holding attitudes produce a social information system simultaneously linking people into groups and attitudes into clusters.

FIGURES 1, 2 AND 3 ABOUT HERE

This bipartite network structure has several advantages for modelling attitudes. Like the belief systems approach (Boutyline & Vaisey, 2017; Brandt et al., 2019), the symbolic layer of the network captures the conceptual links between attitudes. But, additionally, the agent layer simultaneously captures how people are linked together in groups (or differentiated) by virtue of the attitudes they hold (Breiger, 1974; Breiger et al., 2014; Erickson, 1988).

Network models are well suited to analysing adaptive systems, representing opinion-based group processes as dynamic and emergent. Figure 3 displays a subset of the network from Figure 2. Note how removing the edge marked *Z* (bold and red in figure 3A) has a disproportionate effect on the global network structure, causing schisms in both the people and

attitude layers of the network (shown in figure 3B). This offers a tantalizing glimpse of how modelling attitudes with this structure might explain how certain people and certain attitudes are particularly influential in group and opinion dynamics.

FIGURES 4, 5, 6 AND 7 ABOUT HERE

While this multilayer structure holistically models group-relevant opinion clusters (in the attitude layer) and attitude based groups (in the person layer), it will usually be practical to make sense of the bipartite network structure with separate projections, where edges in each projection represent dyadic homophily via the other layer. For example, in the projection of the agent layer, the more attitudes two people hold in common, the stronger the edge between them; and if they hold identical sets of opinions they have the strongest possible edge, essentially inhabiting identical positions. Similarly, projecting the symbolic layer, each dyad of attitudes will have an edge strength relative to the proportion of people who express both. Put differently, a strong edge between two nodes indicates high redundancy of information and thus represents compressibility (i.e., that the two nodes carry the same information).

Since the resulting networks are fully connected, with an edge of some strength between every possible dyad, it usually makes sense to apply a threshold to retain only stronger edges to best describe the social structure of the attitude system. An example agent layer projection with toy data is shown in figure 4 where a clear group-based network structure can be observed across ten bimodal simulated measures.

Note that, while the vector of attitudes expressed by each person provides a set of coordinates in a multidimensional attitude space, the structure of the network depends on chains of homophily between dyads of people. Just as a path through a maze is longer than the straight-line distance between points (figure 5), the network distance between two distal people can be greater than direct distance metrics such as Euclidian. A more complex example is

displayed in figure 6, where ten simulated measures have no obvious structure at the unidimensional level, but a complex chain of differentiable groups is woven across multiple dimensions. A structure of this intricacy is perhaps unlikely in real social systems, but it illustrates the capability of the method to identify group structures woven across dimensions by homophily between dyads. Figure 7 provides a more realistic simulated example of multiple groups differentiated in an attitude space, demonstrating the utility of the approach for modelling multipartisan systems.

FIGURE 8 ABOUT HERE

Moving from simulated examples to an empirical one, Figure 8 displays a longitudinal mapping of UK health attitudes at three time points at the start of the COVID pandemic in the UK in 2020. The specific attitudes underlying these representations are not important here, and full details are available in Maher et al. (2020) for the interested reader; however, note how this network approach shows (a) how people are individually located within a social information system by their specific combinations of expressed attitudes. Given that two people are connected by an edge only if they expressed very similar attitudes, it shows (b) how social structure emerges from associations in responses across variables; and (c) that, while group structures require between-group differences, they can still contain substantial within-group variability. Observing the system over time shows (d) that the extent to which group identity is written-in to, and thus readable from, any specific combination of expressed attitudes changes dynamically in relation to system dynamics, as people re-orient their attitude expressions to the emerging identity-loading of various positions in the social information system. These figures demonstrate the value of the approach for data visualization, but I argue that its core value is theoretical, in providing conceptual scaffolding for imagining people and attitudes in an integrated, co-constitutive social information system in which—simultaneously, and by the

same activities—groups are produced and individuals positioned within them.

A Concise Statement of the Framework

The Social Identity Network approach is more than a different method for making sense of a matrix, merely replacing linear models with network ones—rather, I propose that the bipartite network is useful because it models people and attitudes as a co-constitutive symbolic social structure consistent with the metatheoretical perspective of the social identity and social representations approaches described in the opening section. The Social Identity Network approach provides a framework for understanding how attitudes create a social field in which people are positioned, groups are differentiated, and social identity is produced. This depends on several theoretical commitments discussed above, which I will summarize here.

(1) Attitudes are expressed in social interaction, and these expressions are sensitive to (potential) audiences even if none are present. This is true even when people are participating in academic research, and even when responding to carefully designed measures or surveys. So, although people may have attitudinal repertoires containing a range of attitudes that they might express in different situations, via different media, or to different people (Joseph et al., 2021), these potential attitudes only become socially impactful when visible to others as accountable social conduct (Durrheim, 2012). This terminology distinguishes between attitudes in people's possible repertoires (like cards in a hand) and attitudes actually *expressed* in a given situation (like cards played). The likelihood of someone expressing an attitude depends on the "rules of the game" at a given moment; these are different across contexts and can change over time (Zaller & Feldman, 1992), and—crucially—are embedded in social structure. For example, someone might openly express an attitude about other racial groups at an ingroup braai (barbeque) that they would never express at work (Verwey & Quayle, 2012).

(2) Expressed attitudes are socially functional because they position the speaker in relation both to other people within the context and more abstract features like group identities and social issues that are (or may become) relevant in the context. When we express attitudes

(or agree or disagree with those expressed by others) we inescapably tell people who we are, what groups we might belong to, and what to think of us.

(3) Links between actors are forged via agreement and disagreement over attitudes, where agreement is affiliative, and disagreement is disaffiliative[xi]. In this way, interactions forge a network structure that simultaneously binds people into groups (via attitudes) and attitudes into clusters (via people who share them). In other words, attitude agreements and disagreements form a bipartite network, where people are connected or differentiated by their attitudes. This does not presume that people have met, interacted or observed each-other, but rather, that if they did, they would share common ground—affiliation in potential.

(4) The network interlock between people and expressed attitudes creates a socio-symbolic structure that is a psychological basis for perceived ingroup similarity and outgroup difference and, more abstractly, group identity. Attitude-based groups and group-related attitudes are therefore co-emergent dynamic phenomena, with ingroup similarity and outgroup contrast resulting in perceptions of 'groupiness.' Since this is a *network* structure, expressing a particular attitude links a person to its direct and indirect neighbours as well. In other words, people are positioned via homophily links in the network. The same is true of attitudes.

Group differentiation is not accidental: it is by *acting and responding* as a group member that you demonstrate that you *are* a group member. People actively categorize and differentiate groups in the social terrain (Klein et al., 2007), and strategically express attitudes to construct group identity and manage their own positions within the groups produced (Klein et al., 2007; Reicher, 2004). Thus, there is a dynamic feedback process where associated structure that emerges in the attitude-identity space can be amplified as people opportunistically deploy those attitudes to perform identity.

(5) I suggest the intentionally paradoxical phrase *dynamic fixing* to describe how social information systems can stabilize to associate specific configurations of attitudes with specific social identities via socially accountable networks of agreement and disagreement; but also

how these associations can unravel, allowing rapid reconfigurations of groups and attitudes. These social configurations typically have a phenomenological sense of solidity for people within them and yet can change dramatically, even over short timeframes. The network structure is sustained through interaction and therefore constantly produced and reproduced (Durrheim & Quayle, 2025). As it is reproduced it can be remade. People are socially strategic and opportunistic and can be very creative in refashioning old attitudes for new purposes, shifting the meaning of attitudes and beliefs, or sometimes creating new attitudes altogether. These reconfigurations in the network are like threads weaving between different parts of a larger fabric; new threads can draw different parts together; and snipping threads can disconnect them.

This model can explain how shifts in collective attitudes can occur even with little underlying individual attitude change, since the "stuff" constructing collective attitude systems are attitude expressions (cards played), not the full underlying attitude repertoires available to individuals (the cards in our hand). In other words, the theory provides a way of understanding how attitude change can propagate rapidly through networks (and the limits of such propagation)—even if few individuals are aware of any great personal conversion—since the changing system state may be dynamically validating or "fixing" attitudes already available within individuals' repertoires rather than (or as well as) actually changing those repertoires. An obvious example would be how the norm against overtly expressing racism rapidly rolled-back following Donald Trump's election as US president in 2016 (Crandall et al., 2018; Giani & Méon, 2021).

Before considering the advantages of the approach, it is worth stepping back and noting that it is a theoretical framework and model, not an objective fact: there will be many ways of mathematically describing a social field of people holding attitudes, and each will inevitably make assumptions and have limitations. For example, a cluster analysis can identify similar group-level features to network cluster-detection on the bipartite network (Dinkelberg,

O'Sullivan, et al., 2021). Machine learning or large language models can do the same (e.g., Schuld et al., 2023). However, the framework proposed here fits into a tradition of work developing quantitative methods for describing social representations (e.g., Clemence et al., 1993) and social identity embedded in collective language activity (e.g., Schuld et al., 2023) and is a way of methodologically operationalizing the metatheory of the social identity and social representations approaches described above. With that proviso, I will now describe some advantages of the approach.

How this Framework Helps: Applications and Advantages

The key advantage of the bipartite network model as a representation of a social field, is its duality (Breiger, 1974)—it natively treats the people and their attitudes as different components of the same social fabric, and therefore helps to conceptualise interactionism in social identity systems as part of the conceptual model rather than a *post-hoc* conceptual add-on. Modelling features as both individual and collective—simultaneously and co-constitutively—will get closer to understanding attitudes as social coupling points, explaining how individual and collective group attitudes are structurally inter-related. Just as "paired data" provided a conceptual basis for the empirical method of correlation to show how variables are associated *within* units of analysis, the bipartite network provides a conceptual basis and empirical method for making sense of the duality of relations *between* people and constructs like attitudes, opinions, beliefs, values, identities and so on (Breiger, 1974; Breiger et al., 2014). In other words, it provides a conceptual frame and quantitative basis for modelling how people connect and differentiate themselves via their attitudes, exposing synchronization processes in the collective production of social identity. Of course, this model could easily show how people do the same with behaviours, interests, values, beliefs or anything else that can be coded as a node in a network, but the focus of the approach presently is on attitudes, given their special role as coupling-points between the individual and social. Next, I will suggest several features of the framework that will be particularly useful in attitude research.

Ease of Quantitative Representation and Modelling

Conveniently, bipartite networks map quite naturally to the data structure of case-by-variable datasets such as surveys (Breiger, 1974; Breiger et al., 2014), and can easily be derived from social media data. The simple homophily-based social structure is very amenable to computational modelling. For example, Axelrod's (1997) agent-based model of diffusion of culture has the same bipartite basis (MacCarron, Maher, Fennell, et al., 2020).

The emphasis on attitudes-as-expressed in the Social Identity Network approach also minimizes the assumptions that need to be made about the nature of beliefs and attitudes in analysis. Particularly, it is agnostic to whether attitude expressions map to any kind of internal cognitive representation. This has many benefits, but particularly simplifies statistical modelling, since only attitude *expressions* are modelled (which are empirically directly available) not *internal representations* (which need to be inferred).

Determined, but Non-deterministic: a Structural and Dynamical Approach

Because network methods are explicitly designed to model *structured dynamical systems* they do not assume that variables combine additively or scale linearly (Wiese et al., 2010). Instead, attitudes are meaningful in combination; and some combinations have disproportionate identity effects (Breiger et al., 2014; Iannucci et al., 2025). For example, as displayed in figure 8, social identity reconfigurations in the UK at the start of the COVID-19 pandemic were driven by divergence in attitudes towards science and scientists; and shifts in these attitudes had a greater effect on the overall social structure than could be detected by linear models (Maher et al., 2020).

Networks, as complex systems, are subject to non-linear dynamics like cascades where small changes can propagate to produce dramatic system-level changes. Sudden phase transitions can occur, where relatively minor changes under certain conditions can result in disproportionate system dynamics. Therefore, this approach can potentially describe and explain how group processes (e.g., political systems) may have long periods of apparent

stability followed by sudden changes and dramatic reconfigurations (Chen et al., 2024).

However, while these processes are determined—in that they are constrained by the mechanisms of their production and the structure of the systems in which they occur—they are not *deterministic* in the sense that they have predictable outcomes. Rather, a given starting state in a given social system can facilitate a variety of trajectories, and some are more likely than others (Dinkelberg et al., 2023; Durrheim & Quayle, 2025; Liu & László, 2007; Van Der Maas, 2024), but the actually realized outcomes depend on the agency and social creativity of its participants and the way the process plays out (Fennell et al., 2023; Garcia et al., 2024; Reicher & Haslam, 2006a; Titlestad et al., 2019).

Bringing Agency, Contextuality and Interactionism into View

As explained above, this framework is thoroughly *interactionist* (Haslam et al., 2012; Reynolds et al., 2010; Subašić et al., 2012). It provides conceptual scaffolding for thinking about systems of people and attitudes where people's attitude expressions are given meaning by their position in a social field; but where those expressions simultaneously produce it (Tajfel, 1979; Turner & Oakes, 1986). This dynamical social field makes many (but not all) attitudes and related behaviours *identity-laden* since they become readable in identity-terms. Note that the identity-relevance of an attitude is a feature *of the structured social information system*; and it is because of the structure in the system that people can position themselves (and others) by attitude expressions. Attitude expressions are therefore dually functional: they position the speaker within the identity system as the same time as contributing to its production (Klein et al., 2007; Klein & Azzi, 2001).

These outcomes are not (only) accidental: people are strategic and agentic in producing and deploying attitudes. The framework therefore brings focus to *identity entrepreneurship*, that is, how people try to manage social identities to achieve social outcomes (Klein et al., 2007; Reicher et al., 2005). For example, leaders may manage the context of the interaction to bring preferred identities into focus; or strategically express attitude agreements and

disagreements to differentiate groups in preferred ways. Methodologically, network representations of attitudes could be analysed alongside discourse (e.g., political speeches) to explore how leaders strategically exploit patterns in the network to produce identity coalitions or schisms (cf. Klein & Licata, 2003). There are also methods available to code discourse as networks directly (Fisher et al., 2013; Leifeld, 2013/2024).

The ability to clearly visualize individuals' positions in broader social systems potentially captures how power operates at the interface of individual activity and social structure: for example, how someone who *should* have power such as an elected politician may be stripped of it when the attitude-identity system shifts in ways that repositions them to undermine their agenda; or how "little people" can have disproportionate influence on social processes if the system positions them just right in a viral process, such as when fifteen-year old Greta Thunberg started protesting alone on the steps of the Swedish Parliament and documenting it on social media, sparking the global #fridaysforfuture movement (Fridays for Future, 2024). The approach provides a methodological and theoretical frame for visualizing how "all members of a group, from the highest to the lowest, play a part in determining what the group stands for and the type of world it seeks to create" (Reicher & Haslam, 2006b, p. 150).

Attitudes Will Not Be Changed by Rational Argument Alone

The Social Identity Network approach holds that the primary "glue" binding attitudes together into Social Identity Networks is socially coordinated agreement (Erickson, 1988). Other constraints may additionally be imposed by specific groups, for example, when scientists expect logical consistency between attitudes; or religious groups expect beliefs to have doctrinal or scriptural validity. However, these group-specific constraints are themselves incorporated into group identity by social agreement. Therefore, as demonstrated in the belief systems approach (Converse, 2006; Warncke, 2025), logical consistency is not necessary for attitudes to be jointly held. This is consistent with qualitative work showing the ease of holding

logically inconsistent or ambivalent attitudes (Billig, 1996). For example, US liberals are more likely than conservatives to have confidence both in science and New Age spiritualism (DellaPosta et al., 2015). Or, to give an example closer to home: I personally am well aware of the replication crisis and yet also have high trust in science. The Social Identity Network approach helps to explain why attitudes cannot easily be changed by rational argument alone, unless such arguments are consistent with the group-based identity structure encoded in the network (Carpentras, Lüders, et al., 2022). The framework will thus be particularly useful for understanding cultural phenomena like climate denial, conspiracy theories, mistrust in vaccines, and so on.

Attitude Change Is Identity Change: Dynamic Fixing and Conversion Pathways

If attitudes are important ways to establish individual and group identity, then convincing people to change their attitudes (e.g., in health behaviour outreach) is an identity intervention; and some attitudes are more central to identity than others. Attitudes become appropriate or inappropriate for individuals because of the way they link into a dynamic, constantly evolving, attitude-based identity ecosystem (cf. Festinger et al., 1950).

Thus, the identity-relevance of an attitude in the groupscape might be a particularly potent form of attitude strength. This strength derives from the symbolic relationship of attitudes to each-other (Brandt et al., 2019), but also how holding particular attitudes positions individuals within collective identity structures (Hogg & Smith, 2007; J. R. Smith & Hogg, 2008; Warncke, 2025). For this reason, the identity-relevance of a given attitude may depend on an individual's current position in the social identity network.

Looking at the attitude layer, the model provides a framework for identifying attitudes that, at the macro level, are more amenable to social influence based on their position in the network (Chen et al., 2024; Dinkelberg et al., 2023). Attitudes differ in the extent to which they are "locked in" to the intergroup structure in the social identity network. This reveals attitudes (and attitude combinations) that are most important for social cohesion or social change. The

approach thus provides a framework for understanding the limits of dynamic identity-related attitude propagation, for example, in “bot”-driven computational propaganda (Howard et al., 2018) or deepfake misinformation (Ching et al., 2025), since attitudes will not be easily adopted or expressed if they are inconsistent with one’s existing position in the social identity system.

Note that, when an individual expresses agreement or disagreement on a new attitude, they reposition themselves in relation to others in the system. This new local context provides the basis for the next attitude expression, changing how further agreements or disagreements will position them, and so on. A conversion pathway would be any possible sequence of agreements (or disagreements) that shift a person from one position in the identity space to another. Some pathways will be more attractive or likely than others, if they follow sequences of attitude positions commonly inhabited by other people (Maher et al., 2023; Wiley & Martin, 1999).With the Social Identity Network approach, these *conversion pathways* can be mapped in an attitude system, for example, in understanding radicalization/deradicalization processes, climate-change denial, or vaccine hesitancy.

The approach suggests that trying to influence people along high-resistance conversion pathways will have less chance of success. Importantly, conversion pathways are personalized relative to each person’s current location in the system, explaining why campaigns optimized for one group might backfire for another. Counter-intuitively, the optimal conversion pathways might sometimes be via peripheral attitudes. This also provides a structural framework for understanding how some attitudes can be gateways or rabbit-holes, for example to conspiracy theories, since adopting a gateway position would make various previously unattractive positions viable.

However, it is not just an individual’s own attitudes that position them: it is the relation of those attitudes to the attitudes of others; and the system is responsive to the attitude changes of all its constituents. Thus, our *social position* can change, even if our *attitudes* stay the same,

if the system changes around us. For example, people who continue to hold attitudes long after they have ceased to be prototypical can become marooned, and even start to be perceived as outgroup members, as the attitude ecosystem shifts around them—like an older man yelling "get off my lawn" while his younger neighbours tend their wildflower meadows.

Limits of Identity-Related Attitude Propagation

Although social identity systems can undergo rapid change and readjustment when dynamic fixing relaxes, making new positions available to people, there are many attitudes that people in a given community would never agree with or express. For example, people in modern societies would never agree that sacrificing babies to gods is a good thing, despite this apparently having been normative in the past (Watts et al., 2016). It is not just a case of "anything goes." Convincing people to modify their attitude repertoires is probably more difficult than creating contexts in which they are willing to switch between attitudes already within their repertoire. Nevertheless, the framework suggests that identity-consistent attitudes will be more easily adopted and identity-inconsistent ones will be more easily dropped (where identity-consistency is a function of the system state).

A New View on Prototypicality

Prototypicality is a central concept in the social identity approach, and particularly in the self-categorization theory, but operationalization of the construct has been challenging. This is because prototypicality is always relative, both to the intergroup context, and also to the positions of individuals within the ingroup. Thus:

> The most prototypical (normative, valued) position in a group is not simply the sum or mean of ingroup responses, nor is it an individual property of the member holding it. Instead, it is a higher-order category property that reflects the views of all members and the similarities and differences between them and in relation to others (Turner et al., 1987, p. 88)

The challenge in quantitatively representing prototypicality is in capturing its dynamic

and relative nature, as an emergent property of the relations between people and groups on relevant dimensions of comparison. The Social Identity Network adds to our toolbox of methods for representing prototypicality across multiple dimensions in relational terms. Several approaches already follow this broad approach. For example, Relative Ingroup Prototypicality locates categories in Euclidian space from attribute ratings (Ullrich, 2009); the exemplar based approach locates people in relation to category exemplars in multidimensional space (Sewell et al., 2022).

The Social Identity Network similarly shows the relative positions of individuals and groups via attitudes in multidimensional space, but also captures features of prototypicality that are less obvious with other methods. Firstly, social identity networks illustrate how groups can absorb a wide diversity of attitudes once they are woven into a cohesive social identity network. This helps visualize how a prototype can absorb multiple positions; and how people in different parts of an ingroup with a cohesive social identity network can have substantively different opinions despite both firmly belonging to the group (and also how this might become a future fault-line for schism). Critically, the network approach shows how attitudes are meaningful in combination, how combinations are absorbed into groups, and thus how ingroup positions can accommodate non-typical attitudes so long as they are combined with others tying them into the collective. The bipartite network approach also shows the asymmetry of prototypical group norms: for example, in figure 9A it is obvious that contemporary Democrats had much tighter prototypicality on the relevant attitudes than Republicans.

A New View on Polarization

This approach provides a multidimensional view on polarization (Dinkelberg, O'Reilly, et al., 2021). Specifically, it extends the basic principle that polarization on unidimensional scales emerges to facilitate intergroup differentiation (Hogg & Reid, 2006; Turner et al., 1987) to multidimensional systems, where differentiation can be woven across dimensions without extremism (Chen et al., 2024; Maher et al., 2020; Warncke et al., In Press). Accordingly, I

define polarization as a feature of an identity system that allows people to easily recognize ingroup and outgroup members from their attitude expressions and behaviours. In this sense, a polarized social information system is one in which groups are clearly differentiated across relevant dimensions; and where combinations of attitudes provide readable information about an individual's group identity. Even in a strongly polarized system, it can be possible for group-members to hold a wide variety of attitudes, so long as cohesion is maintained in the social fabric where certain combinations of attitudes differentiate "us" from "them" (cf. Martin, 1999). As discussed above, this definition easily accommodates polarization in multi-partisan systems (e.g., figure 7) and multidimensional polarization that is not evident in unidimensional measures (e.g., figure 6; Maher et al., 2020; Warncke et al., In Press).

Group difference also takes on a different meaning when defined in network terms. It is sometimes the few things on which we differ that differentiate groups rather than the many things on which we agree, and this is easily captured by network models. For example, the Church of the Nativity at the supposed birthplace of Christ in Bethlehem is managed and used by five sects that are virtually indistinguishable to outsiders. However, they differ so profoundly on a few key elements of faith and logistics that they frequently brawl; sometimes with broomsticks (Wikipedia, 2020). Bipartite network models can easily distinguish this kind of socio-symbolic group structure when there are a few clear dimensions of polarization, even if there are hundreds of variables on which groups are indistinguishable. In this way, the approach captures how psychological experiences of social polarization can occur even when it looks like groups are otherwise very similar.

The framework provides tools for understanding the importance of context in social processes, as analyses can easily contrast the structure of social information systems with different variable sets. This would allow modelling, for example, how agenda-setting by media, influencers, or politicians, makes different group identities relevant and thus promotes different trajectories for intergroup processes.

Models, Methods, Software and Resources

Several specific methods for converting data to bipartite networks and projecting agent or symbolic layers have been developed and validated (e.g., Carpentras et al., 2024; Carpentras, Lüders, et al., 2022; Dinkelberg, MacCarron, et al., 2021; Dinkelberg, O'Reilly, et al., 2021; Dinkelberg, O'Sullivan, et al., 2021; Leifeld, 2014, 2020, 2013/2024; MacCarron, Maher, & Quayle, 2020; Metz et al., 2018) and are described from first principles in the papers referenced. To make these more accessible, R and Python packages are in development.

Surveygraph (https://surveygraph.ie; Unicomb et al., 2024) is a package available in R and Python for treating survey data as a bipartite network, as described by MacCarron and colleagues (MacCarron, Maher, & Quayle, 2020). The edge weights in projections are usually calculated as Manhattan distances between a dyad's vectors of attitudes (although other distance metrics can be used), and both the agent layer and symbolic layer can easily be projected. This approach is particularly well-suited to creating projections of the agent-layer of the bipartite attitude system, showing how people are connected by homophily in attitude expressions. Core functionality is coded in C++, so projections of the agent and symbolic layers are quick, even for large datasets. The package is lightweight, simply taking survey data as input and producing networks (in edge list format) as output. These can be further analysed with appropriate network packages, such as igraph (Csardi & Nepusz, 2006).

ResIN (https://resinmethod.net; Warncke et al., 2023) is a package in R for mapping survey data as a RESponse Item Network, as described by Carpentras and colleagues (Carpentras et al., 2024; Warncke et al., In Press). This approach is particularly well suited to exploring the relationships between response-options. The method abandons the unrealistic assumption of interval-level measurement properties in Likert-type data (Carpentras & Quayle, 2023); rather, it dummy-codes the scales and calculates edge-weights as binary (phi) correlations between response-options. By treating each response option as a free-floating node in the network, all responses can be included (including non-response) and, counter-intuitively,

more information can be extracted about the precise relation of response-options to each-other; such as asymmetrical relationships that would be overlooked with other methods (ibid.).

Leifeld and colleagues have been developing closely related methods for applying bipartite methods to qualitative data (Leifeld, 2014, 2020; Metz et al., 2018). The Discourse Network Analyzer (DNA: Leifeld, 2013/2024) facilitates the qualitative coding of text to produce bipartite networks connecting speakers via similarly coded expressions.

Empirical Support for the Social Identity Network Approach

Next, I will review empirical evidence across multiple levels of analysis systematically testing the proposed Social Identity Network approach. Specifically, at the individual level, do the proposed psychological micro-processes operate as hypothesized to justify representing agreement on attitudes as network edges? At the macro-level, do the agent and symbolic layers provide information about social groups and their dynamics as the model proposes?

Testing the Micro-Processes: Does Agreement Produce Identification and Vice Versa?

First, I review several studies that experimentally test the proposed psychological micro-processes using variations on the minimal group paradigm. For example, is agreement on attitudes a basis for identification? Are we more likely to agree with people we identify with? Are we able to "read" broader identity information from attitudes that people express to us? The aim of presenting these empirical findings is to weigh the evidence that representing agreement on attitudes as a network edge is valid and reasonable.

Does Agreement on Attitudes Constitute a Social Tie? "Novel" Attitudes in Minimal Groups

A key problem with empirically testing this theory is—if it is correct—any existing attitude a person may express could be identity-laden, already positioning them in an identity system. This is true even of things that have little real-world importance, like your preference for gravy and curds (Canadian), curry sauce (British) or mayonnaise (Belgian) on your fries/chips/frites. For this reason, we started building the chain of evidence with carefully constructed and piloted "novel" attitudes—statements with the form of conventional attitude

items, but with content that participants are unlikely to have attachments to, and which are unlikely to reflect pre-existing identities. For example: *A circle is a noble shape* [agree/disagree] (O'Reilly, Maher, & Quayle, 2024).

Our first aim was to establish whether agreement on such novel attitudes provides a basis for identification with others and, crucially, whether attitudes have additional bonding value compared to completely minimal categories, such as group "X" and group "W" (Billig & Tajfel, 1973). This acknowledges that the categories used in the original minimal group studies were not all equally minimal—some provide more material for inference than others (Hong & Ratner, 2021). For example, expressing a preference for Klee or Kandinsky paintings (Tajfel et al., 1971) is an attitude; being an "underestimator" or "overestimator" (Tajfel et al., 1971) could provide information about personality (Hong & Ratner, 2021); while being in X or W group (Billig & Tajfel, 1973) is (or was) much more arbitrary[xii]. In our study, we used colours (yellow/blue) as minimal control categories, acknowledging that even this distinction might provide associational information for some participants.

Across two pre-registered studies, participants were randomly assigned to a control or experimental group. They were then randomly allocated into groups of four. Participants reported their agreement or disagreement with a novel attitude statement, and this information was used to assign them to a colour group (agree–yellow, disagree–blue). Participants in the experimental condition viewed a feedback screen that directly showed both everyone's expressed attitude and their colour assignment. Those in the control group only saw everyone's colour assignments and, in study 1, were told they were assigned to groups randomly; and in study 2 were told they were assigned to groups based on congruence on arbitrary personal information (similarities in their Prolific user ID).

Results consistently confirmed our preregistered hypotheses: participants in attitude-based minimal groups reported higher identification and attitude strength than those assigned to more arbitrary categories. These findings provide robust evidence that awareness that others

hold the same opinions as your own provides a stronger basis for identification than mere awareness of assignment to the same minimal category. Put simply, people identify more with an minimal group based on mutual agreement than one based on more arbitrary characteristics, demonstrating that attitude homophily has a social bonding function.

However, an important critique of the minimal group studies is that the nature of the situation possibly *inflates* the importance of the category, since there is no other information available for participants to act reasonably; so rather than being "minimal," these categories in these artificial situations are in fact "maximal" groups (Reicher, 2004; Tajfel, 1978, p. 42). Additionally, in our study, the "novel opinions" we asked participants to make sense of are—frankly—just weird. Is a circle a noble shape? Is the letter P a sensible letter? While participants evidently made sense of these statements as best they could, it is quite possible that they would treat more familiar attitudes differently. Obviously, we needed to replicate these findings with "real" attitudes.

Does Agreement on Attitudes Constitute a Social Tie? Real Attitudes in Minimal Groups

To test whether awareness of *attitude congruence* on more familiar attitudes fosters identification in a similar way to congruence on novel ones, we (O'Reilly et al., 2022) used a similar pre-registered experimental design, but with participants expressing agreement to a health-related topic ("I have a favourable view of traditional healers" [agree/disagree]). We drew this attitude item from the Wellcome Global Monitor survey on vaccine opinions (Wellcome Trust, 2018), which we had found in parallel research to have a relatively even split between agree and disagree, and to have no obvious links to pre-existing group memberships in the target population (Maher et al., 2020).

Participating in groups of seven, participants (N = 681) expressed their opinion privately. Those in the experimental condition viewed a feedback screen showing each participant's expressed opinion and the colour of the group to which they had been assigned, knowing explicitly that this assignment was based on attitude congruence. Those assigned to

the control condition viewed feedback showing only the colour of the group to which they were assigned, and believed that assignment was due to congruence on an arbitrary criterion (similarity of their Prolific user ID).

Results confirmed our pre-registered hypothesis: participants in an attitude-based minimal group expressed higher identification than those in the more arbitrary colour-based group. Although the effect-sizes were small, we noted that the design was testing incremental increases in identification over-and-above ordinary minimal groups, which we already know to be robust; and using a one-shot approach. In less contrived situations, people are likely to share more than one attitude at a time and therefore find multiple points of agreement; and this is what we tested next.

Does Agreement on Attitudes Constitute a Social Tie? Sequential Agreement on Multiple Real Attitudes

Using a similar method to the studies reported above, we introduced the opportunity for repeated agreement/disagreement on several real-world attitudes in sequence (O'Reilly, Maher, Smith, et al., 2024). In three preregistered studies, we replicated the finding that people expressed more identification in dyads or groups based on congruent attitudes related to the Russian invasion of Ukraine in 2022, than groups based on congruence on arbitrary criteria, with identification increasing with the cumulative number of congruent attitudes (from a possible total of three sequential attitude-based interactions in studies one and two, N = 654, N = 1,600; and twelve sequential attitude-based interactions in study three, N = 883), but only for those who engaged in attitude-interaction and not for those who expressed opinions privately and believed congruence was based on arbitrary criteria. By testing identification after every attitude-interaction, study three showed that identification evolves over time: it strengthens as people find multiple points of agreement, but can also be spoiled by disagreement. Thus, over multiple studies with "minimal" and "real" attitudes, we find support for the proposed microprocess that agreement on attitudes is experienced as a social bond, and can appropriately

be represented as a network tie.

Cards in the Hand vs Cards Played: Can People Use Their Knowledge of the Information System to Adapt to Each-Others' Positions?

As reviewed above, there was already an extensive body of qualitative work showing that people are sensitive to the way their attitude expressions will position them socially. Here (O'Reilly, Maher, Smith, et al., 2024, study 3), we also add quantitative experimental evidence that people (N = 883) are aware of the social information system in which attitudes exist, and are able to synchronize their attitude expressions to strategically achieve agreement. Over the sequence of twelve attitude-interactions, people interacting in the experimental group—who were aware of their peers' attitude expressions—achieved more attitude synchronization over time than people reporting their attitudes in private. Since the two conditions differed only in having feedback about the other participants' previous attitude expressions (or not), the results demonstrated that participants prospectively adapted their own attitude expressions to those of their partners to achieve congruence and thereby synchronize their positions. Simply put, this shows that participants did not have stubbornly fixed attitudes; rather they answered questions with enough flexibility to achieve higher levels of agreement, and that their peers' prior answers provided enough information to predict future ones and facilitate mutual alignment.

Using a more sophisticated design, we (O'Reilly, Mannion, et al., 2024) showed that, in social media discussions of the Russian invasion of Ukraine, people strategically aligned their attitudes with those closest to them within follower communities (c.f. Lüders et al., 2022). In an interactive quasi-experiment (N = 1368), we used pre-test data to match people either to an ingroup (close to them in the attitude space) or outgroup (distal to them in attitude space) partner. Participants in an experimental condition then shared their answers on eleven items related to the Russian invasion of Ukraine while participants in a control condition answered these attitudes privately and shared arbitrary information. Both groups reported their group identification after each sharing round. Results supported our pre-registered hypotheses that

people engaging in attitude-based interaction align their opinions and identify with ingroup partners and distance themselves and disidentify from outgroup partners (compared to a control group who have circumstantial attitude alignment/disalignment but no relevant information with which to strategically tailor their attitudes based on their social identity connections with their partners). Across multiple studies, attitude alignment was reflected in strengthened identification between partners, supporting the argument that there is a dynamic reciprocal relationship between attitudes and identification (O'Reilly, Mannion, et al., 2024).

At a basic level, these results support the argument that attitude expression is tailored to an audience which requires, of course, that people have some flexibility in producing attitude expressions sensitive to their interactive context. This supports the argument that people have repertoires of attitudes that they may be willing to express, depending on who they are interacting with and the trajectory of the conversation, like cards in a hand.

At a systemic (network) level, we found that dyadic interaction with ingroup members led to alignment of the entire opinion space when analysed collectively; and, conversely, interaction across outgroup dyads produced collective disalignment. These results demonstrate that participants have awareness of the attitude-identity space in which they are operating and how their dyadic attitude expressions position them within it. More abstractly, the findings suggest that dyadic alignment scales up to higher-level social organization, analogous to large-scale flocking processes emerging via local coordination between neighbours (Durrheim & Quayle, 2025).

An obvious question is, where does this information reside? We argue that it is a feature of socially structured attitude systems, which are fields of identity-laden information in which people position themselves by talk and action, and in which they are located by the responses of others. In this associational information space certain combinations of attitudes are more common (and thus more connected in the network). Someone's previous sequence of expressed attitudes thus locates them in the information system, allowing attitudes on other topics to be

guessed. However, a future attitude expression can only be guessed based on previous ones if they are adequately linked in the collective social information system. Thus, the functionality to locate people and attitudes is a feature of the social information system, not only of individual cognition. This argument—that expressions of attitudes are used by people to position themselves and others in a social space and that they actively manage what attitudes they express (and to whom) to manage how they are positioned—is very well established in social representations theory and discursive psychology, as argued in the first sections of this paper. The next question is how adept are people at "reading" attitude expressions within a structured social information space?

Can People Use Their Knowledge of the Social Information System to "Read" Identity From Expressed Opinions?

To explore how well people can infer identity from an attitude expression in an identity-laden attitude space, we (Lüders, Carpentras, et al., 2024) used a preregistered two-step procedure to map a social information-space and assess people's ability to place each-other within it. First, we asked participants (N = 396) to report their partisan identification (difference in identification with *Republicans* and *Democrats*) and their own responses to eight political attitude items from the American National Election Studies known to capture political polarization in the US (Dinkelberg, O'Reilly, et al., 2021; Malka et al., 2014). We then mapped the social information-space using ResIN (displayed in Figure 9A), dummy-coding and separately locating every response-option from every questionnaire item in a network (Carpentras et al., 2024). Participants' own position in this network (based on the centroid of their responses) corresponded well to their self-reported identity ($r = .72$, $p < .001$).

FIGURE 9 ABOUT HERE

In the second step, we presented participants with vignettes where a stick-figure person

was depicted answering an item from the same question pool as the eight-item survey the participants themselves had just completed, for example, “Abortion should be illegal: strongly disagree” (e.g., Figure 9B). Participants rated this imaginary person as “definitely not” to “definitely” Republican/Democrat.

Then, in step three, we compared the location of each vignette response option in the network generated in step one, to participants’ identity-rating of the vignette collected at step two. Note that while we, as researchers, have a bird’s-eye map of the identity network generated with the ResIN method, the participants rely only on their own intuitive knowledge of the social information system. Nevertheless, the correlation was positive and exceptionally strong ($r = .90$, $p < .001$), demonstrating that participants were able to use their knowledge of the social information system to accurately read the identity of (imaginary) others from a single attitude statement (e.g., “abortion–neutral”); and negative affect was correlated with network distance, in other words, the further away the vignette was from the participant’s own location in this polarized network space, the more negatively the participant felt towards the avatar depicted.

Of course, “readability” is not a universal feature of attitude expression: it is a function of strategic action (e.g., talk and behaviour) within an identity-laden information space. As noted above, in Switzerland where gun ownership is uncontroversially part of the national tradition, learning whether someone owns a gun reveals very little about someone’s political identity but, rather, allows you to guess their gender with 90% accuracy (Suvada et al., 2023). Therefore, “readability” is a feature of polarized information spaces and—*vice versa*—a function of polarization is to make (certain) attitudes readable as statements of identity. Put differently, attitudes are a distributed social identity information system where society stores its groups. To explore the system-level processes that allow agents-holding-attitudes to operate as a distributed social information system, we turned to agent-based modelling.

Validating the Macro-Process: Agent Based Models Confirm That Social Identity Is Embedded in Attitude Systems

In a series of Agent-Based Models, we tested whether a social information space already contains social identity embedded in the information structure, or whether intrapersonal social identity variables (e.g., ingroup bias) need to be explicitly modelled. We (Dinkelberg et al., 2023) used Axelrod's model of cultural diffusion to represent people holding attitudes. In the usual model, each agent holds a vector of nominal opinions. We introduced a variation where agents' opinions are on ordinal Likert-type scales, as if they are a participant in a survey (Dinkelberg, MacCarron, et al., 2021; MacCarron, Maher, Fennell, et al., 2020). This model uses a copying mechanism for updating opinions, rather than arithmetic operations like averaging, and avoids many of the problems of "loading" survey data into agent-based models.

In the basic Axelrod model, at each time-step, two agents are selected randomly. A homophily-based interaction rule is applied to decide whether they interact, where they are more likely to do so to the degree they are similar. This implicitly implements a social identity network, even if no explicit social network structure is applied, since agents are implicitly connected to the extent they hold similar attitudes (Dinkelberg, MacCarron, et al., 2021). If they interact but do not already have identical attitudes, one of the non-identical attitudes is selected for social influence. In the modified Axelrod model, agents additionally continue to interact only if close enough on the selected dimension. To interact, the first agent adopts the opinion of the second on the selected item and, thus, social influence has occurred. Note that these rules introduce identity dynamics, whereby people are most likely to interact with people close to them in the multidimensional identity information space, and (in the extended model) are only able to be influenced on a given item by someone close to them on that item.

We (Dinkelberg et al., 2023) compared these base models with two variants that introduced explicit social identity features at the individual level, such as a psychological tendency to ingroup bias. We explored the performance of the various models with simulated

data, and by loading them with longitudinal surveys on political opinions, including ANES data (N = 1,635), and comparing modelled system outcomes against empirical data from later time-points. Perhaps surprisingly for social identity theorists, the simpler models performed better at modelling the evolution of the attitude space and the stability of the attitudes in the system than those explicitly including social identity processes at the individual level (especially if models are penalized for complexity). We argued that even the simplest version of the Axelrod model implicitly captures social identity in the information space via the principle of homophily. Since social identity is already embedded in the social information system, there is little additional advantage to also explicitly modelling it at the individual level. Notably, while these particular models do not accurately predict real individuals' trajectories between survey time points, they are remarkably accurate in identifying the relative volatility of attitudes in the social information system between survey time points, and thus the dimensions on which groups might converge or diverge over time (Dinkelberg et al., 2023).

Note that agents have no knowledge of the macro-properties of the system, no memory, and require no internal representation of social identity. All of the "identity work" in the model arises via dyadic interaction with the homophily principle. This can be difficult to visualize, when we are so used to imagining social identity processes at the level of the individual. The concept of *stigmergy* from ecology provides a very useful analogy: imagine ants leaving a nest and moving randomly until they find food. When they do, they start releasing pheromones that leave a trail as they carry it back to the nest. When another ant crosses the trail, they follow it to find the food and do the same, strengthening the trail. This activity produces a collective system very efficient at searching and route-finding. The route-finding computation occurs in the interaction between the ants and their environment, and the routes linking the nest to the food are stored in the landscape, rather than (or perhaps as well as) in the "minds" of the ants (Moussaid et al., 2009). In the Axelrod model, social identity has similar properties: it is stored in the information space, and is an emergent outcome of the homophily dynamics. No

individual agent needs any mental representation of the identity system or memory for dyadic interactions to produce social identity, because the available identities are progressively written into the structure of the social information system.

Demonstrating the Value of the Approach to Map Attitude-Based-Groups and Group-Based-Attitudes at Scale

The sections above provide robust empirical evidence for the proposed psychological micro-processes that weave attitudes and people together in an identity-laden social information space, particularly that attitude homophily is a social bond that can validly be represented as a network edge; that these edges link people into group structures; that people can "read" the social information system to locate themselves and others within it and adaptively modify the attitudes they express; and that mapping these edges provides important system-level information about the social identities in the system and the positions of individuals within them. The next section demonstrates that these ties can be modelled as bipartite networks to describe social identity processes at scale, and to show the position of individuals in larger dynamic social structures. We have explored this with secondary analyses of survey data, of which I will report two here: the first exploring political polarization in data from the American National Election Studies (ANES) from 2012 to 2020 (Dinkelberg, O'Reilly, et al., 2021), and the second exploring polarization in vaccine-related health beliefs (Carpentras, Lüders, et al., 2022; Maher et al., 2020).

Multidimensional Political Polarization in the United States

Applying the method to the issue of political polarization, we obtained longitudinal ANES data for 2012, 2016 and 2020 (for details, see Dinkelberg, O'Reilly, et al., 2021). We selected attitude items shown in prior research to be employed in political identity differentiation (Dinkelberg, O'Sullivan, et al., 2021; Malka et al., 2014) and confirmed their relevance empirically with a feature-classification approach, retaining items asking participants to express attitudes to social welfare policy, gay and lesbian rights, government intervention in

income equality, racial redistributive policies, environmental regulations on business, abortion, and immigration. To address the differing sample sizes across years, we drew 400 equivalently sized subsamples per year, analysed each subsample as a bipartite network, and reported bootstrapped statistics. This resampling process also confirmed network robustness, since structures are only retained across the bootstrapped analysis if they can survive when substantial proportions of nodes and edges are removed (i.e., a form of network resilience testing). To quantify polarization, we progressively removed the edges most important in linking different parts of the network (technically: each time, removing the edge with highest edge-betweenness, implementing the Girvan-Newman method) until the network split into separate components, and recorded how many edges had been removed (referred to as *cut-size*). To describe the internal structure of the identified communities, we calculated the average length of the shortest path between each in-community dyad.

Results showed cut-size decreasing (and hence polarization increasing) progressively across time-points, particularly from 2016 to 2020. In practical terms, this means a dwindling proportion of cross-partisan dyads with similar attitudes. Practically, if a Republican and Democrat were selected at random, they would have been more likely to find points of agreement in 2012, and more able to quickly identify their differences in 2020 (on these attitudes). This polarization was characterized by ingroup dynamics as well: Democrat attitudes became more tightly coordinated in a smaller part of the opinion space over time, and Republican attitudes became more scattered. Hence, a broader range of opinions became recognisable as distinctively “Republican” and a narrower range as distinctively “Democrat.”

These results show that the bipartite social identity network model provides a valuable window on social polarization. They also open some important questions for future research on the dynamics of attitude synchronization in democratic processes. It is possible that Republicans have less need to coordinate attitudes on key opinions because their members are more recognisable from demographical consistencies, such as ethnicity; or alternatively, these

results could show that well-timed opinion synchronization on key dimensions is important for winning democratic elections (with Democrats under Biden defeating Republicans under Trump in 2020).

Attitude and Identity Coordination in Emerging Social Issues: Vaccination

During 2019, to test our bipartite methods with non-political attitudes, we started working with data from the Wellcome Global Monitor—a cross-sectional global survey of vaccine-related attitudes with nearly 150,000 respondents across 144 countries released in 2018. To explore the dynamics of the networks, we planned a smaller longitudinal survey in the UK using a subset of the items. Coincidentally, we (Maher et al., 2020) were ready to start data collection in the first weeks of the COVID pandemic and were able to use the Social Identity Network approach to detect the evolution of two distinct opinion groups over time (figure 8). These factions were characterised by multi-dimensional alignment across variables, and particularly trust, or distrust, in science. These emergent factions did not neatly correspond with pre-existing identity dimensions, and membership of one faction or the other was associated with relevant health behaviours. This partisan polarization was characterized by multidimensional attitude coordination rather than extremism, and despite being obvious in the bipartite social identity network, was not easily detectable with usual linear methods.

In a separate line of research, we (Carpentras, Lüders, et al., 2022) applied the ResIN method to the Wellcome Global Monitor survey to map the relations between responses to survey items in the bipartite attitude space on topics including trust in vaccines, science and public institutions. As described above, this method dummy-codes all variables, taking each response-option for each item in a survey as a node, and the similarities between response-options as edges (Carpentras et al., 2024).

Across countries, the obtained networks showed tight clustering between all the strongly vaccine-positive attitudes (strong support for vaccination; high trust), loose clustering between all other points on the scales (from mild support, through neutral, to mild and strong

opposition/distrust), and a clear distance between these positions. We called this pattern *attitude-isolation*. Thinking of this structure as an identity system, the line differentiating vaccine-positive from vaccine-hesitant people leaves almost no room for doubt; as soon as a person expresses any doubt at all, they are positioned outside the moral majority, and expressing a "neutral" response positions them well within the community of people who reject vaccination. This provides a counterintuitive insight that would be very difficult to glean from conventional linear models—that, in this context, "neutral" responses to the questionnaires are not neutral at all in identity terms, in the same way as expressing a "neutral" position on whether the earth is flat would position you firmly as anti-scientific.

We "loaded" these data into various agent-based social dynamics models with interaction rules based on homophily (Axelrod's model of cultural diffusion) or confidence-bounds (the Deffuant and Hegselmann-Krause models) to observe how this empirical data structure would constrain the model dynamics (cf. Băbeanu et al., 2018; cf. Stivala et al., 2014). Results show that attitude isolation at the start of the simulation (the distance between the strong supporters and everyone else) correlated negatively with overall trust in vaccines at the end; providing computational evidence that attitude isolation functions as an identity faultline and that this social information structure does indeed expose people expressing doubt to more influence from dissenters than supporters of vaccination under these social influence assumptions. Put differently, the structure of the social information system related to vaccination and trust in science (prior to 2018) reserved uncertainty exclusively for dissenters; and anyone expressing uncertainty is thus asymmetrically exposed to social influence from the dissenting side.

To explore whether these agent-based models had practical relevance, we used data from the World Health Organization Global Health Observatory to estimate per-country change in immunization coverage for measles in the following year (i.e., the year after data was collected for the Wellcome Global Monitor survey that we had used to map the vaccine-attitude

networks). This provided paired data for 108 countries, showing a substantial and significant negative correlation (r = -.31, p = .001) between attitude isolation in a country and the change in vaccination uptake the following year.

These results support the argument that any kind of attitude, including health beliefs, can be incorporated into social identities. Once this has happened, expressing any of these attitudes—even "neutral" ones, or non-responses—positions you in ways readable to others. At this point, the structure of the social information system (i.e., the readable association between expressed attitudes and identity) shapes social influence since, in a structured social information system, attitude change can be identity change, depending on the position of the person and the attitudes (cf. Festinger et al., 1950).

Summary of Empirical Support

This body of empirical evidence provides substantive support for the core claims of the Social Identity Network approach. The psychological micro-mechanisms are supported: people do indeed feel affinity with others who agree with them. This is true of novel attitudes as well as familiar ones; and the effect is cumulative, in that affinity builds as agreement accumulates (and is damaged by disagreement). Thus, there is strong and consistent support that it is broadly valid to code attitude homophily as a network tie. The macro-level structural hypotheses are supported: attitudes produce a social information system that can embed identity information at a social level, and this is well represented by bipartite networks; people are able to "read" identity positions from attitudes as predicted; they are sensitive to how their own attitude expressions will position them in identity space; and are able to fine-tune their interactions with a partner to locate each-other in the attitude space and synchronize their opinions.

Implications for Theory and Research, Future Directions, and Limitations

I will now discuss some of the implications of the Social Identity Network approach and its limitations. To do so, I will look back towards its metatheoretical basis in the social

identity and social representations approaches, and also look towards the future.

Synchronization of Core Attitudes Is a Universal Group Process, Not Limited to Opinion-Based Groups

The importance of attitude synchronization in social identity is very obviously demonstrated in *opinion-based groups* (Bliuc et al., 2007). These are defined as a special case of group identity formed around a specific opinion towards a social issue (Bliuc et al., 2007; McGarty et al., 2009; E. F. Thomas et al., 2010; E. F. Thomas & McGarty, 2009). More specifically, in this framework:

> Merely holding the same opinion as others is not sufficient for such a group to be said to exist, rather the shared opinion needs to become part of that social identity. In this way, people can come to perceive and define themselves in terms of their opinion group membership in the same way as they would with any other psychologically meaningful social category or group (McGarty et al., 2009, p. 846).

The concept is particularly useful for understanding how group identity can emerge around pressing social issues, where experiencing others as allies on the same side of a controversial problem provides a potent basis for experiencing an otherwise disparate conglomerate of people as a coherent psychological group (McGarty et al., 2009; L. G. E. Smith et al., 2015). Although opinion-based groups are not necessarily stable or resilient (Bliuc et al., 2007; E. F. Thomas et al., 2015), they are a strong platform for mobilizing collective action because they are founded on consensus on a core social problem, shared concerns, and common goals for social change (Bliuc et al., 2007; Gee & McGarty, 2013; Monik & Parzuchowski, 2024; Musgrove & McGarty, 2008).

Bipartite networks are useful for identifying and visualizing opinion-based groups (Carpentras, Maher, et al., 2022; Dinkelberg, O'Sullivan, et al., 2021; MacCarron, Maher, & Quayle, 2020; Maher et al., 2020). However, the Social Identity Network approach is making a much broader and more general claim for the importance of attitude synchronization in social

identity processes: that multidimensional attitude synchronization is a fundamental activity for *all* groups (Durrheim & Quayle, 2025; Hogg & Smith, 2007; J. R. Smith & Hogg, 2008). Specifically, for group identities to be recognizable and differentiable, social activity must produce regular patterns of information in which group identity is embedded in readable ways. This social information system, in which attitudes are a prominent feature, allows group identity to be enacted and recognized. Thus, while it is true that opinion-based groups have special properties compared to other social identities; it is also true that regularities in attitudes (and other characteristics) that differentiate them from other comparable groups are a property of social identities more generally.

Attitudes Are Related to Social Representations and Social Identity, but Only Partially Capture Them

In the metatheoretical introduction, I located the Social Identity Network approach to attitudes at the intersection of the social identity and social representations approaches, representing the location of individuals in broader symbolic structures collectively created by their own activities. However, it is obvious that both social identity and social representations have important features that go beyond attitudes. Indeed, both approaches are founded in the conviction that social processes are located in material systems of power and privilege. Although the Social Identity Network approach allows us to consider the location of individuals in socially-coupled symbolic systems, it does not (yet) consider material or power-based structural features. Moscovici (1988) argued that whether people hold attitudes towards social representations or not is somewhat unrelated to the existence or power of those representations; for example he uses the example of hegemonic masculinity or other hegemonic structures which can exert power in society even if no one knows about or agrees with them. This is a reminder that, while the proposed network approach allows us to explore features of attitude systems previously out of view, it still only provides a partial view of identities and social representations.

Intersectionality

Above, I noted the strength of the approach in distinguishing groups that differ systematically on key dimensions, where each person is a member of one group. However, real-life contexts often have a more difficult problem, where people belong to multiple intersecting groups differentiated across the same dimensions (Baysu & Phalet, 2017). It is certainly possible for the approach to be useful for this kind of data: since like-answered people will be located near each-other in the socio-symbolic space, it is likely that intersectional identities will be observed as subgroups in the agent network. For example, women Republicans may be differentiable from men—if the right questions are asked. Thus, as with most quantitative approaches in social psychology, variable selection is still very important, either at the design stage prior to data collection or employing a variable selection procedure after data collection but prior to network mapping. For example, Dinkelberg and colleagues (Dinkelberg, O'Reilly, et al., 2021; Dinkelberg, O'Sullivan, et al., 2021) use a combination of theoretical selection based on prior research and random-forest selection methods to identify variables most associated with the identities of interest. Further research should consider alternative approaches for variable selection, for example, using machine-learning or agent-based models within the bipartite-network space to consider the problem from the perspective of the participants in the system.

Prototypicality

The network approach provides many possibilities for operationalizing prototypicality, as yet unexplored. For example, prototypical attitudes may be those that provide most resilience to the group identity (e.g., that undermine identity structures most if removed during network stress testing). Also, since each individual's view of the "groupscape" depends on their unique location in the network, this approach might allow more radical operationalization of the original arguments for the relativity of prototypicality in the self-categorization theory (Turner et al., 1987). Indeed, there may be as many versions of prototypicality as individuals in

the system based on their unique view from their location. The Social Identity Network approach provides a methodological platform for exploring this kind of relativity.

The Model Is Never the Thing Itself: Other Models and Methods Can Also Capture Features of the Social Information System, and the Bipartite Network Model Can Be Improved

Models are representations, not reality. Thus, I am not claiming that people holding attitudes *are* networks; but rather that bipartite networks provide an excellent model for the complex social information system comprised of people, attitudes and broader social representations. The model is not the thing itself—it is an idealised abstract representation of a complex system, and theoretical modelling always requires choices about what to include, and how to represent those features. Just as Newton's laws and Einstein's theory of relativity both provide useful models for understanding the same physical systems at different scales, it will ultimately be useful to have various mathematical models for representing these social-psychological phenomena. The important thing is to find models that map well to the nature of the system they represent. In the case of the bipartite network model proposed here to understand attitudes, its most important property is its duality—that it captures the function of attitudes as coupling-points between individuals and social systems, simultaneously producing the social information system and locating individuals within it. This is a feature of attitudes easily overlooked when they are modelled within individuals by linear models (and even with networks constructed from linear correlations). However, any successful model must make choices about which features of a system to represent. In this case, by shifting to a system-level understanding of attitudes, some of the more individually-located features of attitudes are overlooked; such as their affective and moral dimensions (e.g., D'Amore et al., 2024; Skitka et al., 2021). Further work will be required to explore whether these can be integrated into this bipartite network approach, or whether other models are more appropriate for exploring those dimensions of attitudes.

Further, there are several other well-established approaches in the social sciences that model variables as networks to represent their relational structure (e.g., Baldassarri & Goldberg, 2014; Boutyline & Vaisey, 2017; Brandt et al., 2019; Dalege et al., 2016; Mische, 2014). All of these approaches describe how structural relationships between attitudes form meaningful networks, but they operate at different levels of analysis and make different decisions about what entities count as nodes and how to identify edges between them. For example, Belief Network Analysis treats beliefs as nodes and infers edges from (partial) correlations (Boutyline & Vaisey, 2017; Brandt et al., 2019). Relational Class Analysis (Goldberg, 2011) similarly treats beliefs as nodes, but defines edges as summaries of a dyadic "relationality measure" (akin to Gini coefficients). These approaches aim to describe structural relationships between beliefs or attitudes at the level of culture. There are also approaches modelling attitudes as networks at the level of individual cognition (e.g., Brandt, 2022; Dalege et al., 2016). Generally, these approaches do not easily consider the location of individuals in the system, and this is the main advantage of the Social Identity Network approach: it treats attitudes as coupling points between individuals and groups, and allows individuals to be located in broader structures produced through their own activities[xiii].

While the evidence surveyed above shows the value of the Social Identity Network approach for quantitative exploration of processes that until now have been most successfully understood with qualitative methods, it does not match or replace their fine-grained nuance. There are still vital processes out-of-view, such as the negotiation of what dimensions to prioritize, and what constitutes agreement on those dimensions. As noted above, Leifeld and colleagues have pioneered methods for bipartite network analysis of qualitative data (Leifeld, 2014, 2020, 2013/2024; Metz et al., 2018), and there is great promise in using generative AI models for coding networks from qualitative data in this way.

Advances Possible in Mathematical and Statistical Modelling

Multilayer and bipartite network methods are still in development (Kivela et al., 2014),

and many conventional network metrics (like transitivity) do not yet have agreed-on equivalents in multilayer or bipartite networks, particularly those with signed edges (to represent agreement and disagreement) (e.g., Horvát & Zweig, 2013). More basic mathematical work may need to be done developing optimal methods for projecting one-mode networks (of people and attitudes) from the bipartite network, since the key point of interest is *agreement* and *disagreement* which is not necessarily well captured in standard methods; and there may be system-level features of homophily that are overlooked by dyadic approaches (Rizi et al., 2024).

More applied work is needed to optimize approaches for processing and analysing Social Identity Networks. For example, like psychometric networks (e.g., Epskamp et al., 2017), social identity networks are dense and complex (indeed, they are initially fully connected). Although reasonable approaches for thresholding edges have been suggested (Carpentras et al., 2024; Dinkelberg, O'Sullivan, et al., 2021; MacCarron, Maher, & Quayle, 2020), work needs to be done to compare alternatives. While existing approaches quantify homophily with simple metrics like Manhattan distance (e.g., surveygraph) or binary correlation (e.g., ResIN), there is great promise in exploring information theory metrics such as mutual information, entropy, and compressibility which map well to the theoretical objectives of the approach (e.g., Iannucci et al., 2025; Martin, 1999, 2002).

Similarly, further research is required to identify the most appropriate methods and metrics for detecting psychologically relevant patterns in the multilayer/bipartite network structure (e.g. community detection, centrality, etc.). It will be particularly useful to validate methods and metrics for identifying attitudes and people in the bipartite network with particular importance for properties such as social cohesion or polarization. For example, a small group of people might have a particularly important role in bridging what would otherwise be a schism between groups (perhaps identified by high betweenness, for example); or a small set of attitudes might play a similar role in the agent network. These questions might

be addressed with methods such as stress testing by iteratively removing people or variables (e.g., Dinkelberg, O'Sullivan, et al., 2021) or injecting noise, computational modelling with appropriate agent based models (e.g., Dinkelberg et al., 2023), or developing network-appropriate metrics such as an equivalent of *leverage* to identify individuals and attitudes particularly influential to network structure.

Finding the Right Level of Abstraction

Like all models, this one requires oversimplification of complex processes. For example, groups can develop abstractions which allow apparent *disagreements* to actually constitute *agreement* at a more abstract level. For example, disputes are an expected part of peer-review, and a sign of higher-level agreement on the scientific method. An important social process is how groups reach agreement on *the essential dimensions of agreement,* and Social Identity Networks do not make this visible.

Related to this is the problem of selection: the researcher has to try to identify the key dimensions of differentiation, or use inductive tools to find them (Clemence et al., 1993). Of course, this is the same in every research method, as the researcher must always choose what data to collect, variables to measure, and what information to model. Additionally, here, the scientific process shadows the *in vivo* social process, as people are always making similar choices about what identities, and what dimensions of identity, to make relevant in social situations. For example, politicians must become adept at emphasizing issues that draw cleavages through the identity space to maximize their own support and fragment their oppositions'.

Not All Attitudes Are the Same

So far, the empirical focus of the Social Identity Network approach has been on the general understanding of the role of attitudes in issue-based social differentiation and has not much considered different types of attitudes, apart from their locations in social complexes (although O'Reilly, 2024 makes a start). Yet, some of the clearest advances in attitude research

in recent years have been in considering how certain attitudes are more important than others for social processes such as those relating to the social contract (Van Zomeren et al., 2024), or those held as moral convictions, which reflect "the belief that a given attitude is a reflection of … fundamental issues of right or wrong" (Skitka et al., 2021, p. 348). Because they are experienced as inviolable and universal prescriptions, moralized attitudes produce particularly potent fault lines within and between social groups.

Skitka and colleagues' approach explicitly locates moral convictions in individual psychology, holding that "morality is very much in the eye of the beholder" (Skitka et al., 2021, p. 362). Indeed, it is undeniable that moral convictions differ across individuals, even in closely-knit groups. They may sometimes be entirely idiosyncratic, for example, the Unabomber ('Ted Kaczynski', 2025) had strong and unique moral convictions. However, having strong moral conviction uncoupled from society is probably the exception rather than the norm, and may be perceived (by others) as mad or aberrant. On the other hand, it is very common for people to synchronize strongly held moral convictions with others, and for moral convictions to be incorporated as core features of group identities (Van Zomeren et al., 2011, 2012, 2018), at which point they become features of social information systems amenable to the Social Identity Network approach. Indeed, moralization of core attitudes is a standard feature of partisan identities in polarized societies (Downey, 2022).

Thus, moral convictions are usually not independently held; a person holding one is more (or less) likely to hold another, and these associations are woven together (at least partly) by identity (e.g., Osborne et al., 2024). Consequently, learning about someone's moral convictions provides particularly significant information locating them in social identity systems, allowing us to "tell friend from foe" (Zaal et al., 2017, p. 519).

Of course, the social meaning of particular moral convictions are not predetermined. Rather, they are dynamical emergent features of specific social information systems. For example, Skitka and colleagues (2018) describe the social process by which abortion became

moralized in the US, and how this differs from other cultures. At the same time as they became moralized, abortion attitudes became associated with political and gender identities (Hout et al., 2022). Thus, as already described above, moralized attitudes can be potent signifiers of identity in polarized systems. However, working in the other direction, attitudes can become moralized *as a consequence* of polarization (D'Amore et al., 2022). Polarization and moralization can engage in a dynamic reciprocal cycle, with each signifying and amplifying the other (D'Amore et al., 2024).

The Social Identity Network approach will be useful for conceptualizing, quantifying and visualizing the structural and dynamical features of these processes. Specifically, the core metatheoretical commitment of the Social Identity Network approach, in line with the social representations and social identity approaches, is that people's positions in larger systems have consequences for their psychological and affective experiences. Conversely, psychological features such as certainty and moral conviction locate individuals in social information systems. This is already demonstrated by social identity approaches to attitudes held as moral convictions (D'Amore et al., 2022, 2024; Van Zomeren et al., 2011, 2012, 2018; Zaal et al., 2017). As noted in other sections, the network approach can easily be extended to model different types of attitudes (e.g., regarding the social contract; or held as moral convictions) in different network layers, or to code features such as strength of moral conviction as node or edge attributes. By providing a framework for conceptualizing the social coupling and social positioning functions of attitudes, the Social Identity Network approach has potential for enriching our understanding of these processes by considering the special status of attitudes held with moral conviction *because of their position in the social information system* and, thus, their special importance for producing and demonstrating group identity between moral communities (Opotow, 1990) and within them, their resistance to change, and their centrality to certain issues and social processes (c.f. Carpentras, Lüders, et al., 2022; Dinkelberg et al., 2023; Dinkelberg, O'Sullivan, et al., 2021).

Beyond Attitudes: Applying the Bipartite Network Approach to Other Constructs

By now, it should be clear that attitude questionnaires can easily be represented as bipartite graphs: questionnaire data are structured with cases in rows and variables in columns, and can in some cases be read natively as a bipartite network edge list (such as when answers are binary or dummy-coded). However, real social groups absorb a variety of "objects" into their group identity, limited only by social creativity. Attitudes are just one class of features that become markers of group identity, and the bipartite identity network approach can easily be extended to include various dimensions of differentiation.

Thus, various constructs beyond attitudes could be modelled as bipartite networks, or included in social identity networks (cf. McPherson & Ranger-Moore, 1991; McPherson & Smith, 2019). These features do not need to be self-report variables—they could be observed from behaviour such as online activity, engagement in collective action etc., so long as the construct is consistent with the logic of the approach, which is that people are able to somehow make sense of the available information as a social information system to place themselves and each-other in relation. Just because variables *can* be modelled as a network does not mean that they *should* be—to do so, you should have reasonable expectations that the variables represent social dimensions for comparison by which people produce intergroup distinctions. For example, secret characteristics that people never, or rarely, communicate with each-other are unlikely to operate in quite the same way. On the other hand, there will be many other constructs amenable to this kind of analysis if they have the requisite social properties (e.g., demographics, see Blau, 1977; McPherson & Smith, 2019).

The "social structure" captured by the Social Identity Network approach so far relates to the symbolic social structure that is the focus of social constructionist and social representations approaches. However, the social identity theory also articulates the importance of more material structural features of groups such as permeability, stability and legitimacy (Ellemers, 1993). Because it identifies symbolic structures and locates people within them, the

Social Identity Network approach in its current stage of development is already showing its usefulness capturing the emergence, stability and permeability of attitude-based group structures (e.g., Carpentras, Lüders, et al., 2022; Chen et al., 2024; Dinkelberg et al., 2023; Dinkelberg, O'Reilly, et al., 2021; Maher et al., 2020; O'Reilly, Mannion, et al., 2024), but future research might consider how legitimacy could be analysed in attitude networks.

Additionally, groups are not founded on words alone but also depend on material and power structures such as wealth, race, gender, occupation, geography etc., which all operate together in the same integrated complex system. The social identity network conceptual framework can be extended to model such features as attributes of nodes, or as multipartite systems with layers for each feature, such as demographics or behaviours. Social networks, such as friendship ties or online interactions, could be integrated as additional layers alongside the agent layer projection of a bipartite network. However, careful work will be needed to understand the relationships between homophily networks and social networks, and these may differ across contexts. For example, on social media, people may interact frequently with people they disagree with. As always, care will be needed to ensure that the logic of representation in the models map well to the social logic of the context.

This Approach Provides a Path towards Understanding Social Identity in Large Language Models

Ultimately, it may be possible to develop more appropriate mathematical models than bipartite networks to account for the way the overall attitude-identity system is comprised of a multiplicity of perspectives where individuals and subgroups only ever have a partial and subjective view of the social information system (Lüders, Quayle, et al., 2024). For example, large language models natively capture similar homophily-based distance features in social identity information systems (e.g., Durrheim & Quayle, 2025; Schuld et al., 2023; Sepahpour-Fard et al., 2023; Sepahpour-Fard & Quayle, 2022). If encoding social identity is one of the fundamental purposes of language, then "bias" in language-based AI models is a feature of the

social system rather than a bug in the models (Durrheim & Quayle, 2025). These social identity features can be inefficiently accessed by so-called silicone sampling approaches (Argyle et al., 2023); but could be more directly represented with explicit modelling of mathematical compressibility and compression in such systems (Deletang et al., 2024). Therefore the broader notion of the social information system proposed in this paper will provide useful scaffolding for social psychologists to understand how social identity information becomes compressible through social interaction, allowing groups to become differentiable and individuals to be located within them through dynamic recursive processes (Durrheim & Quayle, 2025) and thus understand how identity is embedded in large language models from training data, and how individuals (as users or targets; subjects or objects) are located within them.

Looking to the Future: Tools and Training

A risk of introducing a method or framework—if it has the good fortune to succeed in the ecology of ideas—is that it becomes an orthodoxy to be learned by rote; and students focus mainly on learning rules for variable selection, thresholding and so on. This would not be a positive outcome. Instead, my hope is that this approach, and others like it, will encourage imagination and creativity in finding mathematical models of social-psychological systems that map well to their constitution. This requires students of social psychology to have an appreciation for the rich theoretical traditions of our predecessors, as well as the methodological sophistication required to see the potential in new methods to capture them. Nevertheless, a key challenge for the Social Identity Network approach is in developing training materials such as online workshops and tutorials to allow broad access to these tools. Some are already available (see https://resinmethod.net/ and https://surveygraph.ie) and more are in development.

Conclusion

It is of profound importance to understand the social processes by which people adopt new attitudes (e.g., in health behaviour interventions) or reject them (e.g., in radicalization

resistance); and this is a foundational question for every discipline involving human behaviour. For example, even when vaccines are scientifically feasible, they are practically useless if people cannot be convinced to use them (Lindegger et al., 2007). Similarly, the most important obstacle to addressing climate change is not technological advancement, but synchronizing our attitudes to adopt a coordinated response (e.g., McLaren & Markusson, 2020). Understanding the basic psychological processes in attitude systems is particularly important given the rapid disruption of technological innovations that facilitate social interactions online and offline, and thus transform the dynamics of social attitude coordination (e.g., Brady et al., 2020; Mooijman et al., 2018). An improved understanding of the coordination of attitudes in groups will therefore be useful for a broad spectrum of disciplines and global social challenges.

In this review, I returned to the interactionist roots of the social representations and social identity theories to argue that people are positioned at distinctive locations in a dynamic social information system that associates features with groups. This social information system is the context for attitude expressions, while also being dynamically produced by our attitude expressions and behaviour. Thus, when we express attitudes, we are positioning ourselves (by unavoidably providing information that reveals where we are located in this social information system in relation to other people) and simultaneously contributing to the system's production.

While other mathematical models also describe features of this social information system, bipartite identity networks are particularly useful because they explicitly conceptualize the duality of the system—where people are distinguished by the combination of attitudes they hold, and attitudes by the combinations of people who jointly hold them. The Social Identity Network approach thus captures the dynamic social field produced by people expressing attitudes. It is distinguished from other network approaches to attitudes by the ability to locate both people and attitudes within the broader system of which their expressions are a part (see Appendix A for a more detailed disambiguation of terminology). In this sense, it is more closely related to discursive and social constructionist, than cognitive approaches, to attitudes

and is a step towards understanding attitudes as part of a complex collective social identity information system (Durrheim & Quayle, 2025).

This approach exposes attitude expression as activity at the interface of social identity and social representation. Like the social representations approach, it treats the dynamic structure of social representations as fundamental; and, like the social identity approach, it considers the individual location in this system vital. Further, it provides methodological apparatus to observe and theorize how these processes are mutually constitutive. The Social Identity Network approach thus allows: modelling attitudes as features of social identity structures; exploring how attitudes are negotiated and agreed on in groups and societies; mapping the emergence of group structure via attitude coordination; and observing how people navigate this social identity system by their attitude expressions. This makes it ideally suited for applications focused on the dynamic coordination of attitudes, social influence and opinion contagion, and the relation of attitudes to social identity.

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[i] Applying Doise's levels of explanation to locate the Social Identity Network approach within the broader field of attitude research in social psychology, it falls somewhere between level two (interindividual) and level 3 (social position), compared to social-cognition approaches that would frequently consider processes at Doise's level 1 (intra-individual).

[ii] It is worth noting that the use of the term *interactionism* to describe the mutually constitutive relation between people and groups seems idiosyncratic to the social identity approach in social psychology (Reynolds et al., 2010); I am not aware of any other discipline using this word in quite this way, and this leads to confusion with the way this term is used in sociology or anthropology, for example. Personally, I prefer the term "dynamic recursion."

[iii] This concept falls somewhere between Lewin's (1951) more individualised "field theory" and Bourdieu's (1993) more sociological one. Although there are some parallels with both, the term "social field" here is not embedded in either more formal "field theory."

[iv] Based on Google Scholar searches on 14 March 2025 for all papers with titles containing both attitude(s) and social identity against those containing social identity only (349/19,000 = 1.8%); and papers with titles containing both attitude(s) and social representation(s) against those containing social representation(s) only (117/10,270 = 1.1%).

[v] Tajfel used the phrase "system of social identity" (Tajfel, 1969, pp. 165–166)

[vi] Of course, there are contexts like academia where disagreement is expected within implicit bounds; and "agreeing to disagree" shifts agreement to a different level of abstraction.

[vii] In this paper I focus on bipartite networks, which can be considered a special case of multilayer network. It is possible for this paradigm to be extended to consider additional affiliations in tripartite or *k*-partite networks; or for bipartite structures to be combined with social network information (e.g., interaction data) as discussed by Breiger and colleagues.

[viii] Indeed, co-authorship networks *are* bipartite social identity networks to the extent that coauthors can be assumed to agree with the core arguments of a paper.

[ix] Note that Bipartite Identity Networks are distinguished from *social networks* by the fact that people are linked by symbolic homophily rather than any (known) social relationship or interaction; and from other approaches to *attitude networks* by the fact that people are explicitly located within the symbolic structure. There is evidence that people are more likely to have relationships and interact with alters closer to each-other in homophily-space (McPherson & Smith, 2019), but this is not a necessary feature of the model.

[x] Although Breiger himself traces the core idea back further, to essays from more than a century ago by Cooley and Simmel (Cooley, 1902; Simmel, 1922).

[xi] There are contexts where disagreement is valued, such as academia; but, even there, it must be carefully managed to avoid schism and, as bipartite co-authorship analysis shows, agreement and homophily are still fundamental to social identity in this context.

[xii] Although cultural shifts since then have popularised several potential meanings for "X," including "X-Men," the renaming of Twitter to X, etc. At the time of writing, the Wikipedia disambiguation pages for "W" and "X" have 60 and 157 entries respectively ('W (Disambiguation)', 2024; 'X (Disambiguation)', 2024), which shows that both provide plenty of associative material for sense-making; and that "X" has more available associations than "W." This is simply to say that truly empty categories are less common than usually assumed, and might not even be psychologically possible given the associative nature of language and culture.

[xiii] The most common application of network methods in psychology at the moment is arguably *network psychometrics* (e.g., Epskamp et al., 2017). These methods have also been applied to modelling attitudes; however, their focus is psychometric rather than structural. The aim of the Social Identity Network approach is to model the way that individuals are tied into larger social structures via shared attitudes, which would be considered noise, bias, or even violation of assumptions, in these psychometrically anchored models.

Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analysed in this study.

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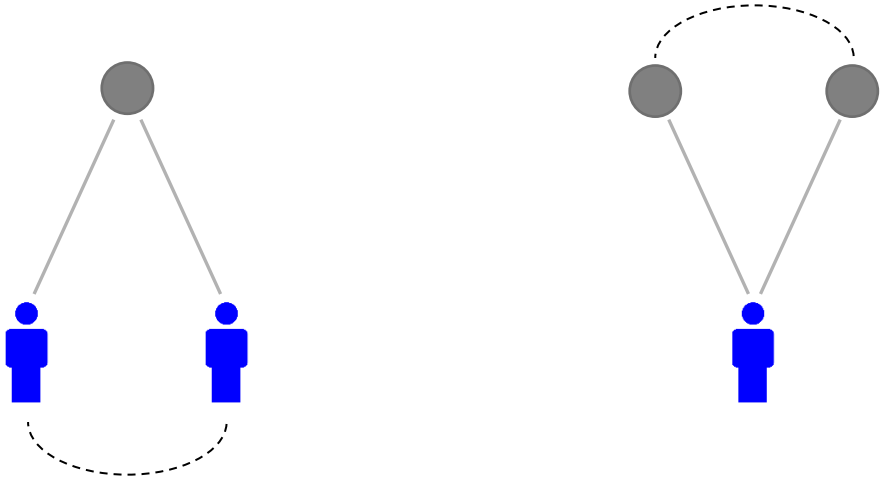
FIGURES

Figure 1

Example of Projected Links in Bipartite Social Identity Network

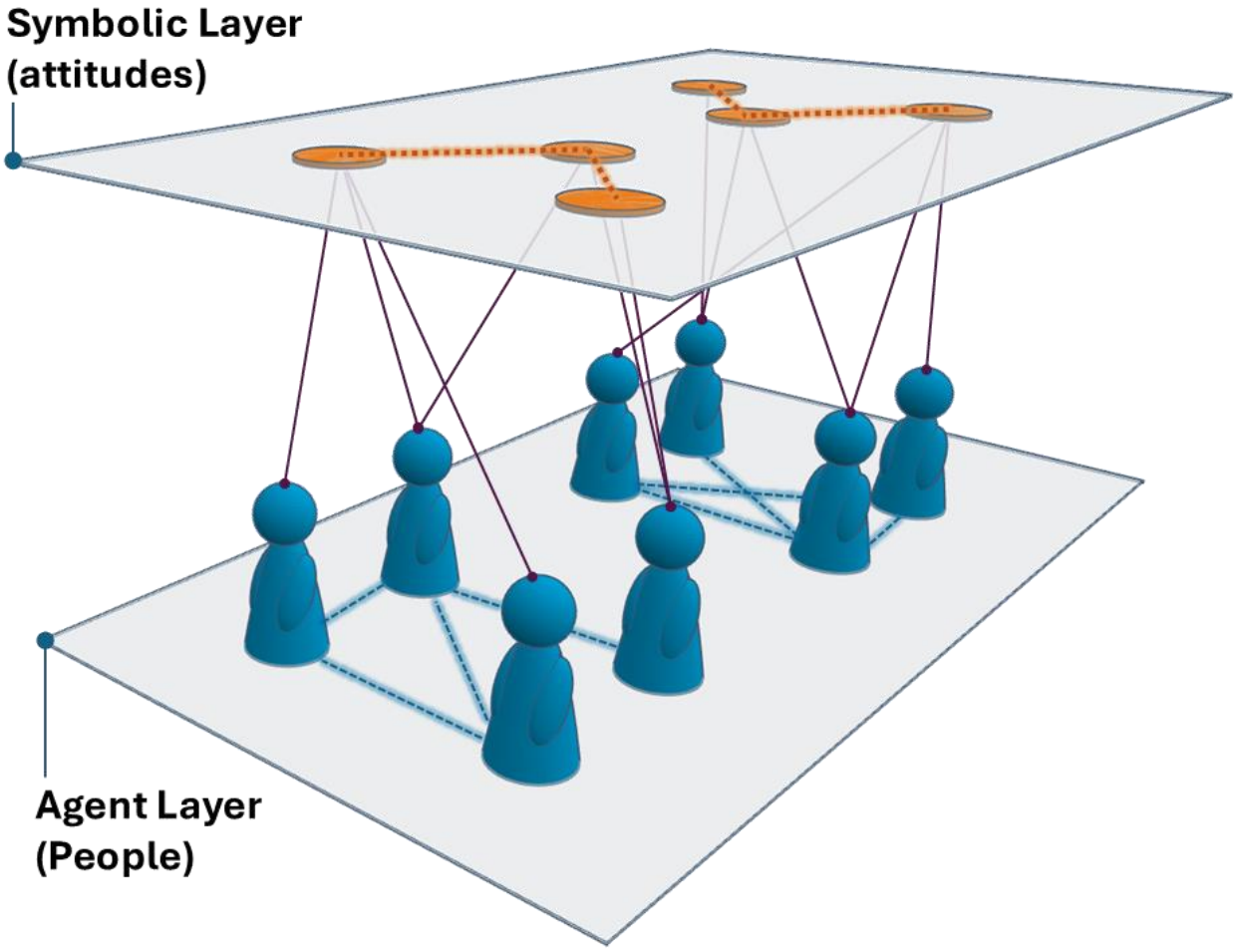


A: People linked by a jointly shared attitude

B: Attitudes linked by a person who holds them jointly

Figure 2

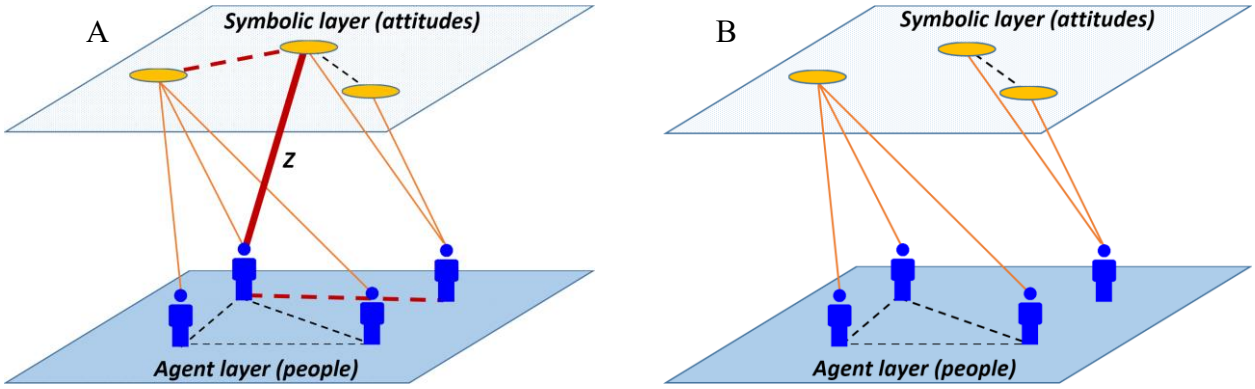
Emergent Group Structure in a Larger Bipartite Social Identity Network



Note. Nodes are people and attitudes; edges represent a person expressing an attitude. Grouping is evident in both agent and symbolic layers.

Figure 3

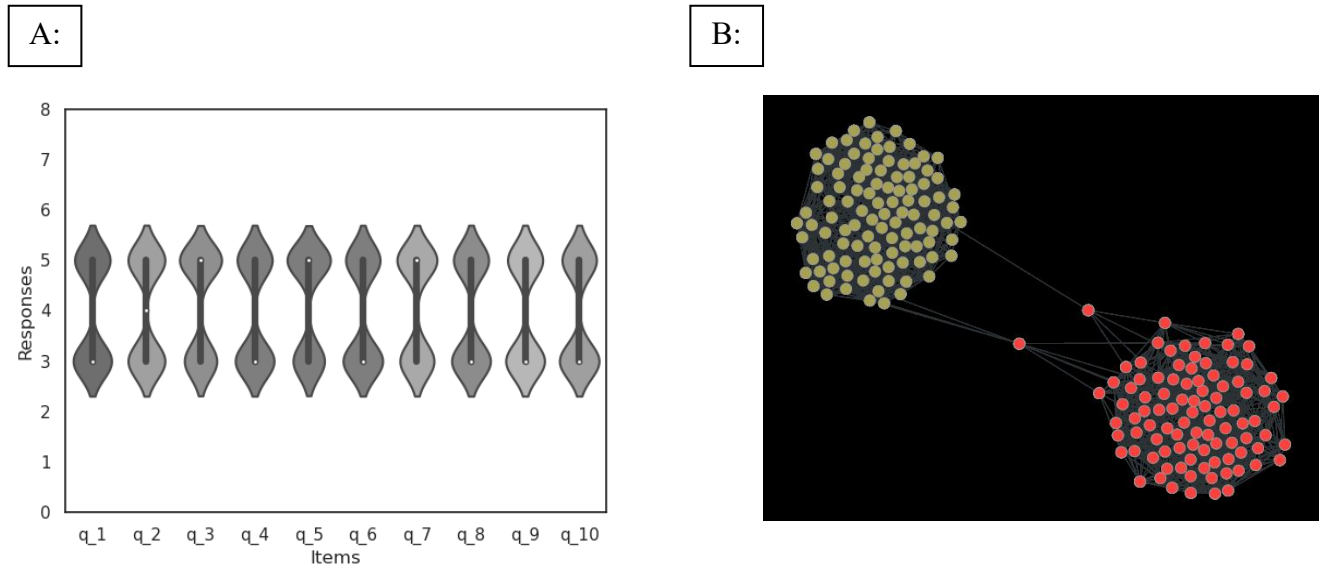
Small Changes can have Disproportionate System Effects.



Note. Removing a single edge marked Z (A; left) results in schisms in both the people and attitude layers (B; right).

Figure 4

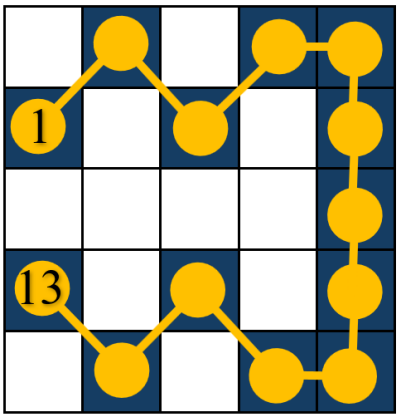
A toy network where bimodal polarization corresponds to multidimensional polarization



Note. A toy network built of responses on ten simulated items (A) and the agent layer projected with surveygraph (B) and network clusters detected with the Stochastic Block Model (SBM) method. In this example, bimodal polarization corresponds to multidimensional polarization visible in the network.

Figure 5

Non-Linearity of Network Space

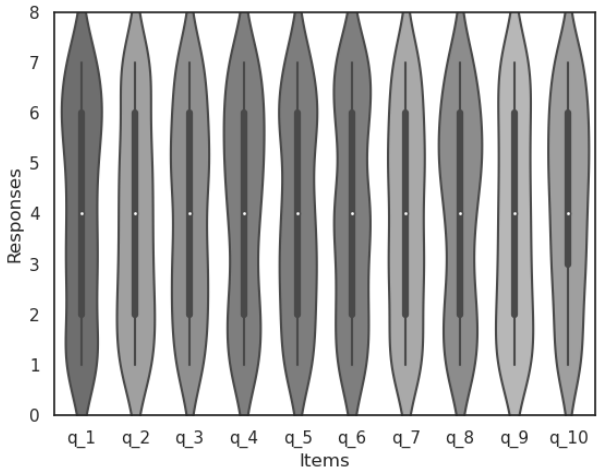


Note. The distance from square 1 to square 13 is further through the network of adjoining neighbours (12 'hops') than in Euclidian space (i.e., straight-line distance)**.**

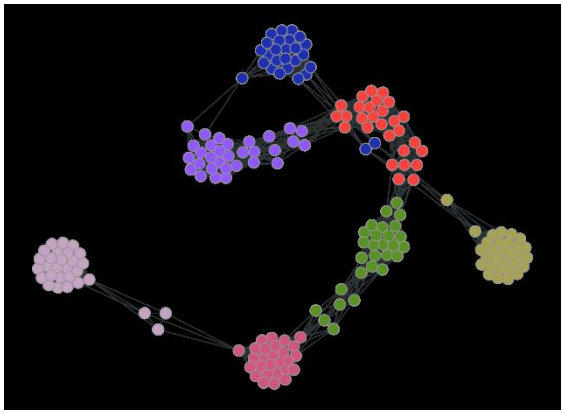
Figure 6

Toy Network with Clear Multidimensional Group Structure Despite no Obvious Unidimensional Structure

A:



B:

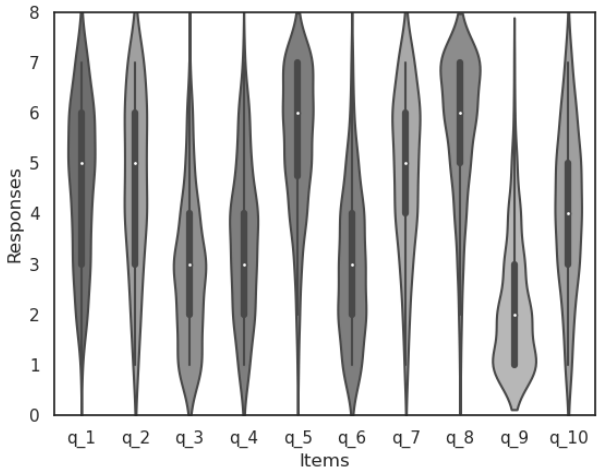


Note. A toy network built of responses on ten simulated items (A) and the agent layer projected with surveygraph (B) and network clusters detected with the Stochastic Block Model (SBM) method. Despite no obvious unidimensional patterns, complex group structure is woven across dimensions, visible in the agent network projection.

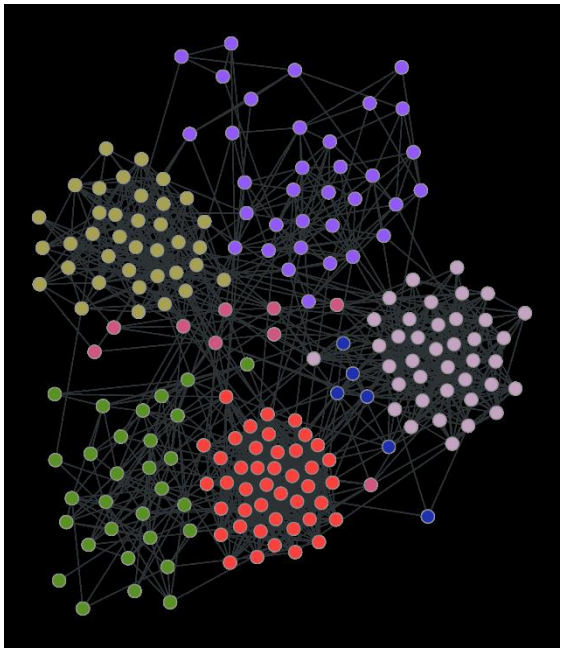
Figure 7

Toy network showing multipartisan polarization

A:



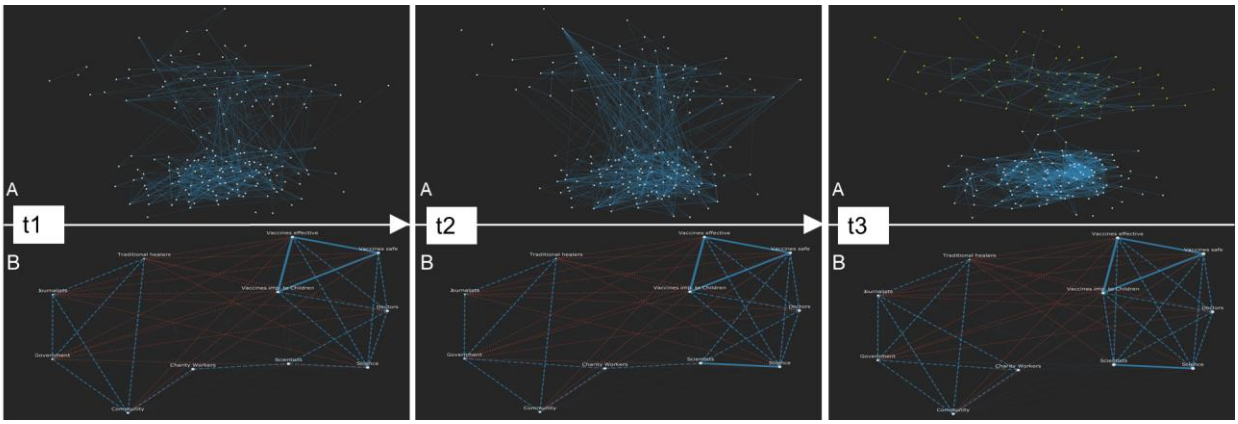
B:



Note. A toy network built of responses on ten simulated items (A) with the agent layer projected with surveygraph (B) and network clusters detected with the Stochastic Block Model (SBM) method. Multipartisan polarization is woven across dimensions.

Figure 8

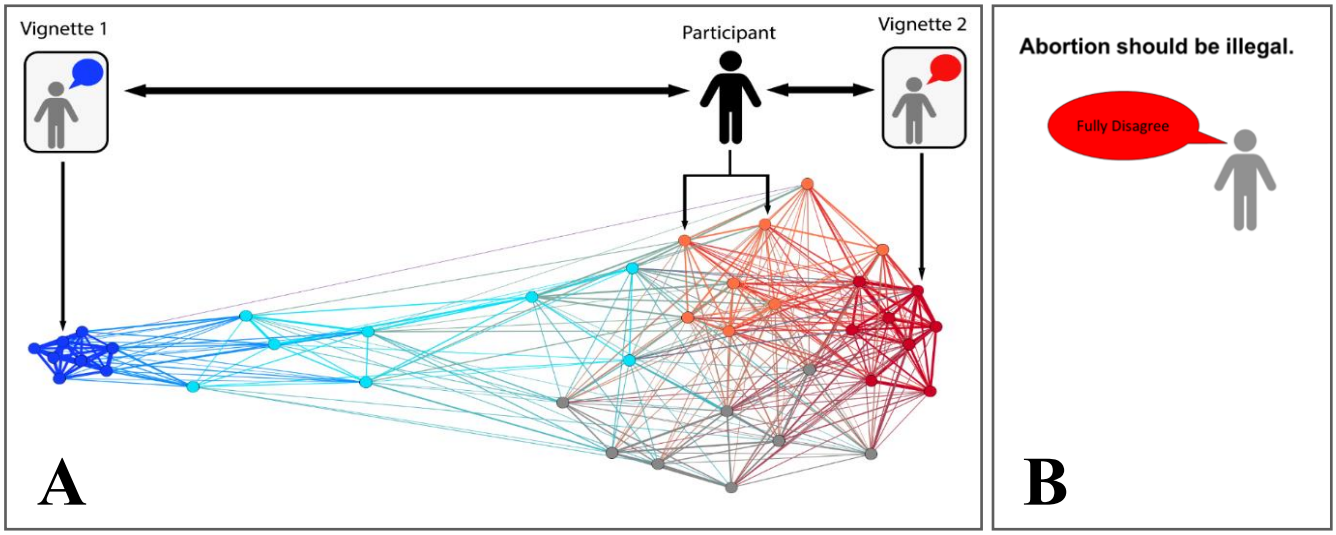
Network representations of UK health attitudes at three time points at the start of the COVID pandemic in the UK



Note. Adapted from Maher et al. (Maher et al., 2020), showing (A) participants linked when they share a high proportion of attitudes and (B) attitudes, where edges between attitudes represent the number of people sharing them (blue edges: most participants align on these attitudes; red edges: they mostly disagree).

Figure 9

RESponse Item Network (ResIN) of US political attitude item-responses



Note. (A) Attitude network reproduced from Lueders, Carpentras & Quayle (2024) constructed from US participants' (N = 396) answers to eight political attitude items plotted with the ResIN method. Nodes are dummy-coded response options (e.g., immigration-neutral; abortion-agree etc.), coloured blue/red towards the extremes of each scale conventionally associated with Democrat/Republican identity and grey for midpoint response options; edges are phi correlation. Participants are located in this network by the centroid of their eight responses (only two responses shown here as examples). Each vignette (B) is located in the network by its response-option.

Appendix 1: Suggested Terminology and Disambiguation

There are a variety of network approaches being developed and applied in psychology. Here, I will disambiguate some commonly used terminology and make some recommendations that may help to avoid ambiguity going forward.

I have struggled to invent a useful name for the present approach. *Social Attitude Networks* would have been ideal, but the term *social attitudes* already has an accepted meaning different enough to be confusing. *Bipartite Attitude Networks* would have described our current implementations but would not scale to more complex multipartite and multilayer network representations. *Networks of Attitudes and People* would not easily accommodate additional agents (such as automated bots online) or additional features beyond attitudes. Therefore, I propose, in a hierarchy from general to specific, the terms:

- *Social Identity Information System* (or just *social information system*) to refer to how social identity is embedded in every aspect of society including attitudes (of course), architecture, food, industrial design, literature, computer software and architecture, music, infrastructure, and ultimately every product of human endeavour; and how this system can be "read" to locate people within it via their expressions and behaviours.
- *Social Identity Network* to refer to network approaches to modelling how people are related to (and differentiated from) each-other via features within social identity systems.
- *Bipartite Social Identity Network*, or *bipartite attitude network*, for describing social identity networks with bipartite operationalization.

In contrast, *social networks* represent people connected by some practical social tie, such as friendship. *Social Identity Networks,* as described in the present review, are not *social* networks since ties represent homophily on attitudes rather than practical social ties. However, a

multilayer network could represent social ties and homophily in a single system; practically this could consist of the agent projection of a bipartite network in one layer and social ties in another, but the relationship between these layers would need to be discovered, and may depend on the specific nature and context of the social ties.

Belief networks represent ties between beliefs (conceptually similar to attitudes), either modelled at the social level (as a kind of "average" representing what most people believe) or at the individual level (representing individual cognitive representations of the social system). A belief system modelled at the social level is conceptually similar to the symbolic projection of the bipartite social identity network, although further research will be required to assess their practical similarities. Note also that the social identity network approach models attitude *expressions* (which can be directly observed) rather than latent attitudes (which need to be inferred) and can thus use simpler statistical models.

Psychometric networks are perhaps the best-known network approach in psychology, and analyses are frequently referred to simply as "network analysis," which is not a practice I recommend. There is only tangential conceptual relationship between social identity networks (modelled at the interface of the personal and the social) and psychometric networks (modelled as network ties between *variables*), which are more closely related to structural equation models.