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Graphing the Self: An Application of Graph Theory to Memetic Self-mapping in Psychotherapy

Lloyd Hawkeye Robertson[1], Robert Cassin McFadden[2]

1) Athabasca University, Canada
2) Mobile Detect Inc.

Date of publication: March 30th, 2018
Edition period: March 2018 - July 2018

To cite this article: Robertson, L.H., & McFadden, R.C. (2018). Graphing the Self: An Application of Graph Theory to Memetic Self-mapping in Psycotherapy. *International and Multidisciplinary Journal of Social Sciences*, *7*(1), 34-58. doi: 10.17583/rimcis.2018.3078

To link this article: http://doi.org/10.17583/rimcis.2018.3078

RIMCIS – International and Multidisciplinary Journal of Social Sciences Vol. 7 No.1 March 2018 pp.34-58

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Lloyd Hawkeye Robertson
Athabasca University

Robert Cassin McFadden
Mobile Detect Inc.

Abstract

The benefits of using mathematical concepts are frequently overlooked in qualitative inquiry. In this paper, Graph Theory (GT) is applied to a series of two dimensional representations of the self used to illustrate the therapeutic progress of a suicidal youth and a young mother coping with depression. These self-maps are shown to be equivalent to GT networks with the self-map memes corresponding to GT vertices, the pair-wise relationships between memes corresponding to GT edges, and the time evolution of the self-mapping diagrams corresponding to GT sequence analysis. Consideration is given to the notion that the self so mapped functions as a small world network with emotive psychological triggers serving as "long range" connections. The advantages of using an interactive Graphical User Interface and GT metrics for client centered therapy and future research applications in social science are discussed.

Keywords: self, self-mapping, graph theory, suicide ideation, memes, small world networks

ISSN: 2014-3680
DOI: 10.17583/rimcis.2018.3078

RIMCIS – International and Multidisciplinary Journal of Social Sciences Vol. 7 No.1 March 2018 pp. 34-58

Perfil Grafeando el Sí Mismo: Una Aplicación de la Teoría de Grafos al Auto-mapeo en Psicoterapia

Lloyd Hawkeye Robertson
Athabasca University

Robert Cassin McFadden
Mobile Detect Inc.

Resumen

A menudo no se presta atención a los beneficios de usar conceptos matemáticos en la investigación cualitativa. En este artículo se aplica la teoría de grafos (TG) a series de representaciones de dos dimensiones del sí mismo usadas para ilustrar el progreso terapéutico de un joven suicida y de una madre afrontando una depresión. Estos auto-mapas se presentan como equivalentes a redes de TG con los memes de auto-mapas correspondientes a los vértices de la TG, las relaciones por pares entre memes correspondientes a los extremos de la TG i a la evolución temporal de los diagrama auto-mapa correspondientes al análisis secuencial de la TG. Se tiene en consideración a la noción que las funciones de mapeo del sí mismo como una red de un pequeño mundo con desencadenantes psicológicos de emociones haciendo de conexiones de "largo alcance". Las ventajas de utilizar una interfaz gráfica del usuario interactiva y métricas de TG para la terapia centrada en el cliente y se discuten futuras aplicaciones a la investigación en ciencias sociales.

Palabras clave: sí mismo, auto-mapeo, teoría de grafos, ideaciones suicidas, memes, redes del pequeño mundo

ISSN: 2014-3680
DOI: 10.17583/rimcis.2018.3078

Using a conceptualization of the self as a cultural construct (Blackmore, 1999; Mead, 1912/1990; Shotter, 1997), Robertson (2010) created two dimensional maps of constituent memes of the psyche[1]. Memes were defined as units of culture that are self-replicating in the sense that they can be passed from one individual to another in a form of imitation, but the properties promoting replication are highly individualized reducing the fidelity of that replication.

In a subsequent case study, he (Robertson, 2011b) presented three diagrams representing a the self of a youth with suicide ideation as it changed during the course of therapy. The client's initial resistance to treatment was understood as a function of her constructed identity centered on the self-descriptor "depressed person." Treatment involving Cognitive Behavioral and Adlerian Psychotherapy proved to be efficacious when augmented with the co-construction of an alternate core to her sense of self. He refined this method of memetic self mapping with subsequent clients (Robertson, 2016); however, the process of constructing these maps continues to be labor intensive involving the identification of memes and their attributes as understood by individual.

This paper re-examines the mapped progress exhibited by youth experiencing suicide ideation (Robertson, 2011b) from the perspective of Graph Theory (GT)[2] networks with memes taken as corresponding to GT vertices and the pair-wise relationships between memes corresponding to GT edges. Self-mapping diagrams are used to illustrate GT's potential for sequence analysis in understanding the evolution of a suicidal youth's self during therapy.

A subsequent self-mapping diagram featuring a woman battling depression is used illustrate how emotions can trigger habitual responses represented as clusters of memes. These triggers are represented as long-range connections as understood in the application of small world networks. This application of GT introduces a mathematical understanding to the process of self-mapping with potential applications to the development of representational software making the technique of memetic self-mapping more accessible to therapists and their clients.

The application of GT to memetic self-mapping implies an algorithmic process with implications for understanding the construction and evolution

of the self. This self forms the core of our worldview and our intentional actions. We therefore include potential applications of this method to disciplines outside of the realm of psychotherapy in our discussion.

Characteristics of Memes used in Self-mapping

Robertson (2010) defined memes as units of culture with four constituent components: connotative, affective and behavioral dimensions coupled with a referent word or phrase used as a mental notation. The meme is understood in consciousness as units of culture representing underlying self-referencing concepts. Robertson suggested that these overlapping dimensions simulated the forces of attraction between memes as posited by Dawkins (1976), Dennett (1995) and Blackmore (2000). Since connotative and affective meaning may also serve to repel discordant ideas and concepts, a dynamic is thereby created allowing for the development of discreet and stable complexes of memes existent in individual minds. The self as mapped by Robertson (2010, 2011a, 2014, 2016) is such an interlocking complex of mutually attractive memes with such complexes exhibiting persistence and stability coupled with a capacity to change or evolve over time. Repellant memes may either exemplify "what the self is not" or introduce instability into the self.

Figure 1 recreates a memetic self-map co-constructed with a client known in the literature as "Suzie" (Robertson, 2011b). Words within ovals are referents for a complex of connotative, affective and behavioral characteristics describing self-referencing units of culture or memes. Memes near the core of the diagram were considered more central to her self-definition.

Each meme in Figure 1 represents an individual construct unique to the client but related to the client's culture. For example, the meme labeled "heart shaped boxes" included: (1) the connotation of love, (2) emotions of wistfulness and regret that she could never obtain that love and, (3) the behavior of collecting heart shaped boxes. That the same meme was presented in a song of that name by the group Nirvana[3], popular at the time of this youth's therapy, is indication of how internalized memes are related to and drawn from a menu of possibilities afforded by culture. The "heart

shaped boxes" meme is depicted as linked to another meme representing a more general concept of love and to the "dramatic person" meme because her behavior in collecting those boxes represented an enactment of her connotative and affective associations with her experience of romantic love. In this way memes form "associations" that give stability to the entire structure. As we shall see, such stability can hold discordant or dysfunctional self-identifying memes in place in opposition to the conscious will of the person whose self is so identified.

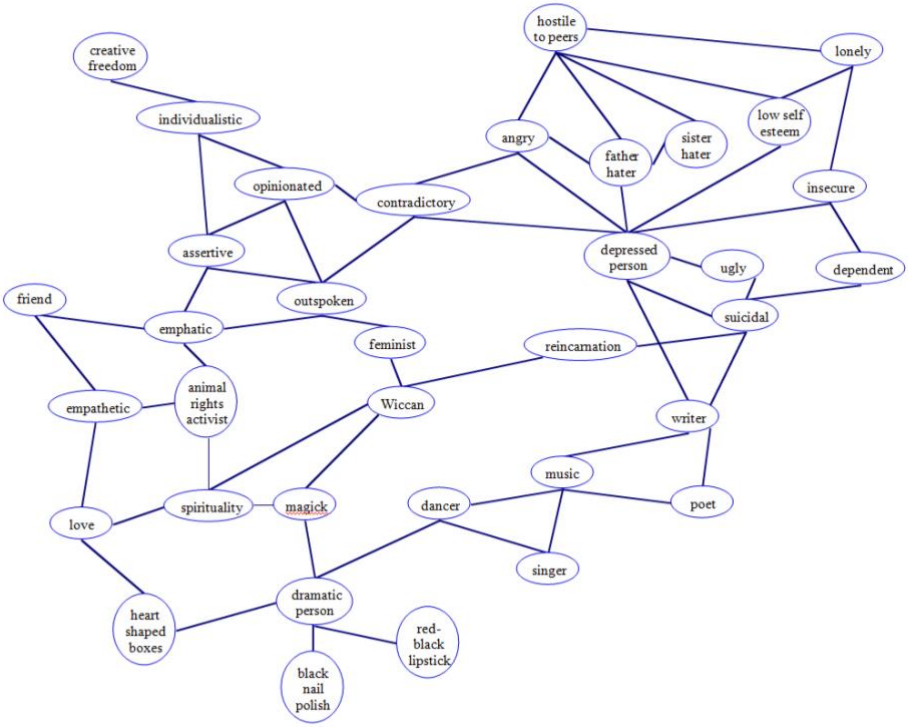

Figure 1. An initial self-map of the suicidal youth displaying interconnected memes

Although memes may be elicited from culture, each is individualized to fit the recipient's reality (Atran, 2001; Gabora, 2004). Thus, Figure 1 contains the meme "magick" (sic), with the referent selected for its

connotation of actual supernatural force. The usual spelling of the word (magic) connoted, in her mind, fakery. The co-construction of a new core self coincided with successful treatment. This outcome is consistent with research showing that a person's conscious scripts impact on emotional functioning and present as distinctive patterns of brain activity (Cerqueira et al., 2010).

An Application of Graph Theory to Memetic Self-mapping

Graph Theory employs mathematical objects in computer [network] science to model real-world systems (Foulds, 2012; Gross & Yellen, 2004; West, 2001). Insight is gained into the system through the application of theorems about graphs and visual and computer assisted analysis. Since the memetic self-map produced in Figure 1 was developed without reference to it, we must consider the possibility that the failure to initially ground memetic self-mapping in GT led to reduced analytical capacity. The correspondences between GT and memetic self-mapping are not immediately clear because of diffences in terminology, but GT has been flexible in its use of terms. For example, graphs are sometimes called *networks*, vertices are sometimes called *nodes*, and edges are sometimes called *arcs*. While acknowledging a spectrum of such usage, each vertex represented a data object with linked directed edges indicating relationships between objects. With respect to intimate attraction, for example, each vertex represented a person and each edge represented a romantic attraction. With respect to airline connections, each vertex represented an airport with edges representing connecting flights. With respect to their representation of the World Wide Web, each vertex represented a web page with directed edges between vertices representing hyperlinks. Additional aspects of the phenomenon to be represented were captured by assigning numbers to edges and colors to vertices. Table 1 illustrates the correspondence of terminology used to map the suicidal youth's self with that used in the development of graphs and networks.

Table 1
Correspondence of terminology used in memetic self-maps, graphs, and networks

Self-map	**Graph**	**Network**
Meme	Vertex	Node
Attractive / Repulsive relationship	Edge	Arc
Map	Graph	Network
Relationship with arrow	Directed edge	Non-duplex
Psychological strength	Edge line weight	Bandwidth
Inter-meme distance → relevance / impact	Edge line length	Transmission time latency
Meme degree (number of relationships)	Degree of vertex	Connections
Path to meme (number of)	Path (countable)	Routing
Adjacent memes	Adjacent vertices	Connected
Relationship incident on meme	Edge incident on vertex	Connection
Meme cycle in cyclic self-map	Cycle in a cyclic graph	Loop

We can see that memes, represented by ovals in Figure 1, correspond with the terms “vertex” and “node” in GT. Attractive forces between memes were represented with connecting lines termed variously as “edges” or “arcs” in GT. Relationships between memes were considered to be bi-directional; however, unidirectional relationships could be represented using arrows. The depictions of other characteristics such as psychological strength, impact, relationship, and internal cycles could be enhanced using GT concepts.

Robertson (2011b) represented the strength of bonding of two memes by the proximity of their locations: memes closer to each other exhibited greater attractive force than those further apart. Considerations of attractive or repulsive psychological strength may be clinically estimated and represented graphically using edge line weight. Similarly, other psychological considerations, parameters and psychometrics such as represented by meme degree and cognitive pathways can be identified, captured and notated explicitly using GT theory thereby increasing the precision and the representational accuracy of the figure.

In Figure 1 we see that the meme "depressed person" is connected to eight adjoining memes (degree = 8) supporting its designation as a core of the self-structure. While the referent "depressed person" was defined as one who suffers from the condition, for this client it connoted suicide ideation, feelings of being ugly and the behavior of writing from this perspective. Sequential patterning can be observed between proximate memes. There are approximately a dozen routes (self-map paths) by which Suzie's thoughts could turn suicidal, most of which involving the core meme "Depressed Person". Figure 2 isolates and illustrates two such routes.

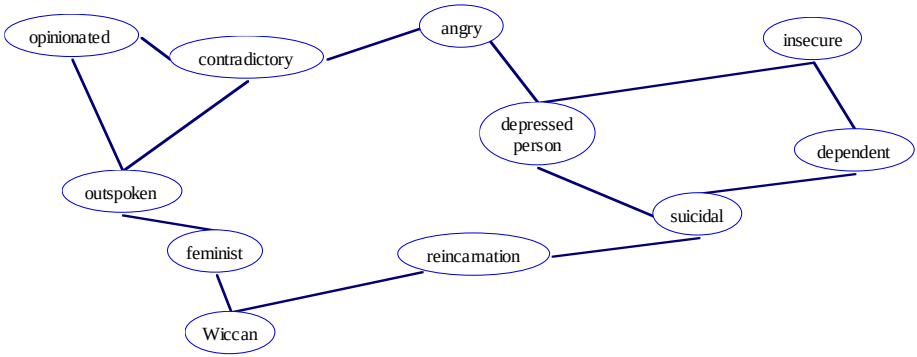

Figure 2. An illustration of memetic self-map paths or routes leading to suicide ideation in the self of "Suzie"

This client's cognitions could begin at any point along the paths reproduced in Figure 2 and lead to suicidal thoughts. Once experiencing suicide ideation, a positive feedback loop is represented leading from

"dependent" to "insecure" to "depressed person" and returning to "suicidal". Rumination on this feedback loop served to increase client distress. Although the most common pathway to suicidal thoughts with respect to this client was through depression, an alternate route leading from the client's beliefs in Wicca to reincarnation to suicide ideation is also illustrated leading to suicide ideation without the necessity of first experiencing anger or depression, but amplified by the now familiar feedback loop. This self-destructive cycle may be activated by random internal or external events leading to suicide ideation and an eventual attempt.

Sequentially linked memes as illustrated above may be viewed as cognitive scripts leading to patterned behaviors within an overarching self-defining narrative. The self that is the protagonist in such narratives may be mapped so as to identify and graphically represent internal relationships and thematic possibilities. The emotive mechanism by which external events may trigger rumination on self-destructive memes is not shown here but will be considered in the examination of the self as a small world network. First, however, we trace how treatment progress may be understood using GT.

Treatment of a Suicidal Youth from a Graph Theory Perspective

As was noted in Table 1, the number of edges attached to a vertex is the "degree of the vertex." A success metric in therapy would be the reduction in the degree of memes leading to adverse or negative outcomes. In the case of Suzie's self (Figure 1) the meme with the highest degree (8) was "depressed person." Since an edge represents a force of attraction, attempts to lift her depression met with unconscious resistance from connected memes. In addition, linked memes (anger, suicide ideation and low self-esteem) are representative of high suicide risk (Burns, Patton & Burns, 2000; Cornette, Strauman, Abramson & Busch, 2009; Eltz et al., 2007; Valadez et al., 2009). Two clusters of memes are evident in Figure 1 with the cluster including "suicidal" largely self-negating. Using a GT and memetic self-map perspective, transitions between the self-negating and self-enhancing clusters may be thought of as occurring through "gateway memes" and "gateway paths". The four gateway memes illustrated in Figure 1 include: angry, contradictory, reincarnation, and writer. The eight gateway paths enabling

affirmative to negative transitions are: angry –> hostile to peers; angry –> father hater; angry –> depressed person; contradictory –> depressed person; contradictory –> angry; reincarnation –> suicidal; writer –> depressed person; and writer –> suicidal.

Robertson's (2011b) therapeutic strategy was to create a new and alternative memetic theme with the referent "human rights" around which a positive cluster of already existent memes could be organized. Such a development would strengthen the "social interest" aspect of the client's self to help give her life meaning and purpose. Aspects of memes surrounding that theme were reframed to support the new theme. For example, the gateway meme linking the depressed person and human rights clusters, "contradictory," was reframed as having a positive connotation with respect to the client's ability to take unpopular stands with respect to causes in which she believed. The client was challenged to direct her writing toward topics associated with her new memetic theme of "human rights" as opposed to the theme "depressed person." The effects of these therapeutic interventions after three months are illustrated in Figure 4.

The meme "depressed person" is illustrated in a rectangle to signify its centrality as a life theme. The new meme "human rights" is also represented in a rectangle signifying our therapeutic attempts to develop it as a life theme or alternative personal center of gravity. Directional arrows flow from the new theme to signify our attempts to attach it to memes already existent in the client's self. The number of edges connected to "depressed person" and "suicidal" remained the same, but with six edges the new thematic meme allowed for an increased number of pathways associated with positive behaviors. Continued therapy served to increase the number of edges supporting the new human rights core while reducing those supporting "depressed person" with progress indicated in subsequent maps (see Robertson, 2011b).

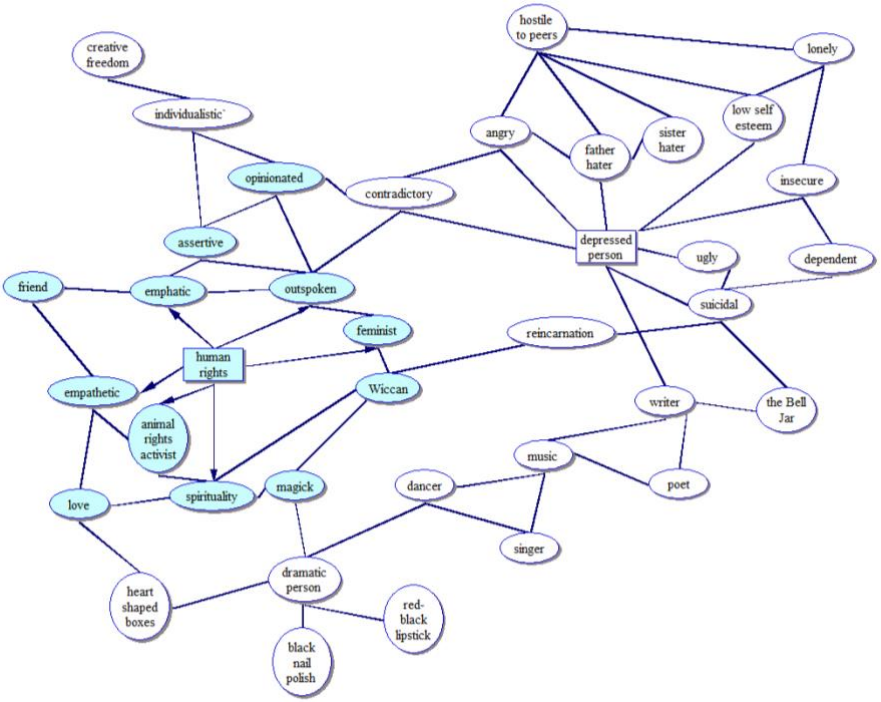

Figure 3. *Memetic self-map of a client with suicide ideation three months into therapy with themes represented by rectangles and those memes supporting a new "human rights" cluster highlighted*

During the fifth month of treatment "human rights" with nine degrees had become the defining memetic theme in Suzie's self while "depressed person," was reduced to six. The number of gateway memes leading to the cycle of suicide rumination had been reduced to two. After seven months "depressed person" was not viewed as a self-defining meme but as an emotional state people sometimes experience. During the course of therapy the degrees associated with the meme "suicidal" were reduced from five to two and the degrees associated with "depressed person" were reduced from eight to two. Treatment progress is summarized in Table 2 using a GT analysis.

Table 2.
Cluster, gateway and selected degree of meme changes during the course of therapy provided a youth with suicide ideation

Sequence # Months into therapy	Suicidal meme degree	Depressed person meme degree	Number of gateway memes	Number of gateway paths	Thematic clusters
#1 One month	5	8	4	7	Depressed person
#2 Three months	5	8	4	7	Depressed and human rights
#3 Five months	4	6	2	4	Depressed and human rights
#4 Seven months	2	4	1	1	Human rights

The Self as a Small World Network

In their examination of connections in GT networks, Watts & Strogatz (1998) demonstrated that the existence of even a few longer range connections reduced the minimum path length of networks of self-organizing systems without deleterious effects on local clustering. Drawing on research using fMRI experiments, Bassett and Bullmore (2006) concluded that such a small-world network model provided a powerful approach to understanding the structure and function of human brain systems. The self as illustrated in Figures 1 and 3 are without recognizable long range connections; yet, from an evolutionary perspective such connections would be expected. As Bassett and Bullmore (2006) explained, "Small-world topology is associated with low wiring costs and high dynamical complexity, suggesting that small-world brain network topology

could indeed have been selected to optimize the economic problem of cost-effective information processing" (p. 516).

The memetic self-maps discussed previously in this article were created by linking memes that shared connotative, affective or behavioral characteristics. Pathways were mapped highlighting cognitive and behavioral scripts related to suicide ideation. These pathways involve a progression through short connecting links simulating conscious thought, but sometimes events, both internal and external, can act as triggers to focus attention on certain aspects of the self. Missing is representation of intuitive and unconscious forces that can lead to thought clusters instantaneously without the necessity of pursuing a series of short connections from a given location.

The illustration of a young mother's self in Figure 4 resembles that of "Suzie" with the addition of directed edges emanating from her emotional centers pictured at the base of the self-map. Emotions, when triggered, could in turn activate specific clusters of her self-definition centered on themes such as "empowered", "family person", "love" or "anxious" (Robertson, 2014). Such emotions, in turn, could be triggered by internal factors such as memories, or by external contextual cues. Her self presentation, then, would flow from a combination of local clustering and longer range thematic and emotive connections.

The addition of long-range connections in the example illustrated in Figure 4 had an unexpected therapeutic application. The woman whose self is presented had previously refused anti-depressant medication because she believed it was important for her to experience all of her emotions. During the course of self-map construction she realized that her depression and associated guilt had been blocking her ability to feel other emotions, and she became amenable to the idea of using medication to remove that blockage. The addition of such long range connections whereby specific thematic clusters may be triggered by various psychological mechanisms including emotions represents a further refinement that can explain comparatively sudden changes in behavior including the experience of insight. From the perspective of GT it can explain an additional variable that could otherwise confound analysis.

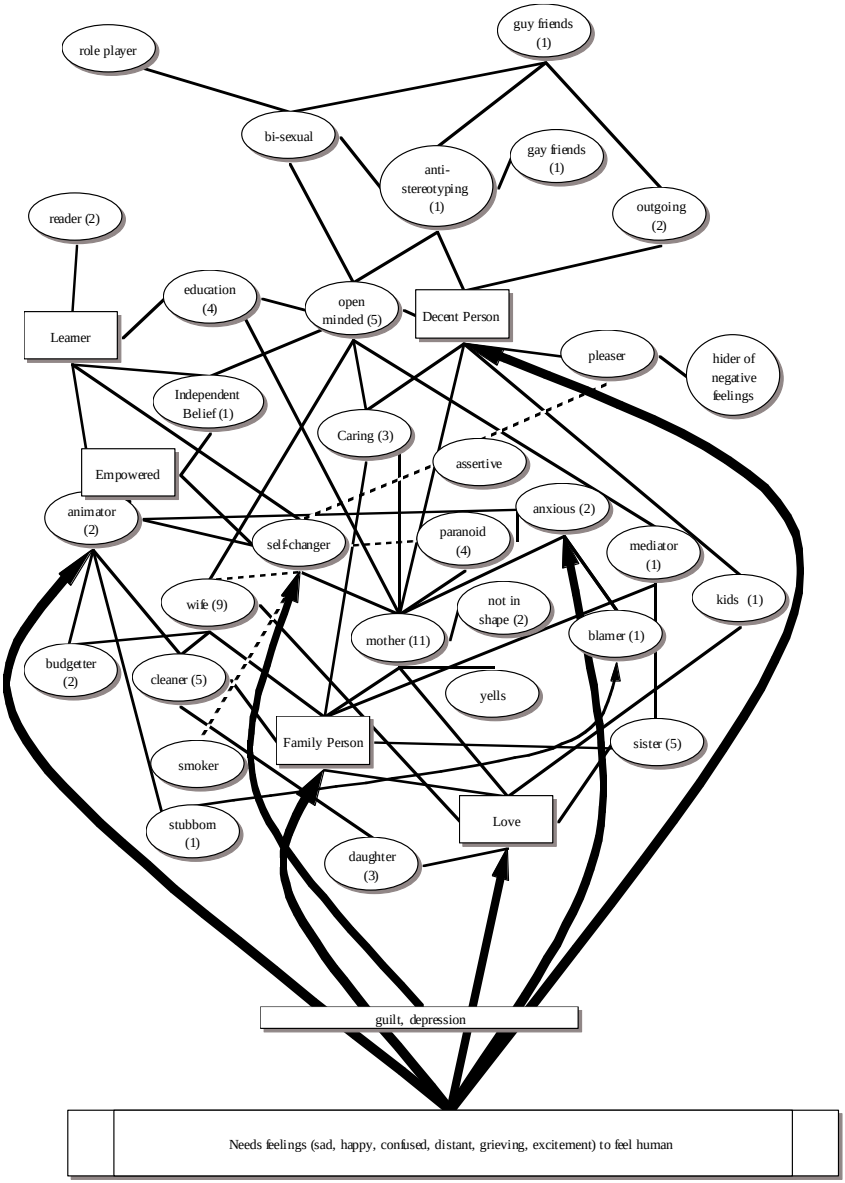

Figure 4. The self of a young mother displaying directed edges emanating from emotional centers

Discussion

This review demonstrated synchronicity between memetic self-mapping as it has been used in therapy and GT. It is argued here that GT can be used to understand the process used to create memetic maps of the self and this will allow for more precise construction of such maps while giving practitioners a way to quantify client progress. It is further argued that the benefits of a GT understanding of memetic self-mapping will be enhanced, and the ease of self-map making increased, through the development of software using a GT analysis. We begin this discussion with the implications this applied GT understanding has for the practice of psychotherapy. This will be followed by a discussion of some implications this melding of theory and technology for research into psychology and related fields in the social sciences.

Implications of GT Enhanced Self-mapping for Psychotherapy

The practice of psychotherapy has been dominated by constructs in which a self is assumed as with self-esteem (Bachmana, O'Malleya, Freedman-Doana, Trzesniewskib & Donnellanc, 2011; Crocker & Major, 1989), self-concept (Cummins, 2005; Nguyen & Scott, 2013), self-actualization (Maslow, 1987; Tang, 2001) and self-efficacy (Bandura, Barbaranelli, Caprara & Pastorelli, 2001; Caprara et al., 1998). Curiously, discussions of the self that lies at the core of such constructs have been dominated by philosophers (Dennett, 1995; Hume, n.d.; Seigel, 2005; Taylor, 1989). Those psychologists that have made contributions to our understanding of the self have frequently done so from a philosophical stance (Cushman, 1995; Hermans & Hermans-Jansen, 1995; Leary, 2004). Psychology as an applied science (with psychotherapy an even more applied subset of the discipline), requires concrete measurable paradigms from which to operate distinct from philosophy. GT enhanced memetic mapping could provide such a way of understanding the self similar to the function of inventories and scales in the study of sub-categories like self-esteem, self-concept, self-actualization and self-efficacy. Specifically, it provides a concrete way of visualizing and measuring the represented construct.

The self has been described as a personal theory about who one is (Harre, 1984). This cannot be simply objective self-description as we tend to become who we image ourselves to be, yet it is often difficult to change our imagined selves. As Robertson (2017a) noted, we have an evolved objective sense with individualized notions of what constitutes evidence. As the example of Suzie demonstrated, we cannot simply wish ourselves to be a different person; we need evidence that the imagined difference is real, and such evidence must meet our unique criteria to overcome the feeling that we are merely fooling ourselves. Psychologists dealing with the problem of low self-esteem have noticed that clients frequently require extraordinary evidence to build that self-esteem while evidence maintaining a negative self-image is more readily accepted (de Man & Becerril Gutierrez, 2002; Wiederman & Hurst, 1998). Change to the self involves a complex interplay between the objective and the subjective, and the need for a stable self will sometimes trump the need for a better self.

Both cases reviewed in this paper demonstrated the potential of memetic self-mapping as a method of acknowledging and examining the constructed self, and in the process, visualizing opportunities for change. However, as Blustein and Noumair (1996) noted, the concept of the self appears to be idiosyncratic to the practitioner, and unless the process of creating self-maps is standardized there will likely be problems with respect to replicable validity. The translation of memetic self-mapping into the form and language of GT invites the possibility of computer applications that would standardize the process of self-map creation and in the process increase the ease of doing so. In addition, this process would make the automatic capture of numerical data relevant to GT analysis possible. Such a software package could then be used to identify cognitive paths by which clients re-enact ritualistic behaviors allowing for nodal point clinical interventions reducing risk during times of personal crisis.

The number of paths to inappropriate or dysfunctional behavior is both a metric of memetic self-maps and a consideration in therapy. Relationship strength on the map is specified by the user through the relative placement of memes. This user-defined relationship length can then be quantified using the coordinate system of the map. Each relationship thus has an associated user defined length. In creating the map, users would have the opportunity

to express the relative psychological proximity of all the relationships so entered. Further, changes that occur over the course of therapy with respect to the degree of each meme, number of paths between pairs of memes and strength of relationship can be automatically calculated and presented to the therapist as system output.

Thick edge lines, such as those found in Figure 4, may be used to represent specific psychological clinical factors. Such factors include triggering emotions, inherited characteristics and cognitive themes that serve to trigger context specific presentations. Such refinements represent the long range edges recommended by Bassett and Bullmore (2006) as contributing to efficient mental processing. User specified numerical weights could be assigned at the time of self-map creation or later in editing. During the course of therapy a temporal series of memetic self-maps may be used to represent evolving psychological characteristics.

Applications of GT Enhanced Self-mapping for Research

In a qualitative study of a cross-cultural sample Robertson (2010) found that the selves of healthy adults universally included elements of volition, constancy, distinctness, productivity, intimacy, social interest and feeling. It is a reasonable speculation that the self-maps of some populations with mental health disorders would display deficiencies in one or more of these areas. The initial self-map of Suzie (Figure 1), for example, did not display indicators of effective individual volition or social interest[4]. We can visualize a computer software program that would facilitate the quantitative research necessary to demonstrate such characteristics in random samples of clinical populations. An example of a population that may be served by such a software program would be those individuals whose self-identities need to be rebuilt following acquired brain injury. With a template of the functional healthy self, it may be possible to develop strategies to replace missing elements using the brain's plasticity for self re-construction.

The application of GT analytic tools and metrics to memetic self-mapping has broad potential application to psychological research. Harter (2012), for example, suggested that the self undergoes a series of developmental transitions with the early childhood self exhibiting

narcissism. Developmental psychologists could use this technology for tracing the development of the self over formative years. Similarly, it could be used in sociological research into cross-cultural difference, comparisons between individualist and collectivist selves, and gender difference.

Computerized self-mapping has potential applications to post-colonial research. While the concept of historic trauma has been shown to be more of a metaphor for the ethnostress caused by colonization than a valid psychological construct (Kirmayer, Gone & Moses, 2014; Robertson, 2015; Waldram, 2014), its affect on the self could be estimated by examining existent populations.

This technology would be useful in sociological studies involving self transformation. For example, Robertson (2017c) demonstrated that in Canada people were as likely, over the course of their lifetime, to marry despite legal changes reducing the economic advantages of marriage, outlawing discrimination on the basis of gender, elevating the status of common-law unions, and increased economic support for single-parent mothers over the course of four decades. Since common law unions predominate in the younger adult cohort (age 21-31) and since social stigma associated with non-traditional unions had also been reduced in Canada (Bouichard & Lachance-Grzela, 2016), he reasoned marriage is not, primarily, a response to social pressure nor a rite of passage. He suggested marriage meets a need to acknowledge or reinforce a transitional change in the self. Further research into the transitional selves of betrothed couples would be aided by the development of the suggested software. Similarly Robertson and Conrad (2016) suggested that the process of Prior Learning Assessment and Recognition used to give experiential learning educational credit resulted in transformative change in the individuals undergoing the process. Again, that change could be seen and measured using the suggested technology.

Public policy development with respect to populations not amenable to research such as terrorists or criminal gang members could be undertaken using GT software technology applied to memetic self-mapping. Through the organized application of collective observation, using group assessment to counter individual bias, the analysis of writings, recordings and other artifacts of such targeted populations could be undertaken to develop

memetic profiles. These profiles would include the identification of triggering factors, psychological intervention strategies and the prediction of behavioral outcomes.

Recognizing the notion of a mind-virus as proposed by Dawkins (1976, 2006), Brodie (1996), and Dennett (1995) has been criticized as tautological (Boyd & Richardson, 2000; Burman, 2012; Gabora, 2004), Robertson (2017b) outlined conditions by which the metaphor of a mind virus could be useful avoiding such concerns. He argued the self may be understood as a corporeal body upon which structures that metaphorically act as viruses, may be understood. Using examples from suicide contagion, suicide cult, terrorism and religion, he discussed possible mechanisms for mind-viral transmission and criteria for defining whether a mind-viral "infection" has occurred. A subsequent article (Robertson, 2017a) traced the cultural evolution of the self from approximately 1,000 B.C.E. and suggested that the mind, as it evolved culturally, has certain attributes such internal consistency, causal thinking and individual volition. A mind virus, then, would be understood as a culturally transmitted complex of memes that would cause the individual to forgo such operations of mind. The existence of this phenomenon would be demonstrated if successive self mappings showed a deleterious effect on the mind of the individuals so mapped. The effects of communication strategies and advertising on the mind of target groups (such as those targeted for jihadist recruitment and indoctrination) could be measured with potential security and commercial applications.

In summary, we have demonstrated how Graph Theory may be said to apply to the technique of mapping the self memetically. This application has implications for future uses of this technique, and for the development of software applications that would simplify and standardize the creation of memetic self-maps. The collaborative approach of self-map generation would be enhanced by increased client input and oversight allowed for by shared computer technologies. Potential interdisciplinary applications for research were discussed.

Notes

[1] The word "meme" is a neologism coined by Dawkins (1976) to represent a small unit of culture that is self-replicating. Atran (2001) suggested that memes function more as elicitors than replicators since they do not copy with fidelity. In this article the term "replicator" is

used with the provision that the replications are understood as modified in the process of transmission.

[2] Graph Theory is the study of the mathematical relationship between variables that constitute such graphic representations.

[3] From the song "Heart Shaped Boxes" by Nirvana which includes the lyrics:
She eyes me like a Pisces when I am weak
I've been locked inside your heart-shaped box for weeks
Readers may find the full lyrics of "Heart Shaped Boxes" at: http://www.azlyrics.com/lyrics/nirvana/heartshapedbox112621.html and the performance with video at https://www.youtube.com/watch?v=n6P0SitRwy8

[4] This self-map did display a meme labeled "animal rights activist" and this could be taken to indicate social interest; however, as was explained, this label was suggested by the therapist to represent the experience of becoming verbally abusive to people who were perceived as abusive to dogs or cats. The label, in this case, may be taken as the therapist's "re-frame" of emotional outbursts.

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Lloyd Hawkeye Robertson is instructor in Integrated Studies at Athabasca University, Canada

Robert Cassin McFadden is consulting physicist at Mobile Detect Inc.

Contact Address: Master in Arts Integrated Studies, Athabasca University, Box 647, La Ronge, SK, S0J1L0, Canada. Email: lloyd@hawkeyeassociates.ca