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Denotation and Connotations of Biotechnology in Korean Public Opinion: a semantic network approach

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Denotations and Connotations of Stem Cell Research in Korean Public Opinion: Operationalizing semantic network analysis

Submitted to the degree of MPhil

Department of Methodology

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Abstract

This thesis tests how the frames and social representations of human embryonic stem cell research in South Korea could be visualized and measured by semantic network analysis. The contents of published articles take an eclectic approach to integrate sociological, social psychological, and semiological concepts and perspectives. By combining ethnographical and sociological approaches with applied semantic network analysis, concepts usually inferred and narrated by the researcher gain more vivid and intuitive visual representation along with mathematical substantiation. The methodology especially proposes indices to measure the most salient concepts that represent denotation and connotation out of the text corpus, and the ways to categorize themes more efficiently.

The study concludes that the failure to establish a sustainable public relation and deliberative atmosphere regarding human embryonic stem cell research in South Korea is mainly due to polarized framings of opinion-leading newspapers, progressive side's incompetence to present an alternative agenda to economic development and suppressed discourses of lay people who strive for more transparent and just (scientific) governance. The semantic network represents the diverging core concepts of newspapers and people's concealed motives in supporting the disgraced Korean scientist Woo-Suk Hwang and urges readers to deliberate on the scientific issue from a different perspective.

Keywords: Stem cell research, Hwang scandal, semantic network analysis, automated text analysis, frame analysis, social representation

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Introduction

Understanding public opinion has been an invariable desire of those who want to govern or engage in a communicative action. From various methods of survey to interview, statistical tests to qualitative enquiries, numbers to reasoning, the common aim of the knowledge is to understand the driving force of popular idea and desire leading to a collective action. Behind the majority preferences simply depicted in polling charts, there are underlying reasons, or variables, that influence on the making of public opinion by referring to a common conceptual metaphor that conceives information as a network of propositions (Collins and Loftus, 1975; Moscovici, 2000; Baden, 2010).

Among the multiple public spheres (Habermas, 1984; Crossley and Roberts, 2004; Jovchelovitch, 2001) where opinions and values are represented and contested, the public sphere of science or biotechnology (Durant, Bauer and Gaskell, 1998) is a particularly interesting field of knowledge/opinion because expert knowledge and lay people's representation mutually intersect to form a scientific discourse. This characteristic is pronounced when the status quo of knowledge fails to pursue its policy and clash with the popularized narrative of science, which is becoming an acute precursor to reestablish scientific community.

What has been manifested as the 'crisis of legitimacy' (POST, 2001) in scientific governance, nevertheless, does not imply the termination of experts' role but rather opens up ways to reflect on better ways to actively include other actors engaged in the discourse of emerging science such as genome profiling, stem cell research, etc. The method, as Brian Wynne (2002) argues, does not mean to simply redefining the boundary of participants in scientific decision-making. It raises more profound question about 'how public issues are framed and thus given meaning, unveiling the neglected questions about how proper knowledge…should be negotiated as matters of 'civic epistemology', shedding new light on its hidden context, public meanings and representations' (Wynne, 2002: 402-405). The extension of content of discourse, other than the formal inclusion of actors, has become important. In order to deepen our insights into overlooked layer of communication, we need to innovate the methodology of comprehending public communication and the underlying cultural context, public meaning and representation.

From a social-psychological perspective, the public construction of knowledge, that is, how the contended knowledge is framed, becomes 'more real' (Moscovici, 2000) than the 'expertise'. Social struggles having been observed over imported genetically modified soybean or beef (Torgersen *et al.,* 2002; Park *et al.,* 2010), the endorsement of embryonic stem cell research (Bauer and Gaskell, 2002) and the implementation of hybrid and chimera embryo research (Kim, 2012); these cases highlight the growing influence of public opinion. Although discussions exist of 'older' technologies such as nuclear power, new technological objects that will require people's 'life choice' (Giddens, 1991; Rose, 2007) are making public discourse more diverse and dynamic. Therefore, we need more creative ways to extend our knowledge of public opinion in relation to cultural context, public meaning and social representation. The opinion, imagination and values of lay people as well as those of experts in relation to the new life science are increasingly important, and novel ways of studying their content is becoming an essential part of social studies of science. In fact, emerging life sciences such as stem cell research have become an 'arena' (Bauer, 2002) that tests actors' discursive capacity to formulate the future of science and governance.

Human embryonic stem cell (hESC) research is an example of an emerging technology that may bring about fundamental changes to human social and socio-biological life. This is so not only because stem cell research may deliver a revolutionary change in medical science, but also because the debates on ethical issues of life science epitomize a power struggle (Beck, 2006) to define the socially correct way to regulate influential knowledge and practices. If debates on the crisis of scientific legitimacy and the task of extension present a deepening challenge to such governance, so do they to the utility and effectiveness of researchers engaged in the science and technology studies (STS). Wynne's (2002) questioning of the role of social study in elucidating actors' framings, representative strategies and their intersections, urges us to seek better answers to the question of 'how to do' technoscience, rather than emphasizing the imagined field of 'alternative forms of politics' in various subfields (Papadopoulos, 2010; Beck, 2009; Castells, 1997).

Although I agree with the inclusion of the public in scientific decision-making, I argued in the Article 2 of this thesis that merely adding actors or their organized sets is not enough to provide just and effective scientific movement. In the area of emerging, unpredictable science, extending the possibility of different ways of thinking and identifying overlooked risks is more important than simply incorporating more people

and organizations into the same way of thinking. In order to solve the problem, both methodological sophistication and sociological imagination are necessary. To cast light upon underrepresented characteristics of scientific discourse is a prerequisite to substantiate both the democratic and rational, rather than rationalizing, practice of science. This enterprise may also provide significant anthropological insights into the 'forms of life' (Wittgenstein, 2001) that reflect the social nature of science, continuously reassembling itself (Latour, 2005). As I will explain, I believe these ends can be effectively sought by visualizing, in a literal sense, the structure and dynamics of semantic signifiers and their related public actions practiced by interested actors. This process highlights additional meanings to those currently held on the social functioning of life science.

In this regard, this thesis adopts a methodological approach based on a semantic network representation of concepts (keywords or key phrases) that attempts to reveal the interlinked pattern of signifiers and its social meaning beyond sociological reflection of 'structure'. By reviving the earlier tradition of social psychology advocated by Gabriel Tarde (Tarde, 2010), Latour (Latour, 2010: 8-9) urges to understand society not as an overarching 'collective self' but 'a highly unstable aggregate that had to be constantly surveyed and reassembled through interaction' of sub-individual monads, that is, the 'nodes' of sub-individual network that are subject to a structured analysis.

> The gap between overall structure and underlying components is the symptom of a *lack of* information…What is really scientific is to have enough information so as to *not* have to fall back upon the makeshift approximation of a structural law, distinct from **what its individual components do**…An actor hesitates as a monad which has already gathered within itself vast numbers of other elements to which it offers the stage for an indefinite number of logical duels to take place…Behind every 'he' and 'she', one could say, there are a vast numbers of other 'hes' and 'shes' to which they have been interrelated…This is precisely the reason why quantification is so important: not only does it capture internal logical duels, but it is the only way for monads to coordinate their actions externally with others in the absence of any providence…He [Tarde] imagines **a progressive fusion between the technologies of statistical instruments and the very physiology of perception** (Latour, 2010: 2-12; bold by myself).

Behind the monads, there are numerous signifiers that collectively exchange knowledge and opinion and define the identity of individual subject. For the contextual information of signifier to form a social meaning, it needs to provide a coherent interpretative backdrop for comprehension (Gamson and Modigliani, 1987). Coherence between individual nodes of information is not inherent to either piece, but must be supported by a web of relations that elucidate how one is connected to the other (Kintsch, 1988; Baden, 2010). Meaning, in other words, emerges by the coherent integration of information. This perspective is committed to unveil contextual elements and visualize the trajectory of the public sphere composed of the interrelated representations and manifestations - the visualization of opinion and frame. Although this semiotic interpretation is not new to the genealogy of social and cultural studies (see Berger and Luckman, 1967; Barthes, 1967; Goffman, 1984; Lotman, 2000), its function for the prescriptive engagement of social studies of science (STS) can elucidate the difference of expert and lay people's representations in a novel form. The semantic network analysis in this sense can function as a powerful tool for social reflections when adequately associated with the latest semiotic assumptions that incorporate computerized text mining. In this thesis, I try to develop and claim this linkage.

Theoretical review: semiology, frame, social representation and others

In the theoretical and methodological level, building a bridge between the characteristics of textual communication (semiotics), the processing (framing) and underlying cultural context (social representation) requires active and eclectic incorporation of core elements in each theory. Amid the deep and large ocean of each theory, the short summarization below highlights the most conspicuously extracted and incorporated concepts and idea for the operationalization of semantic network analysis from a novel perspective.

Semiology

The studies of semiology (Barthes, 1967; Lotman, 2000; Eco, 1984; Greimas, 1990), despite their varying and sometimes contradicting levels of explanation, similarly attempt to construct a bridge between the formal and pragmatic usage of

language and the underlying social context. If some language-related theories like Berger and Luckman (1967) and Searle (1995)'s works paid particular attention to how perceived social 'reality' (in my understanding, dynamic and historiographical 'actuality' but not static and ontological 'reality' per se) was constructed by the mediation of language, despite their different understanding of the term social reality, and social interaction, they left little room for concrete conceptualization and analysis of social interaction through the language play other than reifying and ontologizing the social function of language and the social world we live in.

What I was interested was more pragmatic and conceptual guidelines that could elucidate the difference between apparent usage and underlying cultural context, justification and strategy, key rationale and hidden concern in the dialogue. In this regard, some structural or interpretive approaches hinted at the important structural characteristics in relation to semantic monads (Lotman, 2000) and the pathway to flexible yet authentic interpretation (Eco, 1984) of textual information. However, they were still not sufficient to empower the researcher to engage in concrete analysis of text, and lead to escape his own, pre-established, cognitive-schema. As happens in social research, those great authors' theories and writing styles were easier to adopt and justify the researcher's translation of text rather than establishing a methodology that could test the existing hypothesis.

Yuri Lotman (2000) does offer a theoretical landscape that actively imagines the linguistic interaction as a systematic semiosphere, influenced by early cybernetics model, where hierarchies exist and the signifiers in the center and in the periphery contest each other over time. Although culture is being interpreted as this dynamic process of signification, actual tool to identify the cause and effect of sudden symbolical eruption and its underlying cultural context are weak. Thus, Lotman (2009) can only describe that proper noun that reflects mythical consciousness would surge in comparison to noun that reflects demythical consciousness in society, as witnessed in the represented wordings in Russian newspapers in times of Soviet's disintegration. Such phenomenal, and post hoc, description might frustrate a researcher who wants to capture more concrete and analytical characteristic of on-going social dialogue and offer more acute prescription to the present social interaction.

In comparison, the concepts of 'denotation and connotation' by Roland Barthes (Barthes, 1967: 89-94) that are older in origin, clearly delineates the relation between the expressive denotation and the implied connotation that represent the embodied

culture, knowledge and history. From the perspective of pragmatics of language, these concepts enlarge the analytical scope to hypothesize and verify what concepts are being utilized as denotation and connotation in the cultural context, and what it means in terms of discursive interaction.

Here, I intend to mention denotation and connotation in terms of their structurally identified functions and characteristics and from the side of *parole*. Indeed, there are a variety of definitions of denotation and connotation among different schools, and a potential tension is observable between structuralist (Greimas, 1990; Lotman, 2000; Barthes, 1967) and interpretative approaches (Peirce, 1960; Bonfantini, 1987). Still, a systematic approach, more or less influenced by Saussurean structuralism, does not foreclose a room for contextual interpretation as far as the classified code (represented sign) of connotation still remain a semantic object open to an 'encyclopaedia' (Eco, 1984) that contains the set of various possible interpretations. Then, the problem of endless interpretation becomes apparent:

> The meaning of a representation can be nothing but a representation…the interpretant is nothing but another representation…and as representation, it has its interpretant again…Lo, another infinite series (Eco, 1990 cited from Suerdem, 2013: 5)

As will be explained later, the problem of endless interpretation of signs of text can be tentatively resolved with abduction (Eco, 1979; Suerdem, 2013), which is a form of logical inference going from an observation to a hypothesis that accounts for the observation, ideally seeking to find the simplest and most likely explanation. In abductive reasoning, unlike in deductive reasoning, the premises do not guarantee the conclusion, but enriches the layer of critical reflection of a social phenomenon. The question then arises why we need a new form of analysis other than multi-textual interaction of existing ones for the abduction. Before answering the question in methodology section, let me move on to the incorporated part of frame studies for the analysis.

Frame analysis

As previously mentioned, existing semiological studies are not sufficient to capture communicative specificities that reflect social movement and transformation. They are more general and descriptive rather than context-specific and analytical. Conversely, frame studies in general attempt to represent salient aspect of communication under specific context. Frame studies (Tewksbury and Scheufele, 2009; Entman, 1993; Gamson, 1992; Gamson and Modigliani, 1987; Lakoff and Johnson, 1980) elucidate the cognitive process how people incorporate or discard information to their own psychological or social interest. The characteristic embedding of information into a particular context, frame, is important in understanding public media's and people's typical belief and narratives in some controversial scientific activities such as embryonic stem cell research.

The word frame, however, is very diversely used and oftentimes hazy to define. For the pragmatic use, text analysis, of the concept, I avoid both sociological generalization of the term as the typical gesture under interactive situation (Goffman, 1984) and too narrow modeling of frame as the perceptive control of gaining/losing situation to predict economic behavior (Kahneman and Tversky eds., 2000). In order to adapt to the purpose of theoretical adoption, more relevant description of frame would be 'a coherent set of contextual information in relation to which the focal information assumes a particular meaning' (Johnston, 1995). This definition, however, does not clarify the difference between frame and social representation that I am going to discuss in the next section. Among the diverse understandings (especially to note, Goffman, 1984; Kahneman and Tversky eds., 2000; Tewksbury and Scheufele, 2009; Johnston, 1995; Entman, 1993; Gamson, 1992; Gamson and Modigliani, 1987; Lakoff and Johnson, 1980), I conceptualize frame as a formalized set of salient communication about a certain issue, which is reduced to a core value and simplified causality. The label frame in this regard is 'an analytical concept superimposed upon empirically discovered structures in discourse' whose utility is 'not self-evident' (Baden, 2010: 23).

Entman (1993) described the four most important functions that frame perform in discourse (see also Baden, 2010). First, frames define a situation, identifying the most pertinent dimensions that need to be addressed. Second, frames may link to causes, actions and intentions of relevant actors, assigning responsibility for the present state of affairs. Third, such causal interpretations are typically supported by value references or

belief systems that suggest the normative grounds on which a situation should be judged. Finally, frames can present a situation as inevitable or changeable, and define a need for action. While these functions are in many ways identical to that of social representation (Moscovici, 2000; Deaux and Philogène, 2001), the semantic 'coherence' or pattern (Scheufele and Tewksbury, 2007; Gamson and Modigliani, 1987) and 'central organizing idea' (Gamson and Modigliani, 1987) constrained and formalized to serve the purpose of forming the smallest functional units of 'denotative' meaning, under the limited availability of information, are what frame analyses can claim their specific role.

In this regard, Baden (2010) summarizes the main characteristics of the frame in three aspects when he tries to incorporate those concepts to operationalize semantic network analysis: First, frames involve selectivity, rendering some aspects of a salient issue. Second, frames give meaning by following some central organizing idea. Third, frames perform argumentative functions: they define situations, establish causal chains, provide the evaluative standards against which propositions are evaluated, and chart the options for treatment and action lying ahead. Insofar as the frames are represented by selective links of concepts, those words and concepts are ideological units of life which both reflect and refract particular social relations (Crossley and Roberts, 2004). Particularly, the characteristic morphology of frame, represented as a semantic network, reflects the 'central organizing idea' (Gamson and Modigliani, 1987) that is the particular object of analysis and interpretation.

Although the following interpretation of social relation and context will noticeably overlap with the study of social representation, to iterate, I find the relative strength and advantage of frame analysis in highlighting the formal and denotative aspect of minimal communication structure organized by center-periphery relations and referential linkages of concepts. Therefore, I try to confine the theory within the empirical research objective of data analysis. In the thesis, I propose the ways of visualizing the formalized representation of multi-layered and asymmetrical signification by systemically deriving core semantic structure, by linking and classifying the concepts, and by identifying the converging concept and value. Then, the connotative and contextual meaning of the salient communicative structure and its social contexts will be more vigorously discussed from the perspective of social representation theory.

Social representation

Social representation theory (Moscovici, 2000; Deaux and Philogène, 2001) presents a formal way of considering multiple levels of signification in science communication, by actively incorporating lay people's knowledge and perception of science. Acquiring similar knowledge through socialization, and constructing their knowledge in similar ways from public discourse, people integrate similar information in similar ways and form similar, social representation (Baden, 2010). In this way, various cultural groups are defined as sharing specific discourses and interpretations, which also implies on-going competition between multiple frames and discourses. \`

In terms of communicative platform, the concepts of 'anchoring' and 'objectification' (Moscovici, 2000) are respectively translated into the semantic network's concepts of referential 'linking' and 'convergence' of the semiotic relations (Kim, 2013; Veltri, 2013; Veltri and Suerdem, 2013). The semiotic concepts of denotation and connotation (Barthes, 1967) can notably clarify the social signification processes among social groups, that is, anchoring and objectification (Veltri, 2013) to result in a specific framing that reflects the social formation of central organizing ideas (Gamson and Modigliani). If anchoring is a process that people in a social group 'make things unfamiliar familiar' (Moscovici, 2000) by referring new objects to already existing, classified, references, objectification is a process through which a new object materializes as linguistic signs are attached to material structures.

These social signification processes highlight the dynamic process of social representation mediated by semantic and social psychological interactions that are not reduced to individual cognition, but remain highly abstract without formal methods of classifying the levels of signification in practice. Denotation in this regard clarifies a relation that serves to connect the expression and the content of sign with means of salient rhetoric, and connotation reveals an underlying contextual meaning or ideology that is manifested through a converging cultural object. By focusing on the pragmatic and contextual nature of sense making, Suerdem (2013) emphasizes that the structural aspect of signification can be methodologically captured from the distribution of words internal to a large text corpus produced by the members of a culture. From this perspective, the theory of social representation can particularly highlight the connotative aspect that is 'implicit, cultural, sensational and phenomenal side of the sense making process' reflecting utterers' embedded social context and shared

phenomenological experiences (Wittgenstein, 2001; Peirce, 1998). To do this, 'semiotic theory of social representation should be the relational mechanism decoding this order rather than the discrete units such as words; themes; or thought units' (Suerdem, 2013).

Hence, the visualized discourses as a semantic network form can facilitate to explain how the socially controversial issues, like the embryonic stem cell research discussed in the thesis, are being defined, what are the salient causal interpretations, what are the associated value references and what is the converging solution and desire (Entman, 1993) signified by central organizing idea (Gamson and Modigliani, 1987). In this way, the utterers are not defined by some presupposed social categories but 'emerge' through the day-to-day practices of producing selective words, facilitated by the theoretical model to make automatic algorithm to classify the words and extract their core relations. I argue that the 'emerging' characteristic requires a particular attention, as our society has become too complex to be preconceived by existing social distinctions like the taxonomy presented by Moscovici (2008) to delineate French Catholics, urban liberals and communists, for example.

While the efforts of classifying keywords of natural texts might reflect a 'universal cognitive tendency which serves to either simplify an overly complex world, or to render it more intelligible' (Lakoff, 1987), it is important to realize that there is nothing inevitable about the particular categories, or the content of those categories (Augoustinos, 2001: 203). If analytical window is only open to an outcome of segregated words thrown together in a box for their co-occurrence, the defining power of researcher is limited to a presupposed causality because words merely thrown in a category do not offer abundant information. But linked variables in an unexpected yet systematized way can raise a pragmatic 'doubt' about the existing explanation.

As Veltri and Suerdem (2013) demonstrate, visualizing the linkage between tagged salient themes and actors that represent them reveal a complex nature of social groupings and crisscrossing signifiers among them. Conversely, I am interested in representing converging themes and concepts from actors despite their social heterogeneity, without prior tagging, implying different categorization of social-psychological grouping that is based on common imagination, belief and ontological experiences rather than social class or formal ideology (Kim, 2013). The second article of my thesis typically reflects this interest.

My stance and inclination do not imply that existing social groupings and tagging are not valid any more. In many cases, they are useful to understand the typical social

landscape. However, we are also experiencing unprecedented empowerment of individual and sub-individual signifiers through personalized internet media, and the modern life and communication style have become ever more fluid (Bauman, 2000). This suggests that social researchers need to develop an enhanced methodology to identify the flux of signifiers and its dynamic significance more effectively: the social groups by themselves no longer adequately represent the society that is being restructured every second, but occurring power relations of concepts might do better. In the end, this approach embraces the salient characteristics of discourses that undergo resistance and challenge from different social groups and individuals. What should be discussed after merging the theories' interests in textual information, communication and societal concerns then, would be the concretely visualized outcome of underlying power mechanism and struggles inscribed in the conscious and subconscious assemblage of knowledge, belief, and strategy. That I understand is discourse (Foucault, 2002; 1978).

A Thought for Actor Network Theory[1]

Callon, Law and Rip (1986) introduced how the philosophical and anthropological concepts of Actor-Network Theory (Latour, 2005; 1993; 1987) could be brought into empirical research by using computerized processing of bibliographical data into a network. The authors extracted keywords from abstracts of academic articles and policy reports and then demonstrated relations of those keywords based on a co-occurrence matrix. With a rudimentary computing tool and techniques available at the time, they expressed hope that these symbols, keywords, could translate once intangible abstract concepts into concrete research objects for calculation and evaluation, opening up a new era of social science.

From a theoretical angle, Veltri and Suerdem (2013:141) claim that Bauer and Gaskell's (2008) 'wind-rose' model that proposes representations constituted by actors' relations with the functional aim of resistance or dominance can 'graft social representation theory onto Actor Network Theory'. According to Law (1999), entities in

[1] This section is based on my PhD thesis: Kim L (submitted) Visualizing Biopolitics: Social Representation and Governance of Human Embryonic Stem Cell Research In South Korea. *University of Sussex.*

[2] Considering that Latour imported terminology and metaphors from physics in his social scientific narrative, it might be helpful to consider Stephen Hawking's emphasis on the

the Actor-Network 'acquire their form and attributes as a result of their relationship with other entities', and claims that the Actor Network Theory should 'conceive both human and non-human actors only in their relational meaning and roles' (Law, 1992), paving a way for the semiotic interpretation of social representation theory (Veltri and Suerdem, 2013). The latter part of Law's claim, however, is controversial or ambiguously accepted even among proponents of ANT. Latour himself refutes some recent social network analyses' claims to fit within his Actor-Network Theory (Latour, 2005), and also suggests that some social scientists ignore grave physical and natural characteristics by reducing them to the work of 'signs and representations' alone (Latour, 1993). I suppose, as aforementioned Searle (1995) did, Latour believes in an external reality that can be material and 'asocial', and judge the 'semantic reductionism' too narrow to represent broader Actor-Network. Sunder Rajan (2007: 20) similarly argues that the account of a system of global capitalism that formulates biocapital, 'cannot simply be a network analysis that traces a various types technoscientific or capital flows that occur in order to produce and sustain this system', and adds:

> This [social network analysis], I believe, is the simplification that actor-network theory, an otherwise extremely provocative analysis of the mechanics of how technoscience functions, falls prey to (Sunder Rajan, p. 290, Note no. 26).

For this reason, translation of Actor-Network Theory into semiotic and social representational perspective will meet challenges arguing that it is mostly averse to a linguistic reductionism or confined data analysis. That is, the Actor-Network comprises not only semantic signifiers but also non-human, material entities. From this perspective, we can imagine and proclaim the social-material world as a holistic entity. However, there is no way to observe it entirely from partial data, however large the sample is. This limitation produces tension between the critical philosophy of Actor-Network theory (that questions the existing representation of the assembled social) and its empirical practice, because any attempts to confirm the theory fitted with the actual world, as demonstrated in Latour's *Pasteurization in France,* inevitably reduces itself to a narrative highlighting preconceived nodes (variables) and their links.

My methodological stance, in comparison, is firmly grounded in sociological questions. My methodological approach is not an active practice of traditional

ethnographical methods, and does not engage in physical enquiry. Instead, I intend to present a different way to focus on an emergent social context, posing further questions to stimulate academic debate. A complete representation of an Actor-Network through empirical analyses of limited data is impossible; however, we can get a snapshot of relations and interactions through the integration of interdisciplinary theories and research techniques to explore novel social dimensions in order to understand underlying contexts, thereby practicing the abductive method. Under such an assumption, I delimit my research objective to focus on the social construction side, as I am more interested in, and capable of capturing social and political aspects, rather than 'pure' nature.

Even if language, text, is not the only media to construct social representation of technoscience, it can be one of the most salient mediators reflecting a complex social environment and culture. In this regard, network representations of human relations (social networks) or keyword relations (semantic networks) do not claim holism or objectivity – the data does not speak for itself, and does not offer a final answer. On the contrary, my eclectic approach is intended to increase sensitivity of the underrepresented features of communicative interactions and power relations, while recognizing arbitrarily constructed social groups and variables. As a researcher participates in the both deconstructive and prescriptive practices of discourse analysis, what is gained is not an objective authority but the improved utility of social scientific reflections based on alternative tools to observe multi-subjective debate, whose gap will still be filled with existing analytical methods.

From a theoretical and methodological perspective, new value could be offered by a visual and quantifiable representation of the network: attempts to fulfill Callon's (2007) aspirations for mapping the Actor-Networks, latterly disowned by Latour, may have greatly benefited from social psychological, communicative and semiotic concepts to bolster their theoretical underpinning while fully acknowledging the limitation of the human observer.[2]

[2] Considering that Latour imported terminology and metaphors from physics in his social scientific narrative, it might be helpful to consider Stephen Hawking's emphasis on the 'anthropic principle' in *A Brief History of Time*: that the natural scientist is constrained in observation by human nature, therefore it is important to bring the observer's limited capacity to observe upon the arena of second observation.

Methodology of semantic network[3]

Besides the substantive parts of the thesis and the conventional use of social network analysis, a detailed explanation of semantic network analysis seems to be necessary, as it is not presently well known. First, the difference between methodology and method(s) should be explicitly stated. In simple terms, methodology is a coherent way of interpreting analytical results from a predefined perspective, based on a set of theories and research practices, while methods denote the functional procedures of data analysis (in this case, systematic coding). In this thesis, the 'methodology' of semantic network analysis is a coupling of a semiological modeling of content analysis and its qualitative interpretation, occasionally supported by some ethnographic and other social scientific research, which is supported by the computer-assisted algorithm that offers particular methods to analyze social groups represented through the arrangement of particular words.

Traditionally, content analysis is a tool for making inferences about the message context rather than just measuring aspects of the message content. As Krippendorff (2004) argues, a message by itself does not have meaning: it is a set of symbols. The meaning or semantics of a message is the connection between these symbols and the things to which they refer. Since each receiver or sender of a message can interpret the message differently, it is important to realize that a message only has a meaning in the 'context of its use' (Krippendorff, 2004: 33). As the communication research question determines which aspects of a message are interesting, it also defines the context in which the message is to be interpreted. The task of content analysis is to 'infer' the relevant meaning in that context from the symbols in the message (van Atteveldt, 2008: 16).

Wouter van Atteveldt (2008: 16-28) compares semantic network analysis and Krippendorff's frame of traditional content analysis (Figure 1.1). In contrast to the relatively simple procedure of inference derived from the stable correlation between text and research question in traditional content analysis, semantic network analysis goes further, exposing multilayered contexts of texts and research questions, and proceeds to infer the answer through an active feedback loop between network representation and

[3] This section is based on my PhD thesis: Kim L (submitted) Visualizing Biopolitics: Social Representation and Governance of Human Embryonic Stem Cell Research In South Korea. *University of Sussex.*

background knowledge. Background knowledge is substantiated by an explicit ethnographical review (Tambayong and Carley, 2012) and/or implicitly what German sociologist Max Weber refers to as *Nach erleben* (reliving) through the ideal-typically reconstructed representation. Therefore, the methodology of social and semantic network analysis is positioned in the academic tradition of interpretive sociology, and aims to invoke critical questioning.

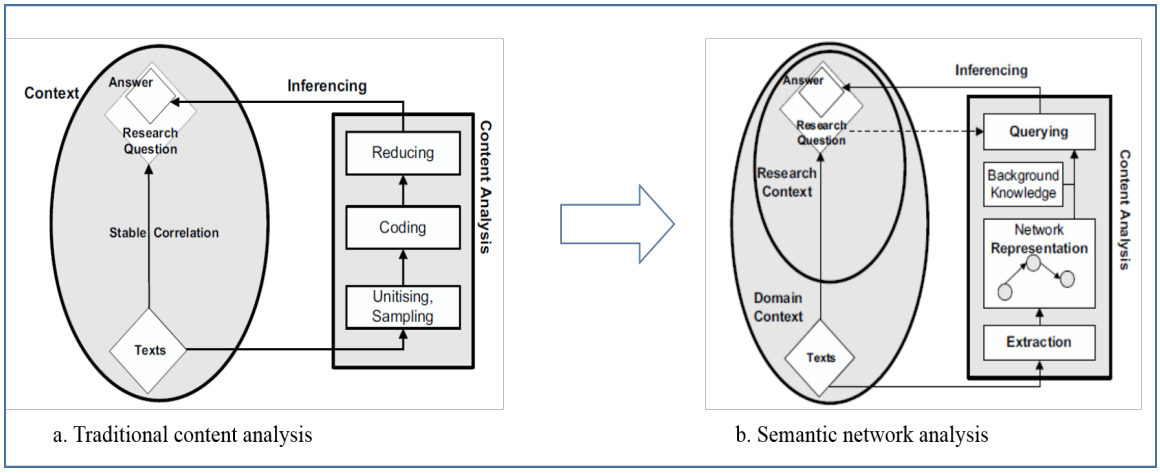

Figure 1.1. The framework of content analysis and semantic network analysis
* Source: van Atteveldt, p. 17, 26.

As described in Figure 1.2, both social network and semantic network analysis (SNAs) seek to find prominent actants, respectively persons (a social variable) and concepts (a semantic variable) as central nodes, and their established linkages. The linkages are said to reflect power relations (a social variable) and conductivity of discourse (a semantic variable). Although extracting these research objects might be possible without utilizing SNAs, the SNA approaches offer a standardized way to extract core representational characteristics out of large scale of unstructured data. Henceforth, the representation undergoes a verification process with collected evidence and counter-evidence: an ethnographical review of related actors and utterers either confirms or denies the interpretation of social context and structure that are mainly inferred by researcher's experience. Although the answers derived from the review are necessarily subjective, the former part of the data processing is an opportunity for the researcher to challenge preexisting notions for interpretation.

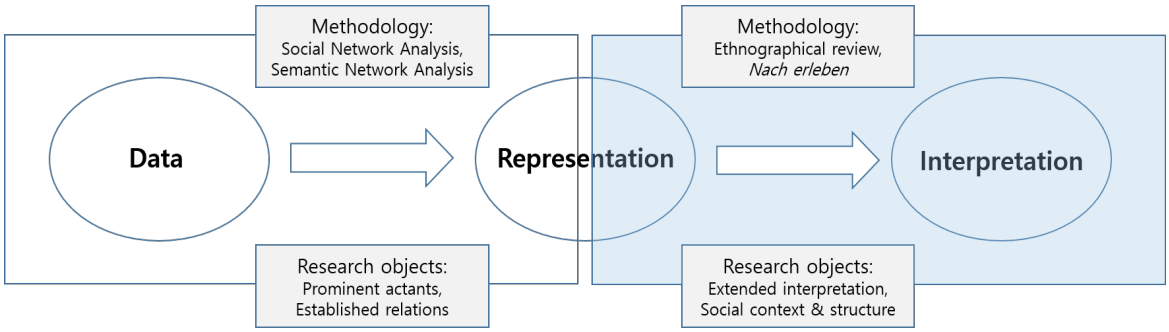

Figure 1.2. The role of SNAs in interpretive sociology

The selective links of concepts in the semantic network represent a symptom of the social representation (Moscovici, 2000) of utterers, and they are incorporated into discourse analyses that delve into microscopic relations of power among actors – mediated by language. To paraphrase Wittgenstein, 'A representation (image) is not a picture, but a picture may correspond to it' (2001: 86, para. 301). The dialogue, depicted graphically in the SNA, is a social action that creates a collective narrative, or an 'occurring' event (Bourdieu, 1991). The event represents specific socio-historical contexts; and words and concepts become ideological units of life that both reflect and refract particular social relations. Therefore, when a word is uttered it is not merely an individual's identity that is invoked, but also a social and historical whole through which the utterance has been indicated and through which it has gained a specific evaluation (Crossley and Roberts, 2004: 77, 85).

Two measurable concepts other than frequency in content analysis – 'conductivity' and 'prominence' – are proposed to open up additional dimensions in analyzing the discourse. Both are represented by the linkage of identified concepts in the text. Conductivity is the capacity of an expression in context to carry (or trigger) information in a directional flow, which is connected by a path between two nodes of concepts as keywords or phrases (Carley and Kaufer, 1993). Information flows in a certain direction when it triggers and is triggered by other available information in the context. Based on the sociological assumption of utterance, I analyze the relational content of keywords, the thematic 'roles' determining the association between subjects and descriptives that are composed of substantives (Moscovici, 2000). This thematic role can be identified as segments, or subgroups, in the network. This root idea is already applied in co-occurrence analysis of text that applies hierarchical clustering of

co-occurring keywords. Conceptual realms are very often hierarchical, meaning that an object A is inferred or thought about within the context of the object B, but not vice versa. (For example, people used to refer to 'peace' after 'war' but not the other way round). Social psychological inferences can be made from examining relations (and their hierarchies) in a network. This psychological translation of semiological characteristics embodies a powerful methodology for classifying keywords (Kronberger and Wagner, 2007: 302–309). To analyze the pattern of 'conductivity' in network analysis, the criterion of categorization is 'structural equivalence'. Structural equivalence focuses on the structural/functional role of nodes (keywords), by studying their associations among semantic relations, and identifying homogeneous nodes identically located in the network of relations (Wasserman and Faust, 1994: 348–349).

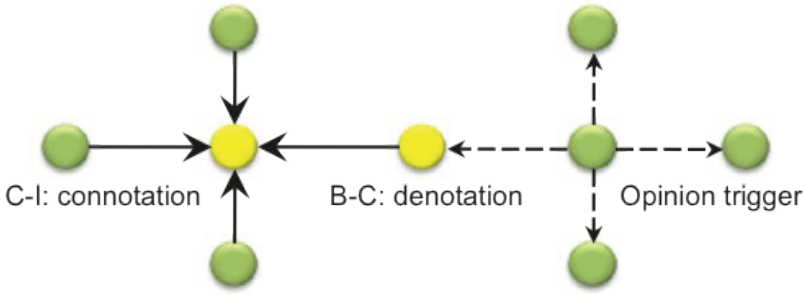

Figure 1.3. The network model of denotation and connotation

In regard to the 'prominence' of concepts, the two network indices of 'betweenness' and 'input-closeness' centrality, respectively, deliver Roland Barthes' (1967) main tool of investigation, that is, a semantic dichotomy of 'denotation' versus 'connotation.' Denotation is the literal or core meaning of a sign and connotation refers to secondary meanings associated with it. Denotation clarifies what serves to connect the expression and the content of sign, and connotation reveals an underlying contextual meaning or ideology, manifested through a converging cultural or symbolic object. To explore the cultural features on which this thesis concentrates, connoted meaning is more heavily drawn upon. The social network analysis attempts to translate these concepts as the relevant (corresponding) nodes of keywords essentially inherit the functionally prominent roles. That is, a node (conceptual keyword) with the highest betweenness centrality takes up the role as a mediator of communication, as it is required to represent itself explicitly to bridge different clusters of concepts. In comparison, a key concept with the highest input-closeness centrality is 'connotative'

because it is the eventual result of communicative interaction that positions itself closest to the center of reference (Figure 1.3). As I previously differentiated the analytical role between frame studies and social representation theory, they respectively highlight the denotative (formal) side of semantic pattern and the connotative (interpretive) characteristic of society and culture. Therefore, the measured and extracted nodes of connotation in this sense are not the socio-cultural connotations per se, but a symptomatic precursor, or a formally converging idea, to facilitate such interpretation.

As to the coding, the researcher should be aware that the selection of data and coding requires semantic and cultural interpretations of the data (Carley and Cicourel, 1990). Despite variable manual and automatic techniques developed for different contexts, there are certain transcending principles and convergence of ideas regarding the procedure and rules for the coding of textual data into a matrix format of network. Above all, defining the relation of a directed link between two concepts, has to do with whether the first concept is seen to have some type of 'prior' relationship to the second concept (Franzosi, 1990; Carley, 1993; Kronberger and Wagner, 2007). Various types of prior relationship can be thought of. For example, 'a implies b,' 'a comes before b,' 'if a is true, then b is true,' 'a qualifies b,' or 'a (subject) <verb> b (descriptive).' This coding directionality can provide information about the way in which the impact of new information propagates through the network and affects decisions, and the structure of meaning (Carley, 1993: 96).

In comparison, automated co-occurrence analysis consists of measuring co-occurrences between search terms consisting of words or word combinations which according to the researcher measure a certain concept. It is assumed that search terms identifying actors or issues that appear close to each other in a text indicate an association between these actors or issues. The drawback of this technique is that it ignores the semantics of concepts, context and expressed relations (van Atteveldt and Takens, 2010), and the links become too complex to concisely denote the relation of reference (in the end, mechanical relation of co-occurring words in a sentence or a paragraph presupposes the relation of reference, but those words are not always mutually referential). Moreover, the currently available automated technique gives limited insight, for example, into the direction of the relation and the question as to whether it is a relation expressing association or disassociation. Therefore, it is sometimes meaningful to revisit the traditional manual technique focused on identifying a key associative thematic relation between two concepts of keywords in each posting,

summarized as an ‘a refers to b (a→b)’ relation, and study their emergent meanings. In this operation, the emergent pattern of linkage, instead of frequency of linked words, (number of co-occurrence or degree of centrality) becomes the object of analysis.

In sum, the ‘cognitive map’ (Carley and Palmquist, 1992) representation of text can be regarded as a constellation of signifiers expressed by linkages of keywords or concepts. Links have directions, arrows, that, like Lacan’s ‘transference’ (Lacan, 1994) that means the displacing of one’s experience onto the other, refer to not only syntactical statements but also the implicit flow of desires embedded in people’s expressions by displacing the preceding concepts to the accompanying experiences, thoughts and feelings. That is, a node emerges as a central object when it is strategically positioned in the entire communicative map to become an explicit passage point in the communication (denotation) or most meaningfully positioned in the referential structure (connotation). Different segmentations of communicative themes emerge because of the differing patterns of referential relations. The applied automatic methods are trials to imitate the cognitive process of human coders to link related (subject-descriptive) word sets from the flow of text, in order to reconstruct a social meaning. The network visualizing and analyzing this relational dimension broadens the concept of social representation, because it introduces a methodology that might uncover concealed meanings in the complex web of signification. In doing so, I try to open a novel way of ‘understanding’ (again, *Verstehen* in Max Weber’s sense), rather than claiming a fixable interpretation, of the observed outcomes of the systematized semantic network analysis. Automatic algorithms are efficient and stable ways to derive results, but from a methodological point of view what should be at the core of the discussion is the underlying assumptions and qualitative capacity to interpret them.

In sum, visualizing the representation of multi-layered and asymmetrical signification can be done with a systematic method of linkage and classification; this opens up rather than constraining questions about a fluid society that constantly undergoes resistance and challenge. In this way, the semantic interpretation is designed to encourage the sociological and anthropological ‘possibility of thinking otherwise’, via the social psychological and semiotic perspective of the actor-network. To reiterate, visualizing and evaluating the relational pattern of keywords in a systematized way can open up insights and questions beyond an existing statistical or narrative style of explanation. Considering this benefit, my methodological approach and the underlying assumptions can be summarized thus:

- The formalized social frame is constructed by a selective reference between concepts: the smallest instance of coherently contextualized information is formed when two formerly disconnected concepts are related. In this case, these two nodes of concepts allow the interpretation of one in light of the other
- When such relations become complex, a disparity between the central organizing idea and peripheral concepts emerge. Sometimes this can be intuitively discerned by the density of connections between semantic nodes, but also sophisticated centrality indices can be applied to measure importance
- By translating the definition of the centrality index, semiotic characteristics can be represented: if 'denotation' represents dense traffic (citation) in referential linkages, 'connotation' might indicate a converging secondary idea stemming from those denotations
- If semantic categories can be classified by such a pattern of linkage of concepts alongside denotation and connotation, we might be able to derive new opinion groups or multi-faceted personae and their discursive characteristics in more structured way. This does away with the need for pre-categorization of social groups and post-hoc explanation, allowing more flexible interpretation and questioning of socially represented characteristics

Based on the assumptions, the presented work attempts to bring social representation of a scientific event into a lively 'phenomenon', not a static 'concept' (Mosocovici, 2000: 30-33). I extract the concrete features of public communications into measurable word units, and study social actuality as a network of ideas, concepts, metaphors and images that would mediate intersubjective relations and reproduce social actions.

The grouping and classification of keywords of natural texts, as attempted by many cognitive theoreticians, can reflect a 'universal cognitive tendency that serves to either simplify an overly complex world, or to render it more intelligible' (Lakoff, 1987). However, to reiterate, the reason that I emphasize methodology over method is

because 'there is nothing inevitable about the particular categories, or the content of those categories' (Augoustinos, 2001: 203) resulting from each method: the methodological choice to integrate theoretical perspectives, in order to stabilize and focus on a certain way to categorize, turns out to be more important. Thus, semantic network analysis is a response to overcome limits of existing quantitative and qualitative approaches, by systematically representing more dynamic linkages of symbols utilized in mass media and people's utterances, to derive social meanings out of the calculated result (Hellsten, Dawson and Leydesdorff, 2010; Kwon, Barnett and Chen 2009; Carley and Palmquist, 1992).

Admittedly, both the method of coding and the boundary of interpretation in its current form turn out to be limited and sometimes problematic. Firstly, there is not a unanimous consensus how to code data. Carley (1993) proposes a 'story-line coding' method that merely links keywords, after deletion of redundant words either manually or automatically, along the flow of sentences. Kwon, Barnett and Chen (2009) and Hellsten, Dawson and Leydesdorff (2010) similarly utilize co-occurrences of words in text and set up statistical and mathematical thresholds[4] to cut off less frequent pairs of words in the linkage between keywords. However, the frequency of co-occurrences of words alone is usually not fit for acquiring counter-intuitive results, and in itself does not reflect the natural flow of wordings. Also the question follows, how does one derive the significant part from the complex network of words? This is one of the technical areas I have explored, and I have tried to make a methodical contribution through various techniques, in the following articles.

The chronological development of methods is depicted in Figure 1.4 (from top to bottom). The initially utilized method (top) concerns manual coding of word relations and then automatically measures centralities of words and categorizes word groups. The semi-automated method (middle) used the tool Automap to automatically code, and then produce a semantic network; however, the automatic method of coding will produce very complex syntactic relations between words devoid of their semantic significance, making the network too complex to derive insights. The latest proposal (bottom) has tried to address the limitation and tentatively stabilized the automatic

[4] The specific applications and criteria of threshold are different: Kwon, Barnett and Chen (2009) used Spearman analysis to derive correlations of common words in the *Universal Declaration* scripts written in seven different languages. Hellsten, Dawson and Leydesdorff (2010) proposed cosine measure that uses the geometrical mean or vector-space model (Jones and Furnas, 1987; Salton and McGill, 1983).

process of coding, by measuring and reducing the core characteristics of textual data, enabling anyone utilizing the new semantic analytics system Optimind to evaluate the text with the same result in more accessible manner. While this can offer the benefit of representing relational characteristics of signifiers, better theoretical and methodological assumptions to come are expected to improve its procedure, technique and results for useful insights.[5]

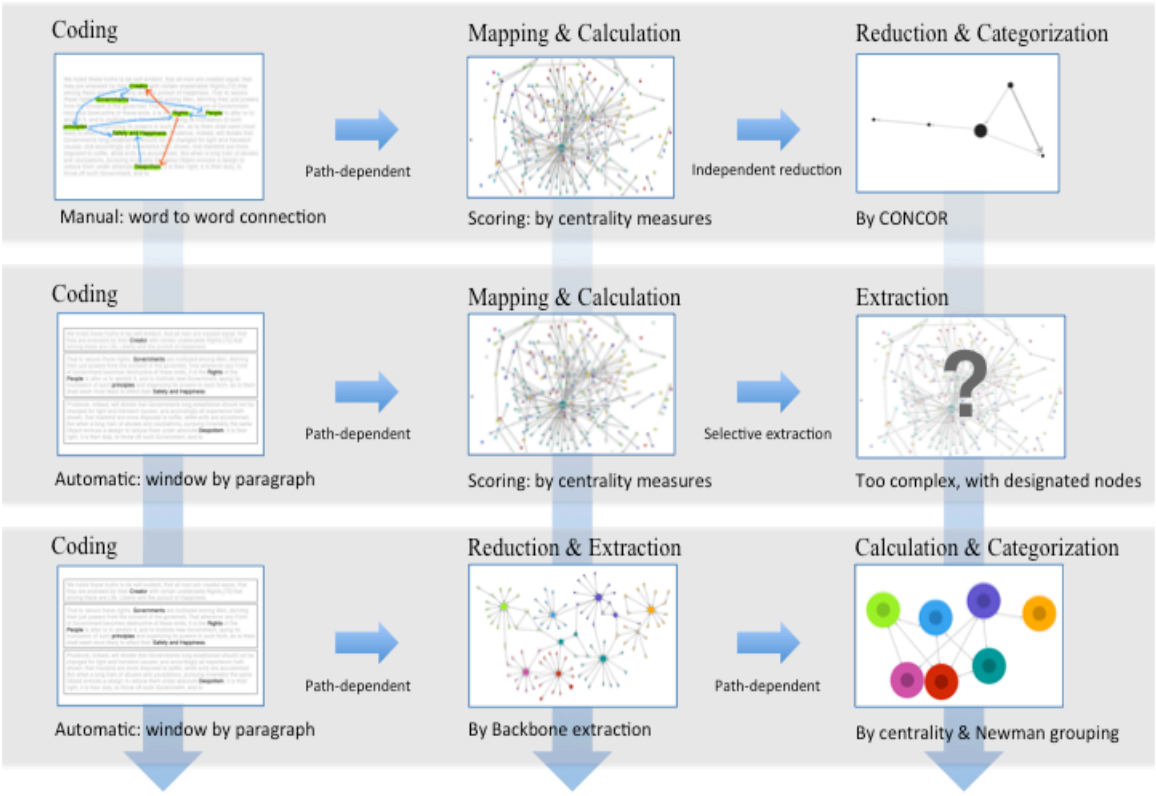

Figure 1.4. Methodical development of semantic network analysis

The applications of technical methods presented in the empirical analyses are not chronologically presented along the chapters. Article 2 was my initial trial with manual coding (top row in Figure 1.4) to excavate concepts overlooked by existing studies of public understanding of science in Korea. Although the derived results from

[5] It is a well-known fact among SNA researchers that centrality measures and categorization greatly vary depending on the size of network. Therefore, it is wrong to treat the SNA result as a statistically robust one. From my experience, it is practically important to settle on a certain specific procedure to define the size range of nodes and links that are adapted to different genres of texts and research purpose. Although vast experiments and the adoption of machine learning algorithms are expected to elaborate and stabilize the process, some caution against the result is necessary for social scientific research.

the automatic algorithm by SNA tool Pajek were unexpected and interesting, as it seemed to represent overlooked concepts like 'national trait' and 'competition' (beyond the cliché of 'nationalism'), there was a limitation by way of robust, at least in a statistical sense, justification. The work remained essentially qualitative, using a graphical tool to highlight a certain aspect of discourse in public representation of science.

Previously, I intended to address the limit by utilizing automatic text-coding tool Automap. But, producing a semantic network based on some quasi-statistical principles of co-occurrence made the links of keywords overly complex. In its application, a very high level of threshold was inevitably applied to focus on the most salient and representative aspect of keywords for comparison. This experience lead me to explore an alternative method of coding and applying a threshold. I have tried to improve the existing 'story-line coding' method by Carley (1993), and develop better algorithms for extracting the semantic map through an automatic process. In Article 1, the recent map extracting algorithm of the 'backbone extraction model' proposed by statistical physicists Serrano, Boguñá and Vespignani (2009), was imported to address the problem of complex links.

Automatized or computerized methods might easily deliver the image of robust or legitimate research but the social scientific researcher should not be tempted to present the data as if it spoke for itself. The utilization of social network analytical techniques are still experimental and provide evidence that on its own, lacks sufficient reliability for the decision making process. The results of visualization are often unstable, i.e. they depend on choices in parameters of coding, extraction, mapping, reduction, et cetera, and the methods have not yet been used in many studies.

Still, this approach can shed light on the characteristics of complex networks that are difficult to depict through traditional social research methods, and thus may invigorate further ethnographical observations. As clarified in Figure 1.1, the approach augments inference, when adequately supported by background knowledge and insight of the researcher. In this way, the novel methodology helps to explore a pathway to uncover underrepresented causal relationships of actors, symbols and actions, and effectively visualizes these relationships. Semiotic characteristics of life scientific discourses, represented as a network, provide insight into the 'conduct of conduct' (Foucault, 1982) or 'habitus' (Bourdieu, 1984) of human life in scientific practices, when considered alongside qualitative studies. For practical applications of network

analysis, therefore, we need comprehensive work joining transparent quantitative methods and insightful qualitative interpretation. This is possible only if we put together an integrative theory and practice that above all reconciles the unnecessary tension between qualitative and quantitative approaches. The results of this type of data analysis do not imply a statistical 'correlation', but more flexibly interpretable 'causal relations'. In my cases, besides document reviews, I interviewed 20 notable Korean and British figures who worked in governmental bodies, scientific labs, media corporations, academia and regenerative venture firms that were directly or indirectly engaged in the development of stem cell research. I used the interviews to verify and substantiate inferred results and selectively incorporated some quotes to clarify my arguments. Although this thesis does not have the last word on integrating theories and methods, I think it presents a methodological avenue to integrate data analysis and qualitative interpretation, and hopefully go beyond them.

Field of discourse and semantic analysis: South Korea and stem cell research

In the application of semantic network analysis, science and technology stands out to be an exemplary case as denotative expert knowledge needs to interact with lay people's perception and common sense of the world that more often turn out to be connotative. The tension between denotation and connotation as such is manifested when the new science is unfamiliar yet bring a lot of imagination about the potential influence on daily life; and the societal projection of stem cell research is a typical example. Recently, stem cell research has caught the public's attention and especially human embryonic stem cell (hESC) research provokes headlines ranging from 'holy grail' to 'Frankenstein clone'. In less emotive terms, embryonic stem cells are more versatile than adult stem cells in developing into the nearly 200 different cell types and organs of the body. The hope is that these cells will cure numerous chronic diseases simply by replacing damaged cells (Scott, 2006). But, the 2005 'Hwang scandal' in South Korea has left hESC research tainted by controversy and impacted the science worldwide. One controversial side of stem cell research is that it requires destroying embryos, which some people regard as full human life. Furthermore, the therapeutic application of somatic cell nuclear transfer (SCNT), also known as 'therapeutic cloning', requires many human eggs for a successful implementation.

Such ethical concerns have led to the creation of guidelines for using human eggs, including the observation of the 14-day limit for growing embryos (Jasanoff, 2005). But the underlying motives and processes for establishing ethical guidelines and people's understandings are very complex. One of the important reasons is because the holy grail of stem cell research also promises lucrative business in medicine. The so-called Hwang scandal, which occurred in South Korea in late 2005, involved a breach of trust in two senses. Woo-Suk Hwang, a Korean scientist who had claimed to have successfully derived stem cell lines from 'therapeutic cloning', not only fabricated research results but was also involved in the unethical collection of ova by coercing his junior female researchers to donate their own eggs and by purchasing many others from impoverished women without proper informed consent (Kim, 2008). However, mass media and people's response to the accusation was extraordinary, as strong part of conservative newspapers tried to protect the scientist and not a significant number of public demonstrated strong support. Was the strong support by lay public a reflection of scientific deficiency, or a simple conformism to major media's framing? My empirical studies argue that this was not so, and the reasons of different contextualization existed elsewhere.

The Korean public opinion of stem cell research and its subsequent assembling of monadic actors, heterogeneous signifiers, presents an excellent case of the hybrid national identity in flux, which encompasses both Eastern and Western norms and practices that overrun the boundary between modern and non-modern. The question remains then how they are being assembled and re-assembled through the mediation of new science that emerges as a strong social object of both expectation and fear. The questioning of regional specificity is important because it reckons that some existing social segmentation presupposed by theorists of semiology, frame and social representation actually reflects their own history and culture, and therefore should not be taken for granted or be applicable universally. In doing so, we need to seek answers to 'what are the actual forms of life in action?' from the empirical analysis of emergent data structure, which refers to the fleeting instantiation of belief sets. By capturing some novel form of semantic characteristics in this way, the question should follow how the frame and social representation theory, bolstered by the semiotic concepts and the recent analytical apparatus, can effectively reflect the diverse and complex characteristics of society. In sum, the asymmetrical semiotic relationship, reflecting the

discourse pattern and underlying power struggle to grasp the initiative in social frames, needs to be studied by new methodology that is able to visualize it.

Structure of thesis

The presented works are structured as follows :

- The first articles, 'Media Framing of Stem Cell Research: An Analysis of Political Representation of Science in South Korea', exemplifies what kind of frame and social representation can be revealed anew with semantic network analysis albeit the apparently denotative characteristics of opinion-leading newspapers' wordings. This could implicate some elites' and experts' strategies of political discourses that are linked to a typical framing of human embryonic stem cell research. This draft is an edited and extended version of the original article, 'Media Framing of Stem Cell Research: a cross national analysis of political representation of science between the UK and South Korea'[6]
- The second article, 'Denotation and connotation in public representation: semantic network analysis of Hwang supporters' internet dialogues'[7], tries to uncover more connotative frame of lay people who are exposed to both experts and non-experts' discourses. In the 'Hwang fandom' in South Korea and subsequent demonstrations against expert authority in the debacle nullifies some conventional social scientific notions in explaining social interactions: A homogeneous social class did not appear as a viable category to explain the resistance of public against the suspect of Hwang's scientific fraud, and the 'cognitive dissonance' theory overly simplified the participants' desires and frustrations. Those frustrations came from individual causes, but converged on a social representation that reflected people's common experiences and judgments.

[6] The original version was published as: L. Kim (2011), Media Framing of Stem Cell Research: a Cross-National Analysis of Political Representation of Science Between the UK and South Korea. *Journal of Science Communication,* 10(3).
[7] This was published as: L. Kim (2013), Denotation and Connotation in Public Representation: Semantic Network Analysis of Hwang Supporters' Internet Dialogues. *Public Understanding of Science*, 22(3): 335-350.

The analytical result and interpretation turns out to be interesting to reflect on the notions of social representation theory and its utility. On the methodological level, this was the initial attempt to utilize the translated concepts from semiology, frame and social representation theories with data coding and utilization of network indices. Methodical developments in indexing, clustering and visualizatiation followed for more reliable analysis afterwards.

The two articles were the initial methodological tests that gave me a significant insight for subsequent methodological developments and social researches. They reflect the gradual development of methodological assumptions and techniques. Still, it is hard to say that the initial analyses are necessarily inferior to the latest version. Although the trajectory of development reflects some improvements and methodological standardizations for more intuitive and reliable automatic algorithm, the main idea and concept of research are invariably placed at the core of the work from the beginning. And the automatic algorithm still mimics human coder's subjective yet principled way of selecting and classifying the textual data, as will be explained in separate papers. In this sense, the question and discussion of reliability and robustness of the induced outcomes and following interpretive contents should be grounded within the boundary of qualitative analysis. Although this thesis does not present a complete methodological solution, it did attempt to present some seminal ideas and practices that tested what alternative method could be possible to represent the pragmatic application of both semiotic notions and social representation theory. After presenting the articles in the main body of thesis, I will discuss some future tasks in the *Conclusion* chapter for the methodological development while recognizing some limitations.

As to the content, the overall structure of the thesis is designed mainly to compare the frame of mass media (newspaper) and social representations of lay people (Hwang supporters). The methodological blue print was to derive the categories of opinion and their converging objects without presupposed social subcategories for evaluation but from a naturally occurring, unstructured textual data. As Jasanoff (2005) points out, the study of 'civic epistemology' in public understanding of science should be able to recognize the arbitrariness of existing social categories, especially the dichotomy of expert/lay people, by visualizing the dynamic process of knowledge formation that penetrates many different actors.

Cultural history enlightens us what is important for the study of this process, as Lynn Hunt (1984) shows the French Revolution as *longue durée* that mobilized

different people from different social status and regions into a common action, unlike widespread myth of class struggle based on narrowly defined interests. Driven by similar experiences of social pain and vision, people have practiced collective action. In this regard, as Durkheim mentioned, 'What collective representations expresses is the way in which the group thinks of itself in its relationships with the objects which affect it' (Durkheim, 1982: 40); but the group may be a collection of interlinked sub-individual signifiers that are not confined to a predetermined social group as we currently define in social science. The cases I chose in my thesis were an outstanding opportunity to test this problematic characteristic, and all about my proposed methodology is how to represent the social representation differently – potentially for the better utility.

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Media Framing of Stem Cell Research: Automatic Semantic Network Analysis of Political Representation of Science in South Korea[8]

Abstract

This article compares opinion-leading newspapers' frames of stem cell research in South Korea from 2000 to 2008 with fully automatized semantic network analysis. The change of news frames in three critical periods (2000-2003 / 2004-2005 / 2006-2008) shows the media's representative strategies in privileging news topics and public sentiments. The political identity represented by conservative and liberal media outlet play a crucial role in framing scientific issues differently. A news frame that objectifies medical achievements and propagates a popular hope evolves as a common discourse, but conservative *Chosun Ilbo* follows the frame of objectified science with a strong economic motivation and the typical frame of success story. On contrary, progressive *Hankyoreh* remains critical of the 'Hwang scandal' and tempers its scientific interest with broader socio-political concerns, criticizing the government's unilateral policy for promoting stem cell research. However, its framing of progressive value associated with life science turns out to be unclear, failing to deliver practical alternatives.

Keywords: news frame, stem cell, semantic network analysis

[8] This chapter (article) is based on my original article 'Media framing of stem cell research: a cross-national analysis of political representation of science between the UK and South Korea', published in *Journal of Science Communication.* 10 (3). The revised version focuses on the elite newspapers' framing of stem cell research in South Korea and conducts re-analysis of Korean data with the new automatic algorithm I developed.

Introduction

The aim of this article is to compare media framing of the stem cell debate in conservative and liberal newspapers in South Korea (*Chosun Ilbo* and *Hankyoreh)*. South Korea has been one of the most proactive and competitive countries in promoting life science, human embryonic stem cell (hESC) research in particular (Kim, 2012). Governmental promotion includes not only financial support but also active institutional establishments, including systematic efforts to develop favorable public opinion. After the first cloning of a sheep, *Dolly*, in 1997, by Ian Wilmut, triggering scientific and social debates on its implication, a Korean stem cell scientist, Woo-Suk Hwang, claimed that he had derived a stem cell line for the first time from a cloned embryo in 2004, using the somatic cell nuclear transfer (SCNT) technique that Professor Wilmut developed. Hwang's 'success' stirred debates across the world even before he was discredited for scientific misconducts that included unethical collection of ova and fabrication of experiments. Hwang's achievement confirmed the potential of hESC research, and the need for an expanded governmental support. However, when it was seen as a success, it heralded a fearful future of 'human cloning', and when seen as a failure, confirmed the uselessness of 'unethical' research. The repercussions of the Hwang scandal did not stop with his disgrace.

It is important to look back how public representations of scientific developments formed an environment of support or criticism based on national and poitical context, especially how the significant opinion-leading newspapers mediate the public representation. The mass media has its own story to tell about science, exerting influence on society while accommodating 'news value' (Bauer and Gutteling, 2002: 125). Science coverage in the media not only exposes cultural trends that indicate the changing position of science, but also represents the changing characteristics of society in scientific movement. Each media outlet highlights certain concepts, discussions, events, persons, etc. differently from the others. These outlets also actively respond to the media's and nation's interest while accommodating the expressions of the public readership.

From a comparative angle, certain themes appear or disappear along the mass media. In this sense, the complex web of media narrative also reveals gaps, intended and unintended, of knowledge and ideas, which are produced while reporting scientific events. This simultaneous effect of concealing and revealing in front of readership

forms a core element of the operation of discourse and power. On the other hand, characteristics and strategies of mass media are affected by national identities and political constraints. They function as cultural seedbeds of media discourse that confine the willingness and scope of media representation. Therefore, salience and frames of media discourses reflect specific national and political realities. Political identity of media influence the framing of scientific events, at least in the context of the stem cell debate, and the way the homogeneities and heterogeneities are negotiated itself reveals interesting characteristics of national culture. The nation culture in turn might gradually change over time, esepcially through a consistent semantic feedback loop between elite's discourses and ley people's perceptions. From this perspective, a systematic research elucidating the semantic characteristics of opinion-leading newspapers' discourses and their evolution is expected to draw significant insight on the public opinion of stem cell research.

Objective

In the comparative design, the two main levels addressed are:

a. Diachronic level: three time spans emerging between year 2000 to 2008 and the meaning of change in frame
b. Synchronic level: national context through the comparison between liberal & consrvative newspapers

In relation to the variables above, the study attempts to answer to the questions:

- Which are the important factors driving the stem cell debate in each period?
- What kind of frames and discourses emerge in driving the public opinion of science by each media?
- Overall, what are the similarities and differences between the conservative and liberal newspapers and what does it tell about the national identity related to the discourses of life science?
- Finally, in terms of methodology, how does the new automatic algorithm of semantic network analysis reveal the semiotic structure more effectively than existing methods and contribute to the frame & discourse analysis?

Method

Salience and framing: a network perspective

Salience designates the coverage of news articles, which indicates the intensity of controversy and interest in scientific issues. Framing, on the other hand, refers to 'the way a story is told by unfolding arguments, using metaphors and imagery that define a problem, arriving at causal or moral attributions, and prescribing particular remedies' (Entman, 1993: 52). A frame is the intuitive structure linking metaphors and concepts that decides the relation between essence and meaning, event and fact. The construction of frame is the process of perceiving a political and social agenda (Lakoff and Johnson, 1980) that emerges out of the public imagination.

In conventional methodology, measuring salience typically means, in brief, counting the number of articles on relevant issues; a frame is measured through content analysis, the clustering of indices such as main topic, controversy, evaluation, etc. (Bauer and Petkova, 2005: 4). The semantic network analysis follows the existing method for salience but offers a more microscopic and relation-oriented approach for frame. Classical content analysis pre-categorizes a certain index and counts the frequency of those categories in news coverage. Thus relational structure of a story in the media is segregated and quantified by pre-established categories. The results of analysis tell little about the frame itself as an aggregated relation of concepts or metaphors. Conversely, relational content analysis based on semantic network focuses on the associated intentions and meanings underlying the selected cluster of concepts, and the discursive strategies behind the arguments.

As a method for the computerized content analysis, the semantic network approach has been used to supplement limitations of traditional human-coded content anaysis, such as the lack of reliability and the crude categorization of analytic framework (Danowski, 1993; Doerfel and Barnett, 1999, Krippendorff, 2004; Tian and Stewart, 2005; Woelfel and Stoyanoff, 2000; Kwon, Barnett and Chen, 2009). While many semantic studies are based on sociosemantic networks, assuming that a social response results in shaping semantic relationsship (Carley, 1997), this study focuses on the keyword relationships within the text, that is, aggregated news articles. In this case, differences in semantic relationships are the result of differences in utilization and arrangement of words that are represented as the morphology of links. This text-based

semantic network analysis enables a more objective examination of discourse pattern than previous methods that are based on socially generated interpretations from respondents (Kwon, Barnett and Chen, 2009: 113). As a result, the measuable network concepts of 'centrality' and 'structural equivalence' out of linkage patterns respectively replace the conventional description of frequency (salience) and interpretative categorization (framing).

Data and time-span

The data corpus comprises a systematic selection of newspaper articles published in South Korea between 1 January 2000 and 31 December 2008. For the study of political attitudes and their interactions with science reporting, newspapers were selected that represent 'conservative' and 'liberal' opinions, *Chosun Ilbo* and *Hankyoreh* respectively. The political comparison attempts in a heuristic way to explore what kind of characteristic convergence and divergence in the discourse of stem cell research emerges across different ideological backgrounds that represents a national identity related to the object of emerging life science such as stem cell research. The newspaper articles were downloaded from media search engine Korean Integrated Newspaper Datatbase System (www.kinds.or.kr)). Keyword 'stem cell' ('줄기세포' in original Korean) were applied, and articles with irrelevant topics were removed after a manual reading. The selection resulted in the collection of 1,065 artciles from *Chosun Ilbo* and 917 from *Hankyoreh*, from the year 2000 to 2008.

As Figure 2.1. shows, the trajectory of the news coverage on stem cell issues are marked by three major shifts of frequency, or salience, in news reports in both countries. It implies that the data can be segmented by three crucial periods, which respectively correspond to the period before and after major stem cell events, domestic controversy and breakthroughs related to the Hwang scandal during 2004-2005. The news coverage of the newspapers South Korea was stable until Dr. Hwang claimed to have realized the theoretical expectation of producing stem cell lines from cloned embryos in 2004. This groundbreaking news created enormous hype and heated debates on the future of stem cell technology, diverging the news trajectories, until the results were finally disproven by the disclosures and investigations of the Hwang team's fabrication of experiments in

2006. Afterwards, along with the legislative debate and call for unhindered scientific progress, the news coverage in the South Korean media plateaued after a surge of reporting during the period of Hwang controversy.

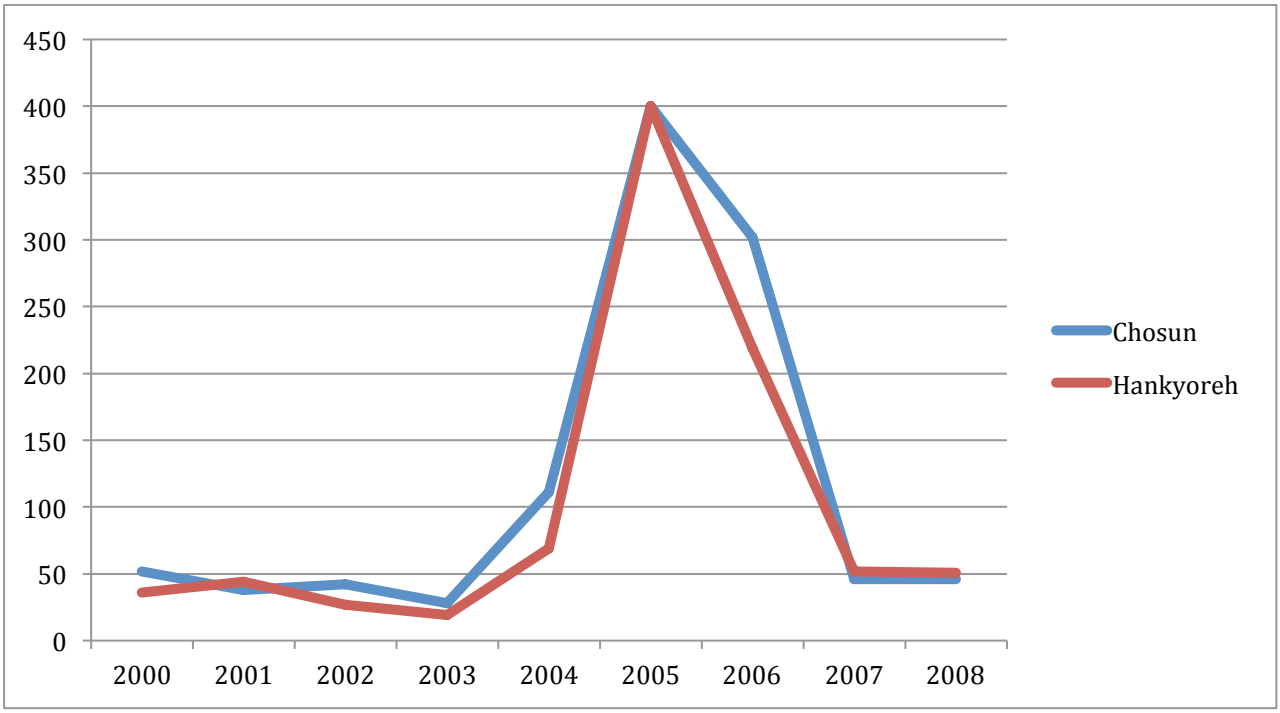

Fig. 2.1. Intensity of news coverage on stem cell

Newspapers and readership

a. Chosun Ilbo

Founded in 1920, *Chosun Ilbo* is one of a few newspapers that started and survived during Japanese colonialism from 1910 to 1945 in Korean peninsular. Although started with strong intent of nationalism and independence, the newspaper had soon undergone severe financial crisis and was finally overtaken by a native capitalist Bang Eung-Mo in 1933. Afterwards, *Chosun Ilbo* had been predominated by conservative editors who conformed to changing political rulers in modern Korean history: Japan, United States after 1945, and authoritarian regimes that seized power by military coups since 1962.

Chosun Ilbo has represented conservatism in modern South Korea that is generally characterized by the support to statism and developmental dictatorship, strong

pro-Americanism, Anti-communism, and recently neo-liberal economic policy. The newspaper has been criticized by liberals and nationalists in Korea for having supported Japanese imperialism from the late 1930s and political dictators since the national independence in 1945. However, *Chosun Ilbo* is the most influential newspaper media in South Korea that had certified average daily circulation of 1,699,430 in 2002. Its revenue from commercial advertisement was about $130 million in 2006, occupying 28.1% of entire market share.[9]

Although it is known that the conservative *status quo* prefers *Chosun Ilbo,* the general readership of the newspaper is not as clearly delineated by a class division. Wide public that shares a certain nostalgic sentiment towards the period of industrialization and rapid economic development by military leaderships from 1960s to 1980s forms a common readership. The readers also share many of *Chosun'*s criticism to ex-president Kim Dae-Jung (1998-2002) and Roh Moo-Hyun (2003-2007)'s liberal democratic governments, which had been depicted by the newspaper as 'radical left' or 'pro-(communist) North Korea' mainly for its reconciliatory policy toward North Korea. Although science reporting is not a specialized area for *Chosun Ilbo*, relevant news are usually framed with national glory, personal drama of scientists and success of industrialism.

b. Hankyoreh

Hankyoreh newspaper was founded in 1988, a year after the official democratization of South Korea when ruling regime coceded to people's will for general preseidential election. Ex-newspaper reporters from *Chosun Ilbo* and *Dong-A Ilbo* who had been exiled after military coup for uncompromising resistance in 1980 formed the main body of the new media. *Hankyoreh* is unique among major newspapers in the world as it is owned by lay people who volunteered to buy stocks, from a few to a few hundreds, to start the newspaper.

The newspaper raised 'progress' and 'trust' as its value based on the reflection that conventional newspapers did not do the job of objective and critical reporting under authoritarian regimes. To ensure institutional independence from large size capital, it

[9] Source: Wikipedia (http://ko.wikipedia.org/wiki/조선일보)

still maintains the policy of being owned by anonymous majority. Its size of circulation is small compared to major conservative newspapers including *Chosun Ilbo,* ranking outside of 10th among South Korean readership.

The general readership is composed of relatively younger generation, progressive intellectuals and college students. *Hankyoreh* stands for liberal and center-left positions, and often expresses sympathy to new progressive issues such as environmentalism and feminism. It is often critical to neo-liberal policy, and emphasizes government's role for fair distribution and social justice. Just as *Chosun Ilbo,* the newspaper does not have an expertise in science reporting, but is likely to raise doubts about possible side effects of new science and technology to environment and society.

Data analysis I: The limits of previous tool

Merging the psychological tradition's focus on textual information and the sociological concern with the construction of meaning, most contemporary views of framing focus on variations in the semantic context of information (Tewksbury & Scheufele, 2009). In this regard, the main characteristics of the frame can be summarized in three aspects: First, frames involve selectivity, rendering some aspects of an salient issue. Second, frames give meaning by following some central organizing idea. Third, frames perform argumentative functions: they define situations, establish causal chains, provide the evaluative standards against which propositions are evaluated, and chart the options for treatment and action lying ahead (Baden, 2010). Insofar as the frames are represented by selective links of concepts, those words and concepts are ideological units of life which both reflect and refract particular social relations (Crossley and Roberts, 2004).

There have been vigorous challenges to developing a methodology to represent this kind of discursive model as a visible mental map, extracted from texts, and analyze and compare these 'cognitive maps' that are networks of symbols composed of concepts and keywords (Carley and Palmquist, 1992). Semantic network analysis (SNA) is a form of content analysis which extracts the network of relations between objects as expressed in a text. Coding texts as maps focuses the user on investigating meaning among texts by finding relationships among words and themes, and by identifying

central words in specified relations. The union of all statements per texts forms a semantic map of keywords that is equivalent to a network (CASOS, 2007: 5-6). The principle of producing the link is based on the measurement of co-occurrences, 'defining word-pair link strength as the number of times each word occurs with another, every possible word pair has an occurrence distribution, whose values can range from zero on up' (Danowski, 1993: 197). Word pairs within a window (a number of word set that becomes an inmaginary unit of document in word x document matrix) can be given a connection weight either equally regardless of a distance or proportionally to how close the words are (Danowski, 1993). Automap utilized for text analysis is an semi-automatic and co-occurrence based network tool, based on the distance model, which extracts and analyzes links among words to model the author(s)'s 'mental map' as a network of links (CASOS, 2007). By operating the semi-automatic coder Automap (with visualization & analysis tool ORA), text goes through the following stages:

a) Preprocessing stage:
    a. Automatic stemming of variable words based on embedded dictionary
    b. Semi-automatic deletion of syntactically functional words including articles, adverbs and verbs. Descriptive adjectives are also deleted, except for those denoting specified meaning or typically containing substantives in Korean language.
    c. Manually producing the list of generalization thesauri of synonyms
    d. Applying a threshold that erases words that occurred less than given frequency[10]
b) Transformation of the remaining text into an adjacency matrix of keywords (.xml file)
c) Visualization and calculation of social network indices by ORA

Although Automap that I used in the previous research (Kim, 2011) turns out to be reliable in coding textual data and analyzing some semantic characteristics, it had a few limitations as well. Firstly, automatic stemming is only available in English, and the embedded Emglish dictionary is not elaborate enough when even applied to English text. Secondly, the embedded dictionary (linguistic library) do not contain grammtical

[10] In my article, the words that occurred less than twice a year were considered insignificant and deleted.

tagging. In other words, syntactically functional words should be discerned by bare eyes and deleted in the window list. Finally, the adjacency matrix produced by Automap out of large size data (see Appendix I) was still too complex, so the author had to choose between presenting the undiscernable complex network in its form or reducing the size drastically by applying a threshold, in this case a centrality measure. When adopting the latter method, a sizable loss of information is inevitable, and the applied threshold can be criticized for its arbitrariness.

Data analysis II: New algorithm for extraction and classification

While the first two problems could be addressed by a comprehensive linguistic corpus that is utilized in commercial serach engines for natural language processing, the last hurdle requires more reliable and sophiticated statistical approach. In short, there is an urge to define a filtering method that offers a practical procedure to extract the important connections in complex semantic networks, extracting the relevant information that would allow a reduced representation while preserving the key features we want to highlight with statistical significance. Mainly applied in statistical physics for extracting the complex weighted networks, the 'backbone extraction model' (Serrano, Boguñá and Vespignani, 2009) enables the preservation of statistically significant deviations with respect to a null model that informs us about the random expectation for the distribution of weights associated to the connections of a particular node.[11] This procedure would determine without arbitrariness how many connections

[11] The null model that is used to define anomalous fluctuations provides the expectation for the disparity measure of a given node in a pure random case. It is based on the following hypothesis: the normalized weights that correspond to the connections of a certain node of degree *k* are produced by a random assignment of from a uniform distribution. To visualize this process, *k−1* points are distributed with uniform probability in the interval [0, 1] so that it ends up divided into *k* subintervals. Their lengths would represent the expected values for the *k* normalized weights *pij* according to the null hypothesis. The probability den- sity function for one of these variables taking a particular value *x* is:

$$\rho(x)dx = (k-1)(1-x)^{k-2}dx \qquad [1]$$

The null model allows this discrimination by the calculation for each edge of a given node of the probability αij that its normalized weight *pij* is compatible with the null hypothesis. In statistical inference, this concept is known as the *p* value, the probability that, if the null hypothesis is true, one obtains a value for the variable under consideration larger than or equal to the observed one. By imposing a significance level α, the links that carry weights that can be

for every node belong to the backbone of connections that carry a statistically disproportionate weight – be they one, zero, or many – providing sparse subnetworks of connected links selected according to the total amount of weight we intend to characterize. An important aspect of this construction is that the ensuing reduction algorithm does not belittle small nodes in terms of strength (frequency) and then offers a stable pocedure to reduce the number of connections taking into account all of the scales present in the system by applying the disparity filter that exploits local heterogeneity and local correlations among weights to extract the network backbone. This approach has proved to be reliable especially for the case of systems with strong disorder, where the weights are heterogeneously distributed both at the global and local level just like the semantic network (Serrano, Boguñá and Vespignani, 2009: 6484-6487).

In the context of semantic network analysis, it is important to identify central keywords and their relations with other words to explore the narrative structure and interpret social meanings. Betweenness centrality index (Freeman, 1979) has been frequently utilized in text analysis (Leydesdorff and Hellsten, 2008; Leydesdorff and Schank, 2005) because of its semiotic relevance and statistical robustness.[12] In the performative communication, interaction between two nonadjacent nodes of concepts is likely to depend on another concept for reference that functions as a 'catalysis' to join metalanguages of concepts (Barthes, 1967). This function is translated into a node with

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considered not compatible with a random distribution can be filtered out with an certain statistical significance. All the links with αij < α reject the null hypothesis and can be considered as significant heterogeneities due to the network-organizing principles. The statistically relevant edges will be those whose weights satisfy the relation

$$\alpha_{ij} = 1 - (k-1)\int_0^{p_{ij}} (1-x)^{k-2} dx < \alpha. \qquad [2]$$

[12] The betweenness centrality of node *v* in a network is defined as:
Across all node pairs that have a shortest path containing *v,* the percentage that pass through *v.*
The formula is:
Let *G* = (V,E) be the graph representation for the network.
Let *n* = |V|, and fix a node *vV*. For (u,w)V × *V,*
let this be the number of geodesics in *G* from *u* to *w*. If (u,w)E, then set = 1.
Define the following:
let *S* = {(u,w) ∈V ×V *dG* (u,w) = *dG* (u,v) + *dG* (v,w)}
let betweenness = Σ (nG (u,v)* *nG* (v,w)) / *nG* (u,w)(*u,w*)∈S
Then the betweenness centrality of node *v* = between/((n − 1)(n − 2)/2).
Note: if *G* is not symmetric, then between is normalized by (n − 1)(n − 2).

highest betweenness centrality in semantic network when the keyword lies on the paths between the trigger of information and referent, performing a mediating role as a semiological facilitator and a denotative controller of communication. On the other hand, closeness centrality[13] focuses on how 'close' an actant (node) is to all the other actants in the set of relations. Central nodes are close if they have minimum steps relating to all other nodes. In a directed semantic graph, a node of concept that has the highest input-closeness centrality is expected to be located in the point of 'converging reference' because most other concepts are likely to refer to the concept to produce the most instantaneous pair of meaning. In sum, the 'flow' or sequence of denotative communication has an ultimate end(s), which becomes a converging point of connotation, or the secondary reference of denotations (Barthes, 1967; Kim, 2013).

For the improved method of categorization, an algorithm based on the Girvan–Newman model (Girvan and Newman, 2002) is utilized after backbone extraction, which clusters nodes according to homogeneous patterns of linkages by iteratively simulating the removal of links from the highest betweenness centrality. This algorithm is relevant for the network structure that is not dependent on the frequency of co-occurrence alone, and much more efficient than hierarchical clustering or other blockmodelling methods such as CONCOR (Wassserman and Faust, 1994; De Nooy, Mrvar and Batagelj, 2005) in terms of computation. From the perspective of semiotics, a homogeneous linkage indicates identical conductivity of discourse, that is, making a similar reference pattern to form an identical theme (Jang and Kim, 2012). Then, the emrging theme can be interpreted both by the author and anonymous readers who cross-check the possible common meanings of clustered words. In this re-analysis of media data, the semantic network analysis company Treum's (http://www.treum.com) solution and computerized system Optimind that incorporate the aforementioned functions have been utilized.

[13] The closeness centrality is defined as: v is the number of other vertices divided by the sum of all distances between v and all others.
The formula is:
Let $G = (V,E)$ be the graph representation of the square network. Fix $v \in V$.
Let distance $= \Sigma\ dG\ (v,i)$, if every node is reachable from v. $i \in V$
Then the closeness centrality of node $v = (|V| - 1)/\text{distance}$.
If some node is not reachable from v then the closeness centrality of v is $|V|$.

Results: different framing of stem cell events

Period 1 (2000-2003): Navigating the prospect of stem cell research

The emergent social implications of embryonic stem cell research attracted the attention of Korean newspapers in 2000 when scientists and legislators in the Western counterpart devised and emphasized the term 'therapeutic cloning', used to combat the public concern that the new cloning and stem cell technology might lead to human 'reproductive cloning' (Jasanoff, 2005). Until 2003, the major news coverage were driven by public concerns and debates on reproductive cloning, hope for new medical application, and legislative issues to regulate the research (Kim, 2011).

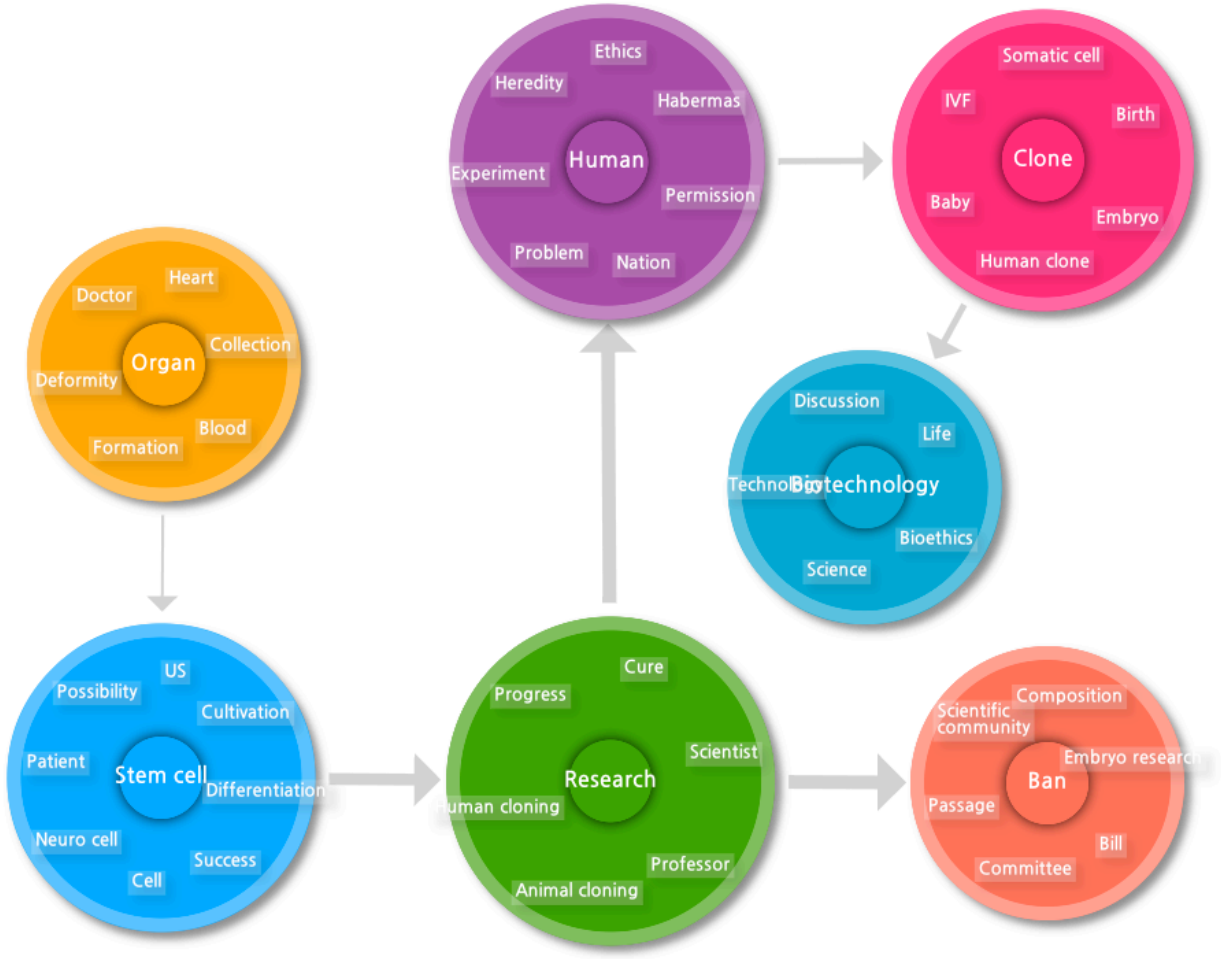


Fig. 2.2. Semantic flow of *Chosun Ilbo*'s frame (2000-2003)

* Graphic produced by Optimind

Figure 2.2 is a semantic map of *Chosun Ilbo*'s news articles during 2000-2003

period. By utilizing Optimind, different word classes are presented as different circles, and the width of directed edges represent the total frequency of linkages between the two word classes. Among the words in the same class (circle), the one with the highest betweenness centrality is being placed in the center. The original Korean words (Appendix II) were translated into English, and then directly encoded in the computer system. The core construct of themes and flows appear to be both objective and informative in discussing how stem cell [Research] might affect [Human] ethics when possibly applied to human cloning just as animal cloning, along with quoting Habermas's precautious remarks and more narrowly defined bioethics related to [Biotechnology]. The reportings of on-going legislative issues to [Ban] embryo research and the response of scientific community are represented with a relatively aloof stance.

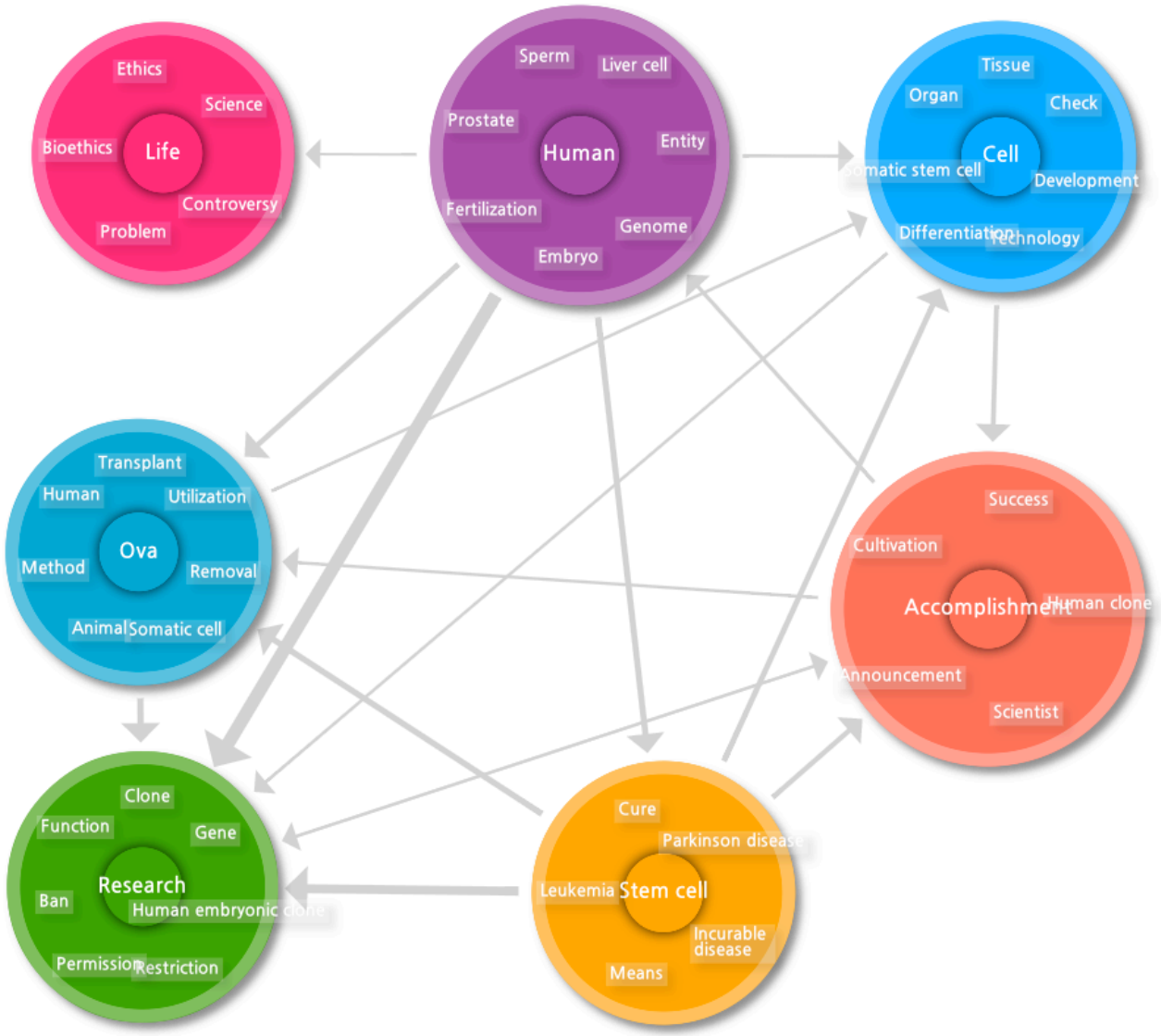


Fig. 2.3. Semantic flow of *Hankyoreh*'s frame (2000-2003)

Hankyoreh's framing in Figure 2.3 likewise delivers a lot of technical information regarding the therapeutic prospect of stem cell research as means of curing incurable diseases, and introduces its controversial ethical aspects in [Life]. *Hankyoreh'*s review of legislative debates either to ban or permit human embryonic [research] appears to be intresting, as the word class is directly related to the question of legitimacy if the embryonic stem cell [Accomplishment] is based on the utilization of human [Ova], while seeking an alternative method of utilizing somatic cell without the supply of female eggs. In sum, both the newspapers explore the prospect of stem cell research with objective manner in this early period. This is mainly because the new development and following debates are regarded as foreign achievements and concerns. However, the frame of *Chosun Ilbo* is simpler when offering information of potential ethical problems, as the reportings subsume to the drafting of bioethical law and vague mentioning about respecting human ethics when faced to the danger of human cloning. In contrast, *Hankyoreh*'s more detailed and complex delivery of technical issues in stem cell research comes to point out the use of ova in embryonic stem cell research somewhat problematic.

Period 2 (2004-2005): Emergence of political identity in news frames

The year 2004-2005 was an extraordinary period for stem cell science, and particularly for the Korean media. After Hwang announced a stem cell breakthrough that was considered far ahead of research centers around the world, *Chosun Ilbo* reported under the title 'Professor Hwang's technology is subject to patenting' that assessed its economic profit would reach $300 billion for the next 5-10 years (31 May 2005). This fantasy was soon replaced by disappointment and anguish after his scientific misconducts. Before the final confirmation of the fabrication of results in 2006, *Chosun Ilbo* actively supported Hwang as the builder of a 'Korea' described as the hub of BT (biotechnology) thanks to his achievements (Kim, 2011).

The story of the Hwang scandal dominates the news frame of the Korean newspapers; but there is a sharp contrast in framing the value and meaning of embryonic stem cell research when confronted with the scandal. While *Chosun Ilbo* (Fig. 2.4) frames the controveries of [Professor] Hwang by faithfully delivering his defensive [announcement] related to an article in *Nature* that raised suspicion of ehtical

integrity (Kim, 2009), the value of stem cell [Research] is semiotically identified with 'expectation', 'progress', 'accomplishment', (need for) 'government support' and (the prospect of) 'commercialization' by statistical grouping (purple circle). Similarly, the 'hope' for 'cure' pronounced by [Patient] syntactically proceeds the description of [stem cell].

Fig. 2.4. Semantic flow of *Chosun Ilbo*'s frame (2004-2005)

In comparison, *Hankyoreh* (Fig. 2.5) reports the controvery of Hwang in more detail, incorporating not only the issue of utilizing junior researcher's ova but also the possibility of fabrication of experiment in Hwang's [Article] in *Science*. There is an

ambivalence toward stem cell research as it might present a solution to [Incurable disease], but the [Research] should be fully aware of the broad 'ethics' of 'life'. The narrative flow from [Stem cell] → [Incurable disease] → [Research] forms a feedback loop with [Professor] Hwang's incident that is framed as an exemplary case reckoning the importance of life ethics. During this period, a political stance is being manifested by whether to defend Hwang or not; and the underlying interest of media is reflected by the degree of support to the commercialization of biotechnology and care for problems of ehtics.

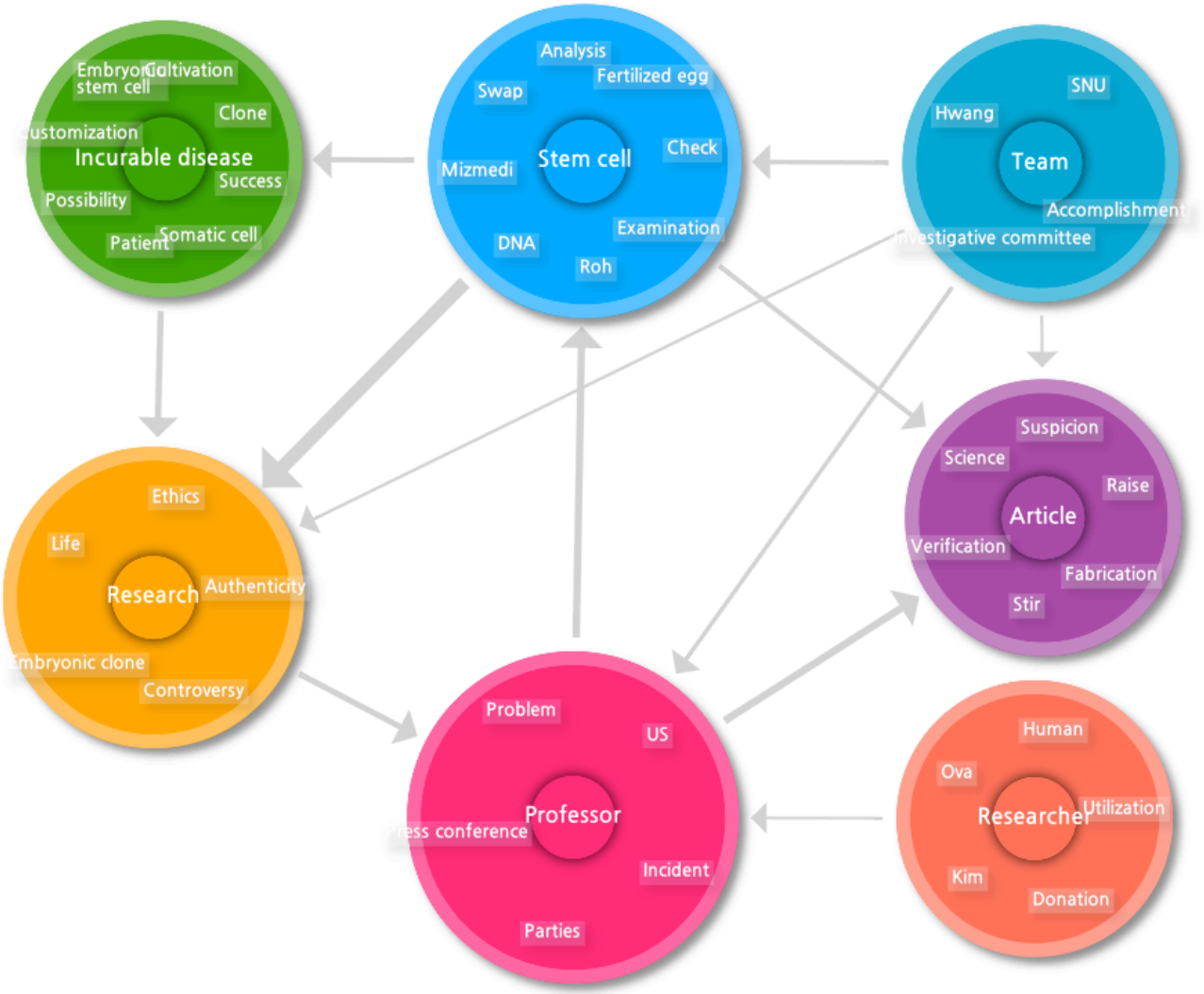


Fig. 2.5. Semantic flow of *Hankyoreh*'s frame (2004-2005)

Period 3 (2006-2008): Differing gaze toward stem cell and world

The Hwang debacle and prolonged media war between the conservative and

progressive newspapers (Won *et al.,* 2006) attenuated the media's capacity to cover various aspects of stem cell research; whether to support Hwang or not had become a predominant subject of identity politics that has roughly drawn the line between right wing supporters of the scientific regime and left wing critics against state-sponsored stem cell research. When Hwang's misconduct has become evident, *Chosun Ilbo* quickly withdraws its support and moves away from the issue. Instead, new [Stem cell] [Development] in the world, such as 'India' in bioindustry, and California's 'bill' to subsidize $3 billion in stem cell research emerges as a warning sign to Korean biotechnology industry, which is faced with evermore critical public atmosphere (Fig. 2.6).

Fig. 2.6. Semantic flow of *Chosun Ilbo*'s frame (2006-2008)

In the same period, the critical reportings of Hwang's conducts and ensuing Prosecutor's investigation occupy 5 out of 7 word classes in *Hankyoreh* that include [Prosecutor], [Professor], [Article], [Veterinary department] and [Somatic cell] (Hwang's cloning of a dog *Sunppy* by somatic cell transplant) (Fig. 2.7). And this ongoing reflection on the Hwang scandal is predominantly mediated by the question of government's financial support to embryonic stem cell [Research].

Fig. 2.7. Semantic flow of *Hankyoreh*'s frame (2006-2008)

While it is acknowledgeable that the *Hankyoreh* continues to inquire about the Hwang scandal whereas *Chosun Ilbo* adopts a defensive exit strategy, a synchronic difference is also obeserved in the usage of 'world' in their word classes between the two newspapers. For *Chosun Ilbo*, this entity is a mirror-image of industrial competition

as it is mainly associated with [Development] frame. The editorial comment titled '[Stem cell research in] Korea is drifting, the world is speeding' (25 April 2006)[14] is an exemplary discourse the media exploits. For more introspective *Hankyoreh,* in most cases the same word has been more ambiguously used merely to denote 'stem cell world' in general. However, the frequent rhetorics of 'no.1 in the world' (best) and 'world first' (earliest) have been commonly emphasized in both media.

Summary: Denotation and connotation

So far, I have described the transformation of media frame through the extracted story flow. Although the essence of frame and media circumstances do not differ from my previous research (Table 2.1), the automatically produced results in this study make it clearer and more intuitive to automatically construct and follow the story line as a connection of grouped themes.

To summarize, the initially objective reportings on the prospect of embryonic stem cell research in both newspapers, albeit their meaningful differences in the tone of framing ethical issues and describing the research, during 2000-2003 change when the expectation of the technological success is brought into the nation in 2004. After the Hwang debacle in 2005, *Chosun Ilbo* tries to protect professor Woo-suk Hwang from defamation and its animosity against opposing *Hankyoreh* escalates: the value of research and the broader ethical value of life collides. From 2006, the commercial potential of embryonic stem cell research in *Chosun Ilbo* whereas the governmental support to the research is put into question in *Hankyoreh.* To mention some technical aspect by comparing the results from the study conducted in 2011 (Kim, 2011), there is a slight trade-off in the number of keywords that are missing. This is because the latest algorithm of Optimind has been designed to apply an optimized threshold (see *Data analysis II* chapter) to extract the most significant words in backbone structure that should not be more than a hundred in total.[15]

[14] URL: http://www.chosun.com/economy/news/200604/200604250013.html
[15] This guideline reflects my accumulated experience that more than a hundred words are not intuitive enough to interpret, and that the more variables the more the mathematical application of threshold might become arbitrary from the perspective of statistics.

Table 2.1.
Stem cell frames in South Korean media 2000-2008

	Media	
Period	Hankyoreh (progressive)	Chosun Ilbo (conservative)
2000-2003	*Public ethics/accountability*; focus on ethical issues related to 'society', 'feminism', 'public opinion', 'public hearing', 'dystopia', 'biopiracy'	*Bioethics;* focus on the drafting of bioethical laws
2004-2005	*Societal irrationality*; emphasis of term 'ethic' in relation to 'mass media' and public 'frenzy'	*National success*; Hwang represented as a success, reflecting the national identity of S. Korea
2006-2008	*Social problems and governance*; focus on general problems in S. Korea reflected by the Hwang scandal	*Legitimization*; focus on new developments in the US to justify research into stem cell technology; emphasize scientific authority; Avoid mentioning Hwang

(excerpt from Kim (2011), p. 14.)

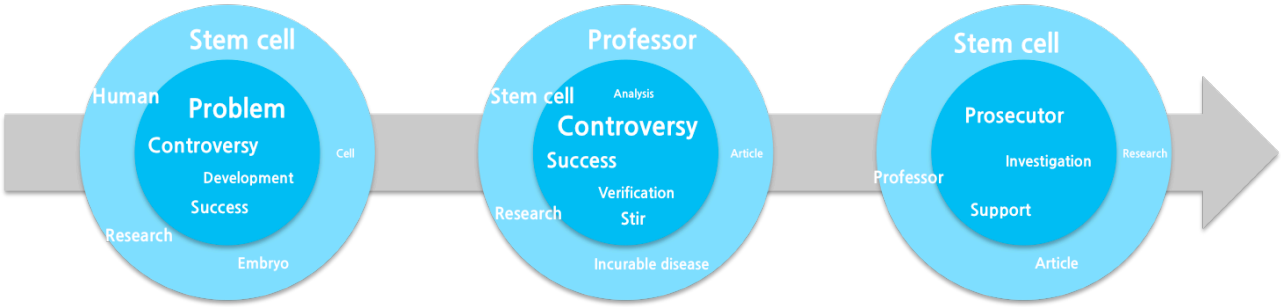
The loss of data is partly compensated by the additional keyword analysis platform that focuses on the location of an individual keyword in the extracted semantic network. As demonstrated in Figure 2.8 (see Appendix III for mathmatical logic), the three circles from left to right in each media respectively indicate the time period of 2000-2003 / 2004-2005 / 2006-2008 and represent the extracted words that are listed at the top in betweenness centrality as main denotation (periphery) and in input-closeness centrality as significant connotation (core) (see *Data analysis II* chapter). Through out the process, it becomes more evident that the two competing media's stances toward stem cell and embryo research have been different each other from the initial stage: During 2000-2003, *Hankyoreh*'s discussions subsume to the concept of 'problem' whereas *Chosun Ilbo* rather neutrally deals with the related theme of 'birth'. During the controversial period in 2004-2005, complex discourses in regard to stem cell research converge on the value of 'development' in *Chosun Ilbo* whereas 'controversy' itself has become the main fixture in *Hankyoreh.* Previously I mentioned that *Chosun Ilbo* had attempted to avoid mentioning Hwang anymore and justify the value of Korean

government's support to stem cell research by reminding international comptetitors' developments afterwards (Kim, 2011: 11-13). Throughout the current analysis, it is newly observed that the core frame, or the indicative connotation, of *Hankyoreh* in 2006-2008 is practically absent, other than the fixated focus on the prosecutor's further investigation on Hwang and the questioning of the state support. Whereas the 'success' story of stem cell research and its 'utilization' consistently survive at the core of the conservative competitor's frame, no explicit answer is given in *Hankyoreh* what could be projected to the public beyond the desired success.

a. Chosun Ilbo

2000-2003 2004-2005 2006-2008

b. Hankyoreh



2000-2003 2004-2005 2006-2008

Fig. 2.8. Diachronic change in denotation (periphery) and connotation (core)
* Graphic produced by Optimind (size of node represents betweenness centrality)

Discussion

This article has demonstrated how each newspaper has developed a unique frame by selectively linking concepts in different ways with effective text-mining algorithm. The contrasting selectivity in linking between proximate concepts has

weaved completely different morphologeis of semantic networks, resulting in the significant differences in denotation and connotation. To conclude, political and national identity of media operate as important causes of framing: and it evolves as an acute object of political struggle even in the framing of scientific events. The national context from the perspective of media framing has been classically studied by some opinion-leading media's contents (Bauer and Gaskell, 2001; Durant, Bauer and Gaskell, 1998) and their statistical representaions. Conversely, the conclusion of my study implies that it could be also meaningful to study the 'absence' of possible frame from the mass media.

As Lakoff (2004) argues, frame becomes successful only when it is effectively iterated and delivered as a 'simplified' concept to people's pre-existing cognitive schema. In this regard, the social-psychological process of 'anchoring' (Moscovici, 2000) is vividly reflected in the discourses of the dominant conservative media in Korea, most notably through 'development' and 'success', that consistently and successfully summon the embedded collective memory of Korea's industrialization period that overlaps with the legacy of development dictatorship. Be it called progressivism or liberalism, the contending counterpart apparently prevails over the ethical discourses of science, but lacks its consistent ideological connotation from the perspective of 'frame war'. Consequently, one might suspect whether the richly discussed reasons of ordinary Korean peoples' resistance in opposition to elite media's discourses, be it conservative or pregressive, and their blind and pointless support to professor Hwang (Kim, 2008; Kim, 2009; Kim, 2011) in the controversial period may not be related to this absence of an effective 'counter-frame' that would challenge the dominant conservative frame of 'successful industrial development'; and science for its ends sometimes at the cost of human ethics. From this critical perspective, methodological advancements could concentrate on the gap of frame by effectively extracting and classifying the substances of complex discourses.

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Appendix I

Descriptive statistics of data

Period	Characteristic	Hankyoreh	Chosun Ilbo
2000-2003	N. of articles	126	160
	N. of words	133,610	65,664
2004-2005	N. of articles	469	511
	N. of words	136,068	199,526
2006-2008	N. of articles	322	394
	N. of words	80,557	130,885

Appendix II

The URL of results produced by Optimind

a. Korean

http://220.85.40.206/_origin/semantic_output/research/20121228/korean/chosun_2000_2003/
http://220.85.40.206/_origin/semantic_output/research/20121228/korean/chosun_2004_2005/
http://220.85.40.206/_origin/semantic_output/research/20121228/korean/chosun_2006_2008/
http://220.85.40.206/_origin/semantic_output/research/20121228/korean/han_2000_2003/
http://220.85.40.206/_origin/semantic_output/research/20121228/korean/han_2004_2005/
http://220.85.40.206/_origin/semantic_output/research/20121228/korean/han_2006_2008/

b. English

http://220.85.40.206/_origin/semantic_output/research/20121228/chosun_2000_2003/
http://220.85.40.206/_origin/semantic_output/research/20121228/chosun_2004_2005/
http://220.85.40.206/_origin/semantic_output/research/20121228/chosun_2006_2008/
http://220.85.40.206/_origin/semantic_output/research/20121228/han_2000_2003/
http://220.85.40.206/_origin/semantic_output/research/20121228/han_2004_2005/
http://220.85.40.206/_origin/semantic_output/research/20121228/han_2006_2008/

Appendix III

The mathematical logic of story flow model in Figure 2.8

1. Let $B = (V_B, E_B)$ denote backbone network where V_B is a set of vertices in B and E_B is a set of edges in B.

2. By Newman-Girvan method, each vertex in V_B is assigned on ith group, where $i = 1, 2, \ldots, n$. n is the total number of groups. Then define a set of nodes S_i as $S_i = \{v \in V_B | v \text{ has group number } i\}$. Also, we can define weighted edge between S_is. Let E_S be a set of edges $e_{i,j}$ between two groups of nodes S_i and S_j, such that

$$e_{i,j} = \sum_{x \in S_i, y \in S_j} \begin{cases} e_B(x,y) & \text{where } e_B(x,y) \in E_B \\ 0 & \text{otherwise} \end{cases}$$

   Surely, E_S is not symmetric.

3. Let flow denote F as;

   (a) $F = (V_F, E_F)$ where $V_F = \{S_{i_1}, S_{i_2}, S_{i_3}, S_{i_4}\}$ and $i_1 \ldots i_4$ is in $\{1, 2, \ldots, n\}$

   (b) $S_{i_4} = \max_{k=1,\ldots,n}$ Input Closeness(S_k). If $\max_{k=1,\ldots,n}$ Output Closeness(S_k) is connected with S_{i_4}, then $S_{i_1} = \max_{k=1,\ldots,n}$ Output Closeness(S_k). Otherwise S_{i_1} is chosen by next maximization step.

   (c) With fixed i_4, $||F|| \geq ||(V_{i,j,k,i_4} = \{S_i, S_j, S_k, S_{i_4}\}, E_{i,j,k,i_4})||$, where $i \neq j \neq k \neq i_4$ and $\forall i, \forall j, \forall k \in \{1, 2, \ldots, n\}$

   $||F||$is 1-dimensional norm, defined as $||F|| = ||S_{i_1}, \ldots, S_{i_j}|| = \sum_{k=1}^{j-1}(e_{i_k, i_{k+1}} - e_{i_{k+1}, i_k})$

4. Define $OC(x)$, $IC(x)$ and $BC(x)$ as;

   (a) $OC(x) : S \to R^+$ where S is a set of sets which contains vertices in Network, and R^+ is a set of positive real number. A range of $OC(x)$ is a set with one element, which is Output Closeness of x.

   (b) $IC(x) : S \to R^+$ where S is a set of sets which contains vertices in Network, and R^+ is a set of positive real number. A range of $IC(x)$ is a set with one element, which is Input Closeness of x.

   (c) $BC(x) : S \to R^+$ where S is a set of sets which contains vertices in Network, and R^+ is a set of positive real number. A range of $BC(x)$ is a set with one element, which is Betweenness Cenrality of x.

5. In each S_i in flow, choose its representative vertex such as

Case of S_i	Representative vertex
S_{i_1}	$\max_{x \in S_{i_1}} OC(x)$
S_{i_2}	$\max_{x \in S_{i_2}} BC(x)$
S_{i_3}	$\max_{x \in S_{i_3}} BC(x)$
S_{i_4}	$\max_{x \in S_{i_4}} IC(x)$

6. Also, choose 10 vertices(words) in each S_i of flow such as;

Case of S_i	10 Vertices
S_{i_1}	$\{x_{j_1}, \ldots, x_{j_{10}} \mid j_k$ is descending order of $OC(x)\}$
S_{i_2}	$\{x_{j_1}, \ldots, x_{j_5} \mid j_k$ is descending order of $OC(x)$ $\} \cup \{x_{j_1}, \ldots, x_{j_5} \mid j_k$ is descending order of $IC(x)$ $\}$
S_{i_3}	$\{x_{j_1}, \ldots, x_{j_5} \mid j_k$ is descending order of $OC(x)$ $\} \cup \{x_{j_1}, \ldots, x_{j_5} \mid j_k$ is descending order of $IC(x)$ $\}$
S_{i_4}	$\{x_{j_1}, \ldots, x_{j_{10}} \mid j_k$ is descending order of $IC(x)\}$

   Each 5 vertices appear in both side of a vertex in flow and represent their edge if they exist.

Second article

Denotation and Connotation in Public Representation: Semantic Network Analysis of Hwang Supporters' Internet Dialogues

Introduction

In February 2004, Professor Hwang's Seoul National University team published a ground breaking paper in the journal *Science,* announcing the successful derivation of a single stem cell line from a cloned human embryo. In the following year, Hwang reported an even more stunning accomplishment, namely the derivation of 11 'patient specific' stem cell lines, which were seen as bearing witness to strikingly improved levels of efficiency in using human eggs. However, what was celebrated in South Korea as the nation's scientific triumph was soon undermined by allegations of ethical misconduct in acquiring human eggs from women in disadvantageous positions, and then followed by accusations of scientific fraud. What brought about the international attention was not Hwang's fraud alone. In November 2005, the South Korean broadcaster the MBC reported Hwang's unethical collection of ova, and questioned the authenticity of his experiment. After the broadcast, tens of thousands of angry South Korean people posted comments on the MBC's web page fiercely criticizing the broadcasting. Online communities of Hwang fandoms each composed of thousands of members boycotted television commercials and organized massive demonstrations in front of the MBC building.

In response to the threat and animosity felt throughout the country, the MBC dissolved the 20 years' long-lived investigative program *PD Notebook* without any promise of return – until anonymous scientists on the Korean website of the Biology Research Information Center (BRIC) started to post evidence of Hwang's fabrications. Meanwhile, a truck driver set himself alight in protest over the charges against Hwang, claiming Hwang was the victim of a conspiracy and unjustness in Korean society. The public protest went on even after, in 2006, Seoul National University and the Prosecutor's Office investigated the affair and concluded that Hwang had fabricated evidence and behaved unethically (see online Appendix I).

The frenetic support of a star scientist and violent activism, even after the disclosure of his misconduct, seems hardly imaginable in other parts of the globe. The phenomenon unveiled a variety of interesting characteristics for researchers in social science as well as experts in the public understanding of science. Firstly, people's support for Hwang and their attack on the MBC through internet media was a new form of social movement that proved the effectiveness of utilizing information technology. Living in one of the most densely wired (with optic fibers and Wi-Fi nets) countries in the world, South Korean citizens spontaneously initiated their social engagement in scientific affairs through online websites. They successfully mobilized a 'cyber attack' that immediately brought down one of Korea's major broadcasters, the MBC, which had raised questions on the unethical collection of ova and the fabrications in Hwang's laboratory. Secondly, the demonstration was unprecedented because supporters refused to conform to official verdicts of Hwang's fraud. Somewhat paradoxically, they actively mobilized social criticisms against state institutions and expert groups by exploiting nationalist rhetoric originally produced by the government and the major mass media to encourage science for national growth. Thirdly, the campaign was not driven by an 'underclass' or 'scientifically illiterate' people. The movement consisted of a wide range of sympathetic and conscious actors including some intellectuals and activists who were willing to fight for a 'just cause' (Kang, Kim and Han, 2006; Kim, 2009).

Previous studies provide some clues for this phenomenon. To counter explanations that de-contextualize or stigmatize the public as merely 'irrational,' some sociological studies focused on the intricate logic of the public's feelings about science. There was a story of Hwang that a number of Korean people readily approved of: a humble boy who had grown up in a poor rural family yet had established himself as a diligent global scientist, always pronouncedly displaying modesty and patriotism. This dramatic personal life also epitomized people's pride in the contemporary history of South Korea, a nation that has risen from being one of the poorest countries to one of the most industrialized countries in half a century. Meanwhile, many media reviews and social science studies have mentioned the lack of accountability of responsible institutions, which undoubtedly aggravated the public's distrust, whilst Hwang's story stirred the pathos of nationalism (Kang et al., 2006; Won and Jun, 2006; Kim, 2009).

Nevertheless, the 'blind nationalism' thesis requires a more elaborate substantiation, running short of explanations when questioned: a) Can people showing support and sympathy to Hwang and his stem cell research be reduced to a simple

nationalism as a formal ideology? b) If not, which connotative elements associated with people's lives, feelings, and social context drove them to violent activism? and c) What explicit and implicit frames used by supporters might be captured by an alternative analysis?

The majority of South Koreans are known to be very nationalistic. However, this does not mean that these people necessarily follow the formal ideology and cultural hegemony that had been associated with Korean nationalism since the colonial modernization from the early 20th century (Shin and Robinson eds., 1999). Even under the rigid hegemonic authority structure (Kim, Jung and Park eds., 2003) as witnessed in Hwang's own laboratory just like other parts of Korean society, the concerned actors applied adept tactics to incorporate, appropriate, and twist the cultural 'rules of the game' for their own interests, finally betraying their master – Hwang (Kim, 2008). This fact leads us to ask:

- What was the narrative told in the public discourse following the MBC broadcast and expert groups' investigations?
- Why did Hwang's case attract such dogged support? What kind of underlying desire was expressed in the public discourse?
- What was a core motive to the discourse underlying the denoted nationalism; was it purely a collective patriotism coupled with the prospect of 'holy grail' of embryonic stem cell research, or something else?

.

. The semantic analysis of the general public's internet dialogues on the scandal attempts to excavate different answers to these questions. In contrast to a nationalism frame argued by existing literatures (Kang et al., 2006; Won and Jun, 2006; Gottweise and Kim, 2009), public anger swelled not only from Korean patriotism, regarding Hwang's confession of his misconduct as dissolving national research capacity. As I argue in this chapter, people were also upset because of Hwang's humiliation and his public disgrace; these were believed to be typical consequences of social mobility in South Korean society. To the eyes of the general public, the personal tragedy was imagined to be motivated by jealous rivals who plotted to embarrass and subdue a gifted individual who rose from a humble, innocent, social status. The feeling of shared

sympathy for Hwang and deep distrust against expert institutions lingers on in the networked semantic representations, with changing objects of blame.

Research object and methodology

Research object

. My target of analysis was the general public, not the official groups of Hwang supporters. I chose to study broader public dialogue on a website for two main reasons. Firstly, the majority of South Koreans, independent from official supporters' activism, have been in favor of Hwang despite his misconduct.1 Secondly, this general support through the internet not only created a sympathetic national environment for Hwang but also provided grounds for public engagement that led to thou- sands of people demonstrating in public places. For similar reasons, I chose a general and open discussion website in South Korea (*Daum Agora)* to analyze the uploaded dialogues. *Daum Agora* is a South Korean website for open discussion that has more than 30 million affiliated members in which both pros and cons freely express their opinions on controversial issues. In the Hwang supporters' official websites, opinions were unilateral and the members usually did not allow dissenting voices to be posted on their boards. In comparison, supporters' discourses in *Daum Agora* tended to be more persuasive, more often than not trying to make sense of their ideas rather than merely bursting with emotion. This provides a researcher an advantage for systematic coding of their statements. (As to the coding method, see online Appendix II B).

The duration of the data coding is separated by three main events, starting from 25 November 2005 to 9 January 2006; from 10 January to 14 May 2006; and from 15 to 31 May 2006. The online debate initially exploded after Hwang made a profuse apology at a press conference on 24 November 2005. Hwang admitted his unethical collection of ova from purchase and from junior researchers in his laboratory. November 25 is one day after; 10 January 2006 is the date the verdict was made by the Auditing Committee of Seoul National University on Hwang's fabrication. 31 May 2006 is two weeks after the Prosecutor's Office announced Hwang guilty of fraud and embezzlement of research funds.

Manual coding and derivation of key themes

As I have presented in previous chapters, network such as a cognitive map (Carley and Palmquist, 1992; Park and Leydesdorff, 2004; Hellsten, Dawson and Leydesdorff, 2010) is not usually based on manual extraction of concepts but automated co-word mapping. Automatic coding and representation, as seen in the previous Chapter 4, enables one to identify and measure implicit as well as explicit concepts in the communication through their position emerging from their pattern of referential linkages to other concepts in more stable manner. The coding choice I made in this chapter, is to merge the two approaches of manual coding of co-occurring words and the automatic analysis of centralities and patterns of linkages. The main reason is that this work predates other developed semantic network analyses I presented in my thesis. In this initial work, my main motive was to represent sequential linkage (see Chapter 4) other than simple co-occurrence models used in existing academy. As explained in *Visualizing and measuring discourses with semantic network* section (pp. 17-18), it is important to preserve the traditional manual technique focused on identifying a key associative thematic relation between two concepts of keywords in each posting, summarized as an 'a refers to b (a→b)' connection, that are relational rather than frequency based analysis. As to the automated categorization of themes, the method of blockmodeling (de Nooy, Mrvar and Batagelj, 2005) in some ways elaborates the co-occurrence approach based on the same principle of hierarchical clustering, but with incorporated patterns of directionality that are more explicitly considered (see Appendix II).

As the textual data were in Korean language, a few moderations were made in manual coding. I initially identified all the 'substantives' in the text. This inevitably filters out adjectives, adverbs and verbs that do not contain substantives in their form. The aim is to focus on 'what' topic people talk about, instead of 'how' they describe it with more subtle expressions that are hard to standardize in coding. This feature, however, can vary across different languages. For example, 'exercise' in English can be either a verb or a noun, but the verb 'exercise' in Korean is composed of the substantive 'sports (운동)' and the descriptive verb 'do (하다)'. In this case, the substantive part 'sports (운동)' is incorporated into the coding whereas the verb 'do (하다)' is omitted from the word 'sports-do (운동-하다)'. Then I linked the substantives from left to right

direction, adapting to the so called natural language flow, by applying a storyline coding method. The stop unit is each paragraph of people's postings. When the adjacent word or concept is not directly related to the prior word in meaning, unlike automatic coding, I skipped the word and link to the next with the same principle, taking more consideration on their semantic relatedness.

Collecting 'smart' samples out of big data

Applying the search keyword 'Hwang Woo Suk' ('황우석') in an IT/science discussion room, out of 12,278 postings in public discussion website *Daum Agora* (http://agora.media.daum.net), I collected 200 postings and divided the data according to the three different phases: 100 for the most controversial first period and 50 each for the subsequent two periods. The reason and criteria for selecting relatively small sample out of numerous documents (postings) needs to be explained: First of all, despite a number of postings, there were significantly fewer documents that contained well-addressed arguments to support professor Hwang; and most contained burst of emotions and abusive words. Secondly, I wanted to focus on some qualified arguments that might shed light on underlying concerns of people rather than to highlight formal statistical results out of the total data. In other words, I regarded the collected data not as a representative sample, but a 'data corpus' (Bauer and Gaskell, 2007) akin to a transcription of a sizable focus group interview (FGI) of discussants that has occurred online. Therefore, the data do not mechanically 're-present' the population of discussants and the frequency of their opinions; but alternatively aim to open up an opportunity to engage in a systematized analysis on the core feature of discussion. And this choice represents my methodological opinion how the method of network analysis should be aligned with existing qualitative methods and the selection of data.

Network representation

The communication between science and lay people is not a simple flow of information from top to bottom. It embodies a complex structure of co-dependency and interaction between different value systems. In the public sphere of science, overlapping representations constructed by various social groups mediate actors' own desires. The

representations reflect their social life, and influence the feedback process between science and social practice. Although discourses as effects of communication are operations that cannot be observed directly (Luhmann, 1995), one can make inferences about them by testing hypotheses against the observable interactions among the agents. Communications and agents are structurally coupled in the network form of communication, which can be used as indicators of the evolving communication processes (Leydesdorff, 2006). Likewise, popular opinions about the Hwang scandal undergo a process of selection and expansion over time, which forms a network of meaning, a system interconnected with other representations. Looking at the frequency of postings, 68.7% are concentrated from November 25 to December 2005 (3,544) and January 2006 (4,890), the periods when the public inquiry into Hwang's misconduct and the investigative announcement by the expert committee at Seoul National University (SNU) were made, respectively. After the SNU team's investigation, the number plummets; and continues to decrease after the Prosecutor's Office accused Hwang in May 2006. This flow generally captures the change of public climate. The lay public's demonstration of support declined rapidly after the SNU announced fabrications in Hwang's experiments. However, the figure may deliver a misleading image that people's general 'feeling' of support also proportionately declined. As observed in recent polling (see Note 1), it is the form rather than the content of support that changed, which can be understood as a transformation from an explicit support to an implicit sympathy.

The semantic network analysis tries to capture the content and meaning of unchanged support through their narrative structures. Figure 5.1 shows the illustrated outcomes of semantic networks in the three phases. The computerized network analysis tool Pajek visualizes the positions of keywords as nodes in the network, and the frequency of their relations as link width. This also locates the most central keywords in the center of the map, and peripheral nodes in the periphery. The mutual distance among the nodes of keywords roughly reflects a proximity in their referential linkage. Finally, the nodes with the same color are grouped together as denoting the same theme by blockmodeling.

Period 1: Surging controversy (25 November 2005–9 January 2006)

In Figure 3.1, the node ‘national interest’ is positioned in the center as it is linked with more neighboring concepts than others, which is strongly linked to the expectation of ‘royalty’ [of patent] that is anticipated to come out of Hwang’s experimental achievements in the future. The concept of ‘moral relativity’ is also frequently mentioned to exonerate Hwang’s misdemeanor; that scientific fraud is a blurry concept and unethical collection of ova could be pardoned when the ‘national interest’ to build a scientific capacity becomes an impending national agenda.

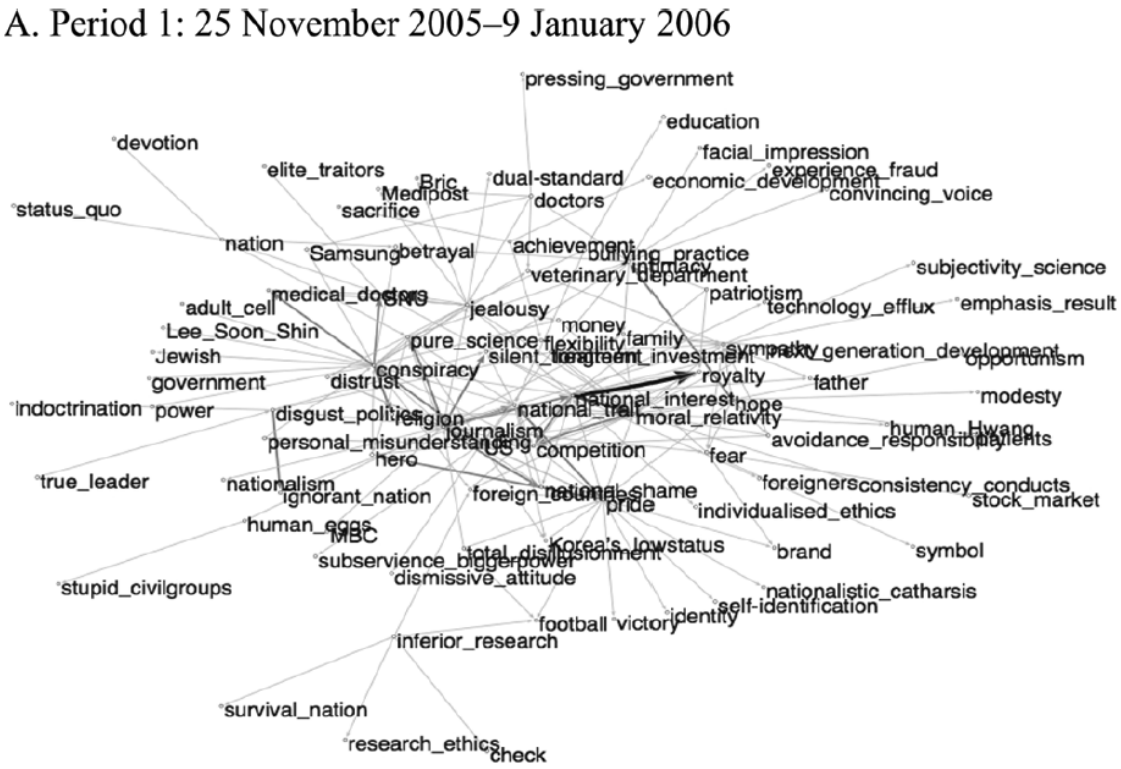


Fig. 3.1. Semantic network

To study the structural pattern of the discourse, we need to reduce the complex network into a visible relation of subthemes. The blockmodeling method categorizes structurally equivalent – having the same pattern of references with the same nodes. In other words, structurally equivalent words have identical referential (linkage) pattern and therefore they are ‘interchangeable’ in functional meaning to construct a common theme. In this manner, six thematic subgroups emerge: while people’s minds are divided by a strong feeling of 1) <pride> and 2) <conspiracy> on Hwang’s scientific

accomplishment and the scandal, 3) emphasis to protect 'national interest,' the people's 'hero' and 'pure science' from the plotting of the 'US' and 'journalism,' or an attempt to trivialize the scandal as a 'personal matter,' led to their constructing a common motivation for the support of Hwang. 4) 'National trait' is grouped together with 'jealousy' and 'competition'; actors such as Seoul National University ('SNU'), competing medical doctors ('MD background'), 'government' and 'foreigners' comprise <conspiring elements>. 5) Meanwhile, people also express their sense of <national identity> through the Hwang scandal. Finally, 6) people express their <emotional feelings> with keywords like 'distrust' and 'national shame'; they also express support for Hwang with feelings of a 'father' or 'intimacy' about him, while criticizing the 'bullying culture' aligned against him (Table 3.1).

Table 3.1. Classified keywords and representing theme

Period 1

Class	Representing theme	Keywords
1	Pride	pride
2	Conspiracy	conspiracy
3	Defending logic	national_interest, US, journalism, pure_science, hero, personal_matter
4	Conspiring elements	national trait, jealousy, competition, SNU, government, MD background, foreigners, etc.
5	Korean identity	identity, nationalism, moral relativity, world_cup, low_status_of_Korea, etc.
6	People's feelings	distrust, national_shame, patriotism, family, father, intimacy, bullying_culture, catharsis, etc.

On the other hand, graphically reducing the network into the core themes by merging the keywords into a thematically labelled node (Figure 3.2) provides an intuitive way to learn how these themes are interrelated to form a collective narrative and how they make the logic of reference. Supporters' pride in Hwang's stem cell achievement produces a strong relation with their self- identity and defending logic; and the defending logic refers to some conspiring elements as their explanatory objects. Likewise, the notion of conspiracy presents dense reference to various conspiring elements. In short, Korean people's pride in their scientific achievement needs a defending logic for the shameful charge against Hwang. And the defending logic induces a drive to find conspiring objects in order to support a conspiracy theory.

Period 2: After the investigation (10 January 2006–14 May 2006)

The report of Seoul National University's investigation on 10 January 2006 cast more suspicion rather than bringing an end to the scientific controversy. The represented network (Figure 3.2) demonstrates people's shift of focus toward general feelings about Hwang's identity and suspected plots against him. As a whole, feelings about Hwang and evaluation of the SNU's investigation occupy the semantic network.

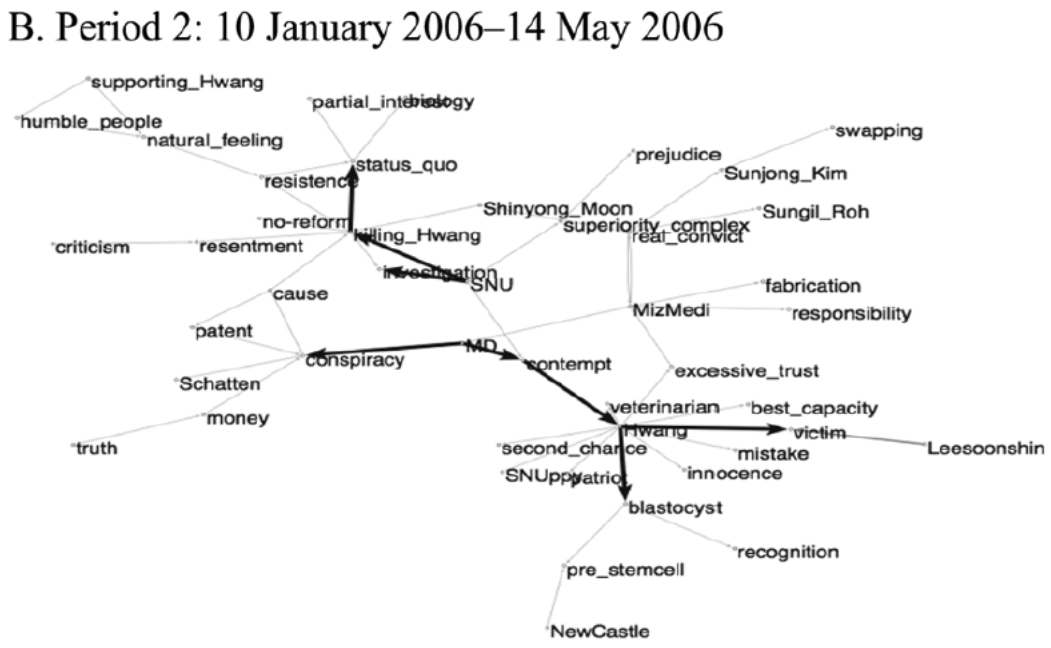


Fig. 3.2. Semantic network

Hwang's ability to produce a 'blastocyst' with his unique somatic cell nuclear transfer (SCNT) technique is consistently emphasized. Meanwhile, Hwang himself is portrayed as a victim of hostile rivals such as more privileged medical doctors ('MDs') who are known to 'despise' Hwang who is from a less prestigious academic (veterinarian) background.

Table 3.2. Classified keywords and representing theme

Period 2

Class	Representing theme	Keywords
1	Hwang	Hwang
2	Hwang's identity	veterinarian, mistake, no_responsibility, blastocyst, patriot, SNUppy, second_chance, victim, best_capacity, excessive_ trust
3	Conspiracy	conspiracy
4	Conspiring elements	essence, money, patent, MD
5	People's feelings	prejudice, superiority_complex, contempt, SNU, investigation, killing_Hwang, responsibility, real_convict, Mizmedi, Sunjong_ Kim
6	Schatten	Schatten

With the manual reading of original postings that contain those searched words, it generally appears that people frequently argue that emotional elements such as 'contempt' and 'prejudice' coupled with the 'superiority complex' of 'MDs' have subdued Hwang who is from a humble social background. Participants in the *Daum Agora* discussion iteratively state that this 'scapegoating' is related to a conspiracy, which is essentially motivated by 'money' or a 'patent' issue. In this typical discourse, contrasting Hwang's humble identity against a conspiring status quo with pejorative motives produces a typical narrative of a fallen hero – of humble origins.

On the fraud issue itself, posted statements do not consider Hwang as mainly responsible for the misconduct. People are aware of the fact that Hwang's own contribution to the experiment was limited to the somatic cell nuclear transfer stage, while the rest of the process – culturing inner cell mass extracted from the blastocyst and deriving stem cells – was undertaken completely by external collaborative teams including Mizmedi hospital, medical researcher Sunjong Kim, and other domestic and foreign collaborators. Therefore people come to inquire, 'Where are others' responsibilities, as they also shared fame and interests?' As demonstrated in the network, people's resistance against the experts' decision springs from this often cited 'common sense' doubt. This doubt not only justifies people's feelings about the Hwang scandal but also compels them to identify a 'real convict' such as Sunjong Kim and the American collaborator Gerald Schatten (Figure 3.4b) who had been a co-author of Hwang but announced severance of ties immediately after the public suspicion.

Period 3:After the prosecution (15 May 2006–31 May 2006)

Canvassing through the postings before the prosecutor's official judgment, many expressed that the prosecutor's investigation could answer the unresolved question of the responsibility of the other researchers. The prosecutor's announcement confirmed that Sunjong Kim brought already established stem cells from Mizmedi hospital and reported to Hwang that he had derived the stem cells. Hwang then asked Kim, initially believing Kim's report, to exaggerate the number of derived stem cells to highlight the efficiency.

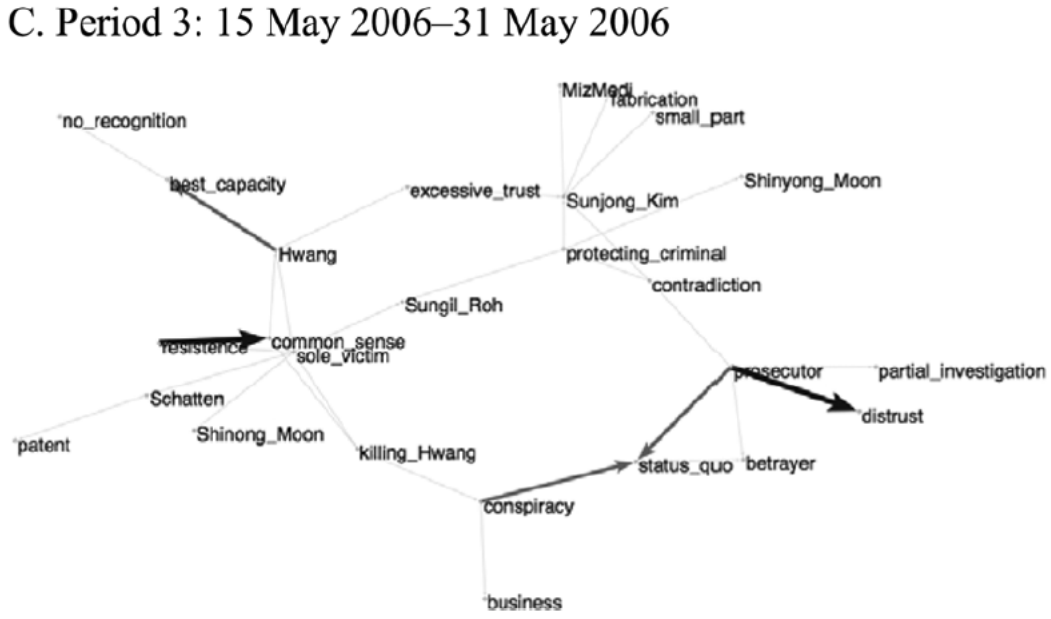


Fig. 3.3. Semantic network

The internet participants' general reactions to the report are critical. The aggregated postings claim that the prosecutor's conclusion as a 'partial investigation' or even a 'contradiction' that is 'protecting the [real] criminal' and concealing a 'conspiracy' while not recognizing Hwang's innocence (Figure 3.3). Supporters question why Sunjong Kim was not convicted for the grave crime, fabrication, while Hwang was charged with the relatively minor transgression of committing embezzlement of research funds. From a legal perspective, it made sense that Kim was only charged for the minor 'obstruction of work' and not for the 'fraud' in legal terms. But people found it hard to accept that this enormous scandal had been reduced to a transgression of a junior researcher, while Hwang had been charged with trivial affairs.

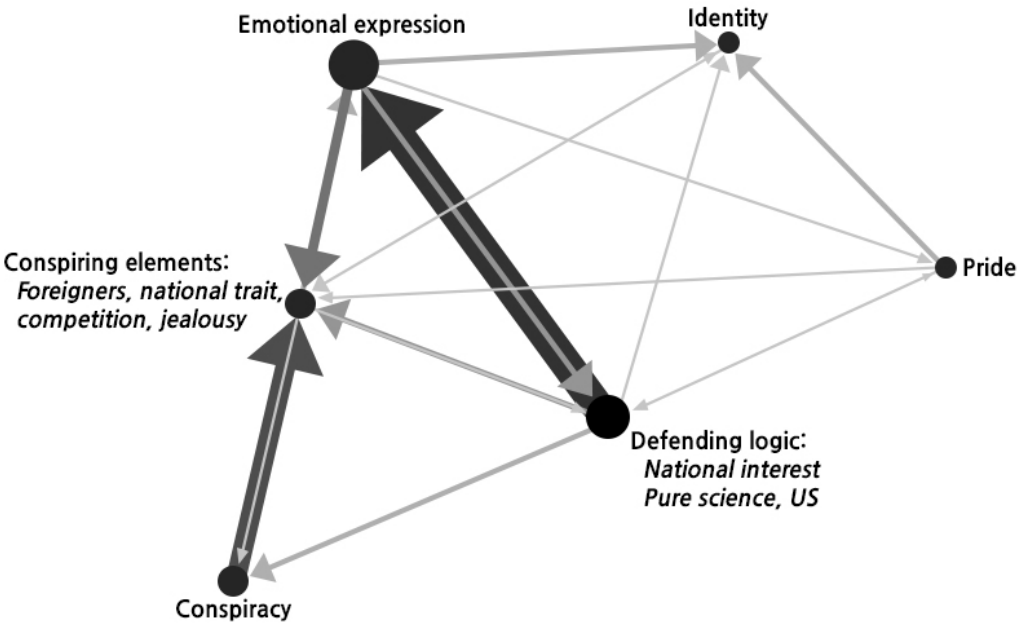
Table 3.3. Classified keywords and representing theme

Period 3

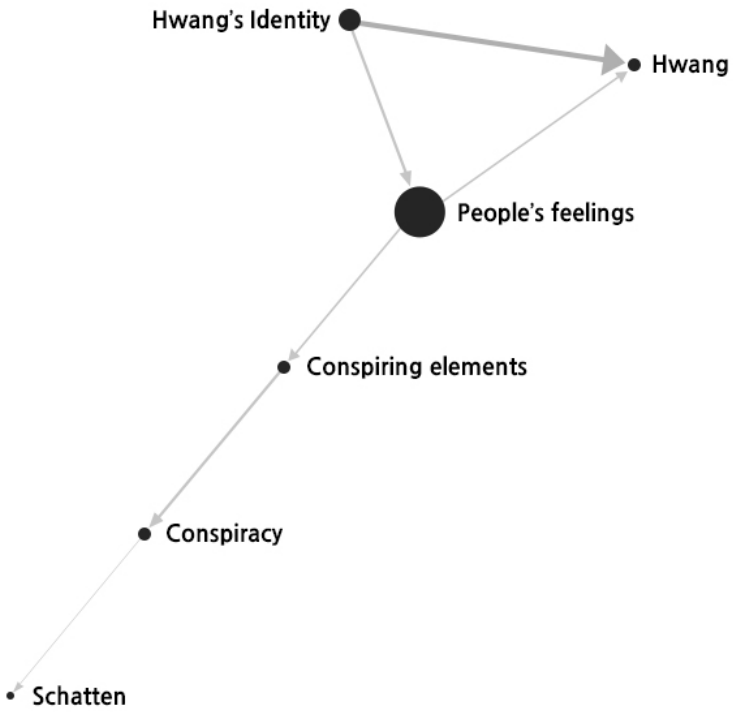
Class	Representing theme	Keywords
1	Public perception	common sense, Hwang, killing_Hwang
2	People's feelings	contradiction, protecting_criminal, distrust, partial_ investigation, status_quo, prosecutor, conspiracy, no_ recognition, etc.
3	Sole victim	sole_victim
4	Objects of resistance	resistance, Moon, Roh (Mizmedi), Schatten

As the evolving map (Fig. 3.4) representing the relations of merged themes by CONCOR in each period signifies, Hwang continues to be the sole victim of the complex and ambiguous crime for the public. Consequently, this dissatisfaction compels people to seek objects of resistance that include Hwang's other collaborators who evaded collective responsibility for the misconduct. In other words, the objects of accusation, Moon, Roh and Schatten, become mediated objects of resentment and distrust, which is finally channeled to the status quo represented by prosecutors, major media and other scientists.

A. Period 1: 25 November 2005 – 9 January 2006



B. Period 2: 10 January – 14 May 2006



C. Period 1: 15 May – 31 May 2006

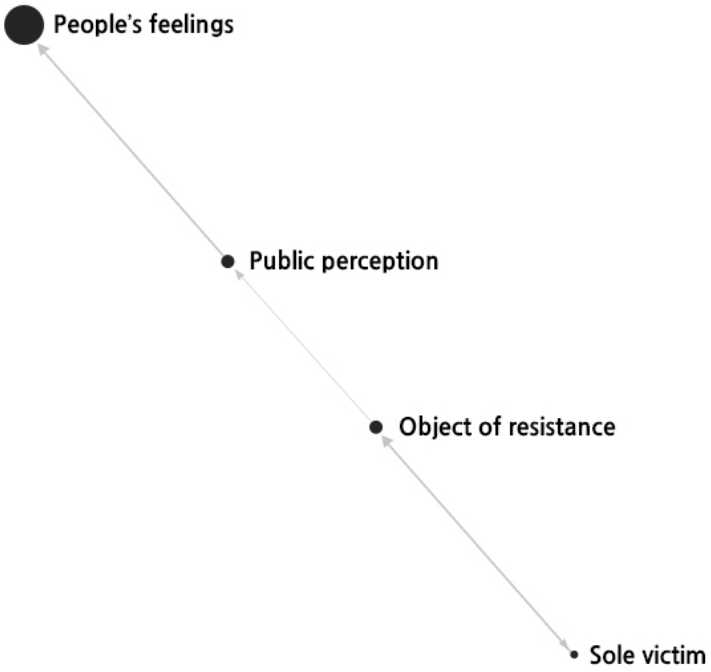


Fig. 3.4. Reduced discursive structure
*Pajek's graphical result redrawn by illustration

Analysis of discourse

Denotation and connotation

The trajectory of Hwang supporters' dialogues shows a narrowing of theme: from national pride and conspiracy theory to a personal sympathy for Hwang, suspicion of his collaborators, and distrust of authority. In contrast to the conventional view that depicts the supporters as irrational, the studied discourse demonstrates a certain rationality of 'collective intelligence.' The participants quickly find logical loopholes in official explanations and request more information. Similarly to Jong-Young Kim (Kim, 2009)'s argument after his ethnographic study on the Hwang supporters, it is inferred that people's resentment comes from an institutional vulnerability: that the institution in question is incapable of handling 'information and legitimation deficits' (Bauer, 2002). Through collective sharing of knowledge and information in the web space, Hwang's supporters gathered a number of, if not always accurate, pieces of scientific information related to the debate. In contrast, the Investigative Committee's accounts did not fully respond to the people's demands, eager to know the truth on every point of the issues. Because Hwang was charged with the fraud of the stem cell experiment that he himself did not conduct at first hand, public suspicion was directed to the role and the responsibility of Schatten and other colleagues. The sudden denouncement of Hwang alone provoked a predictable public resistance. And the expertise of the SNU and of the prosecutor was seriously questioned or denied.

Both in off-line interviews of supporters (Kim, 2009) and the web postings, the discourses of personalized drama represented as Hwang's rise and fall, people's highly emotional attachment to the narrative and anger against rather vague 'status quo' or 'authority' are commonly witnessed; And it becomes important what this kind of discursive characteristics might explain beyond 'blind nationalism' thesis. Besides studying the thematic categories of keywords and their linkages, the analysis of the position of individual keywords unveils their functional and discursive importance. Betweenness (denotation) and In-closeness (connotation) centrality each identify critical signifiers that have central positions in the semantic interactions. While the former represents a denotative character by mediating both triggers of information and referents, the latter represents a connotative concern that positions itself in the center of referents.

As Table 3.4 summarizes, most denotative arguments in the first period mobilize 'national interest' as a rationale and blame 'journalism' and 'conspiracy' that worked against Hwang. On the other hand, the most prominent concept that is located in the connotative frame is 'national trait' (gookminsung). From people's written explanations, this trait is interpreted as a shared national sentiment, describing reluctance to recognize another individual's success and a collective attempt to destroy his reputation out of jealousy. The theme of severe 'competition' is also closely linked to this expressed frustration. These concepts may reflect people's core anxiety felt in their daily lives, the downside of the national trait, as well as a rationale to compete with foreign countries by any means and devoid of just principles in scientific practice. Meanwhile, Hwang is often referred to as a 'father' of a 'family-nation' who should not be disgraced in such an open manner, revealing a family-oriented Korean culture pervasive in public affairs, amounting to a 'silent treatment' of the Hwang scandal.

Table 3.4. Denotation and connotation of public responses

Period	Denotation (Betweenness)	Connotation (In-closeness)
1	Journalism	National trait
	National interest	Competition
	Conspiracy	Silent treatment
2	Hwang	Conspiracy
	Medical doctors	Medical doctors
	Contempt	Schatten
3	Common sense	Shin-yong Moon
	Hwang	Sung-il Roh
	Sunjong Kim	Sole victim

The core concern in the second period is a personal struggle between medical doctors and Hwang. The word 'medical doctors' is one of the most important keywords in both denotative and connotative framing that is represented as a subject of 'contempt' and 'conspiracy' against Hwang. In the last period, supporters finally take recourse to a 'common sense' while defying the verdict of the prosecutor. As the institutional decisions of fraud stand against the people's common sense or belief system, Hwang would finally remain the unfortunate victim of the 'mysterious' tragedy.

Understanding the resistance

Particular institutional conditions and performances that failed to gain the public's trust led the public to coin unofficial interpretations that spurred resistance. No wonder, since the most representative institutional authorities, depicted as the *status quo* by the public, i.e. the government, the scientific community and the press, lost credibility because of their inconsistent, opaque and dishonest responses to the Hwang affair (Kim, 2009). However, the institutional failure does not fully explain the unprecedented degree of public hype, personal aspiration and subsequent frustration that escalated to a social movement that reflects a Durkheimian admixture of 'selfish-altruistic suicide.'

The results of the analysis of the semantic networks imply that public responses were neither purely cognitive nor positioned on the debate about the validity of the experiment. They were rather tied to people's emotional motives, reflecting their own daily experiences. The public image of a fallen hero, Hwang, subdued by a conspiracy of the status quo, is consistently related to the people's implicit concern for the matters of recognition and disrespect. For instance, the director of the Investigative Committee, Myunghee Chung, inflamed the public when she bluntly denounced Hwang's capacity to produce a stem cell line in the public announcement. Although it was clear that Hwang did not produce any stem cell line, Koreans nonetheless highly regarded his team's skill in animal cloning and also felt that having developed quite a number of human blastocysts was already a great achievement. A number of people even called this blastocyst stage 'pre-stem cell.' Therefore, the committee's total denial of Hwang's potential was received as an obscure motivation of other jealous scientists to 'kill Hwang.'

Moreover, the centrality analysis of concepts suggests that there is ambivalence in the notion of a 'nationhood.' In contrast to claims that the 'Hwang fandom' was simply motivated by a culture of nationalism, the represented frame of the network discloses that both 'national interest' as a rationale of the movement and disgust at the 'national trait' coexist in the supportive discourse. More crucially, the absence of salient concepts related to serious debates on ethical transgression or the possibility of fabrication suggests that neither the ethical issue of collecting ova nor the authenticity of Hwang's research itself really mattered to the public at all. In brief, the source of public anger over the scientific event existed elsewhere.

The characteristic of public hype on embryonic stem cell research preceding the Hwang scandal offers a clue to my different interpretation. Before the scandal, the South Korean government zealously propagated the prospect of Hwang's success to justify the elaborate level of state support of the life sciences. Resorting to deeply rooted nationalism was a means of delivering this justification symbolically, and emotionally. And Hwang's success fit well into this symbolic demand for dramatization (Kim, 2008: 402–403). In general, people accepted this symbolic mobilization of national projection, but the cause of their personal enthusiasm and the sentiment of attachment came from elsewhere. As mentioned, people favored the Hwang story because his skyrocketing success from an institutionally humble status inspired aspiration. Living in a rapidly industrialized nation where achievement motivation used to be emphasized as a *raison d'être* to survive severe competition, people identified Hwang's success story with the projection of their own success, while conforming to the official discourse of national glory won by scientific success. When Hwang's sudden failure and the subsequent institutional charges against him were reported, people were ready to react with accusations against frustrating institutional environments where 'pure effort' is thought to be hampered or betrayed. Out of this sentiment, a number of South Korean people firmly believed that resisting the official verdicts of fraud was a civil commitment, in order to restore a sense of justice. An interview on condition of anonymity with a professor of pharmacology in South Korea implies that this public sentiment is not confined to a scientifically illiterate group of activists or 'non-experts':

> It is obvious that jealousy was involved in the killing of Hwang, as it happens all the time. Those medical doctors and other academics who barely make any efforts on their own scapegoated a person like Hwang who had made such sincere efforts to position himself on the international level. Hwang was destined to fall after acquiring such huge fame, and this really is a problem of our national trait. (Interview with a pharmacologist, 5 March 2010)

Therefore, it is logical to conclude that the Hwang supporters' denoted nationalism was only one side of what was expressed. The other side was the connotation of frustration, born of watching Hwang's success slide into failure. Having projected their own aspirations to succeed onto Hwang, his supporters identified with

his failure, thus energizing their defense of the 'fallen hero.' To a certain extent, this kind of Janus-faced representation may reflect the historical background of Korea. This background is one where knowledge, and science, have been typically defined narrowly as a means to gain status and recognition in a highly stratified society (Kim, 2008: 399–401) rather than a pure pursuit of truth. Whereas the fact that popular resistance could occur only when coupled with the rhetoric of 'national interest' reflects Korea's history of modern state-building and industrialization with a recursive, and coercive, emphasis on nationalism for mobilization by military regimes, while suppressing individuals' desires to 'stand-out' in public affairs.

Summary: implications for the mode of public participation

My analyses and conclusion differ from existing literatures in two key points. First, the nationalism frame suspected as the cause of public activism embodies a duality, as it also contains a feeling of disgust against a negative side of the national trait. Second, this feeling of disgust as a source of anger is related to people's frustration over barriers to personal success, imagined to be confirmed by Hwang's disgrace. From this perspective, the public protest in support of Hwang functioned as an opportunistic event for people to express their latent desire and frustration, with little consideration of the scientific issues or the misconduct itself. In a cultural context where scientific progress was thoroughly framed and dramatized as an individual's success, spurred by institutional propagations, there was little room for rational assessment or ethical deliberation on the topic of governance of human embryonic stem cell technology. Institutional incapacity to respond to people's suspicions after the scandal also provoked a conspiracy theory and activism.

The 'active participation' of the public in the Hwang scandal leaves room to reflect on desirable modes of public engagement in science communication. Neither the deficit model (Wynne, 1992) nor romanticization of public participation seems to be a viable solution, as both reify the actors as value-laden social entities without questioning their social capacity to reflect on the science. Reflecting the South Korean experience, how to engage expert knowledge and its underlying logic of debate into everyday dialogues, and construct a 'socially deliberative subject' of communication in

the public sphere, seems to be vital for safeguarding against ‘miscommunication’ that sprung out from a DAD (Decide, Announce, Defend) science policy.

Deliberations on ways of representing scientific issues based on better understanding of the lay public’s general *sentiment* on technology and knowledge in daily life, turn out to be no less important. In this light, my semantic network analysis has proposed a pathway, albeit exploratory and tentative, to study and understand the public’s sentiment and their *Lebensform* (form of life) in relation to science and knowledge. Further methodological rigor should continue to explore veiled characteristics in dialogical data that are waiting to be heard from every ‘gap’ of the public sphere.

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Conclusion: Methodological review and on-going tasks

> Before venturing forth, did astronomy, for example, wait until the universe had been scrutinized to its farthest extent by the most perfected telescope? Fortunately not.
> - Gabriel Tarde, 'Sociologie' in *Etudes de psychologie sociale*

The thesis has discussed the separate denotation and connotation of South Korean newspapers and lay public's discourses by comparing their morphological differences and characteristics of semantic network. Firstly, a notable polarization is found between conservative and progressive elite media. If the former presents the central organizing idea (Gamson and Modigliani, 1987) of South Korea's science-related conservatism as an industrial drive to utilize biotechnology, while paying relatively little attention to ethical governance, the latter reflects an ecological consideration tied to the emphasis of ethical conducts. It appears to be obvious through the ordinary people's discursive responses in the Hwang debacle that the apparent way of framing by the lay people is familiar with the conservatism reproduced by *Chosun Ilbo*, so to speak, 'Money counts, forget ethics'. But, the in-depth analysis also opens up an interpretive possibility that such expression might be only a facet of much more complex narrative. In essence, some of the public response can be interpreted not so much as evidence of conformity to the industrial conservatism propagated by elite media, but as a connotative expression of rebellion — in Hwang's case the collective frustration experienced by the cultural suppression of individual desire and 'unjust' way of living (Kim, 2008: 410).

From this critical perspective, the analyzed results by semantic network analyses elucidate how the integration of semiology, frame and social representation theory assisted by computerized text mining can open up the new horizon of social research. The first article, 'Media Framing of Stem Cell Research: An Analysis of Political Representation of Science in South Korea', revealed that the conservatism related to scientific discourse is overshadowed by industrial development frame, unlike a religious precautionary approach in the US, that aggressively pursues biotechnology as a state economic engine. The newly found characteristic of Korean progressive media is the lack of concise 'counter-frame', which can be outspoken and propagated in a simple word, in opposition to the prevalent economic discourse of science. This absence was depicted by the textual sign of connotation(s) of semantic network that could not

integrate the scattered discourses of ethical value. We can only conjecture, if this emptiness in the newspapers might explain people's different contextualization of the scientific event in South Korea. The formal framing of an alternative projection to industrialism did not emerge effectively, and people constructed something very individual and entirely different. Contrary to the banal blames laid upon the conservative media that blindly supported professor Hwang and the state-driven biotechnology policy, I argue that there may have been the cause of people's misguided support to the technology and scientist in the absence of cohesive objectification (counter value) that a counter-hegemonic media should have provided.

Some interesting aspect of the Hwang supporters' contextualization was discussed in the second paper, 'Denotation and connotation in public representation: semantic network analysis of Hwang supporters' internet dialogues'. The result implies that the social researcher needs an alternative perspective to understand the social identity besides the current demographic or class-based groupings. As the individual and collective identity have become ever more fluid and dynamic nowadays, spurred by the global communications through the internet media and social network services such as Twitter and Facebook, the researcher should be able to contextualize both microscopic linking (selection) processes of signifiers and their emergent, macro, social effects. Therefore, the active movement of Hwang supporters does not only reflect the case of South Korea. Rather, it implies a need to engage public understanding of science and scientific governance differently in the era of network society (Castells, 1996) where sub-individual signifiers that are anchored to various people's forms of life can amplify the social effect of objectification.

I summarized that the core object of South Korean public was the *resentment* against the imagined alliance between experts and status quo. Similarly, there are reported mistrust against government and experts in European countries when GMO, BSE and stem cell research became salient issues. The researches, however, are either focused on top-down surveying of opinions across European nations with quantitative measures (Gaskell and Bauer ed., 2001a; Gaskell and Bauer ed., 2001b) or a meta-description of collective, national, political culture (Jasanoff, 2005). Both approaches have their own merits, but I demonstrated that alternative form of analysis, semantic network, could be feasible and effective to capture more microscopic and dynamic characteristics of 'imagined science'.

In this context, I think more could be said about the paradigm change in science communication. Under the circumstances in which scientific research is increasingly under commercially motivated patronage and actors engaged in the knowledge production appear to care less about the value of truth (Bauer, 2008; Kim, 2011), cultivating critical and deliberative public becomes an impending issue. The solution, however, should not idly defy the ideological assumption of 'deficit model' and in some ways normatively romanticize the public. As observed in South Korea, such public does not exist naturally. In order to make individuals' subdued voices heard, and represent them to invigorate the diversity of qualified public debate, we need good methodology for social representation. The methodology should not only identify emergent social groups, but also trace the linkages of sub-individual signifiers and their common object(s).

As personal experience is getting less bound to social constraints and more connected to alternative spheres of communication, we should be able to 'gaze' the intrinsic processes that have become ever more visible. The operationalized methodology of 'network' and its semiotic representation has proposed one of the pathways. Obviously, my methodological approach has a few limitations. From theoretical perspective, it may still not be clear how it brought the different and sometimes hazy theories together and then translated into the methodology of semantic network. There could be possible strains and contradictions between the disciplines. Still, from an eclectic and pragmatic perspective, what has been tried is to incorporate the vision of semiotic theory and its recognition of social psychological perspectives into the praxis of social representation research, which is to be delivered by a novel form of methodological representation that departs from a certain ideological and historical inertia. As mentioned in the introduction, our society is now too complex to analyze through the taxonomy of preconceived social groups (Moscovici, 2008) alone, not simply because they are no longer salient reference groups in the society but because we are experiencing unprecedented empowerment of individual and sub-individual signifiers through personalized internet media. The alternative perspective and the translation of social representation theory might more effectively elucidate how minority individuals could bring influence over society and make new idea move forward.

Having been trained in sociology for quite a long time and later incorporating social psychological concepts, my implicit objective has been to reconcile Durkheim

(sociology) and Tarde (social psychology). The task is open to studies that will be able to objectify the debated validity of intrinsic interaction of symbols and actors to form aemergent social characteristics, rather than to rely on the crude categorization of extrinsic 'social coercion' (Vargas *et al.,* 2008). Although Latour (Latour, 2010) did not make any explicit linkage to recent social psychological works when he tried to revive Tarde in the domain of sociology, I hope that the pragmatic operationalization of social representation theory will vindicate the value of actor network theory that is not merely a philosophical critique of social science (Latour, 2005) but a more concrete practice of social research based on quantification methods. Objectifying symbols as measurable words in the interlinked knowledge sphere is very important in this regard.

On the specific level of method, it has become more obvious by now what should be improved. In my own evaluation, the original method utilized in the second article is problematic in three key aspects, that is, representability, robustness and clarity. First, the problem of representativeness is much less a matter of sample size than the selection of meaningful words in texts with differing qualities. The selection of texts were based on the clarity of arguments that supported Hwang because it was less certain for some other blurry texts that did not seem to make logical arguments to render the encoded substantives meaningful. Even if I disagree to the recent rhetoric of 'big data' that spreads a misguided notion, 'bigger is always better'[16], decision makers will naturally prefer to collect total data and process all of them in order to deliver the image of objectivity and accountability. In the end, the core question is how to 'filter out' unnecessary information under a certain principle, with automatic processing, and make it 'smarter' to bring into insightful interpretation. In this regard, my later discoveries and systemic improvements for automatic algorithm are reflected in the first article. Nevertheless, my arguments based on the data processing techniques serve to the purpose of abduction, which only invokes further discussions by adding different perspectives and empirical researches.

Second, the question of robustness entails not only the object of replicability but also the value of interpretation. Until recently, the two elements are in a strained relation if not mutually exclusive. It is known among experts that the core measure of

[16] Tom Davenport's comments in Harvard Business Review are helpful in this regard (http://blogs.hbr.org/cs/2012/03/even_small_data_can_improve_yo.html). Also refer to my comments about big data processing (http://thenextweb.com/asia/2012/05/17/koreas-treum-helps-companies-cut-through-the-noise-and-find-value-from-social-media-data/).

betweenness centrality offers relatively a stable result whereas closeness centrality (both input and output) can highly vary depending on the criteria of coding and extraction. While the minimal objective of replication can be delivered by an automatic grammatical tagger in natural language processing algorithm, namely by deleting all words but substantives, more should be done to extract both pragmatic and novel insights. Above all, some machine learning algorithm, or contextual awareness, to calculate the probability of sequential relationship (like Markov chain or Bayesian network) between plural words, e.g. 'war' after 'peace' or 'peace' after 'war', should be proposed to produce links instead of utilizing co-occurrence matrix or simple story-line coding that mechanistically produce a lot of inaccurate and redundant links. The standardization of text-mining based on semantic network analysis will become more reliable and powerful if it fulfills aforementioned requirements, which should be achieved by successful imitation of good human coder who realizes full context of text and decides the causal linkage of significant words.

Third, the call for clarity is about the issue of improved understanding as well as the exposure of many practical details. As I experienced, the full details more often than not only confuse the audience who are not equipped with the background knowledge of the methodology, which is a complex integration of semiological, social-psychological, graph-theoretical, statistical and computer scientific assumptions. This difficulty in essence was related to the problem of trust and the failure of anchoring the new methodology to the existing academic frames. In this sense, the social representation of academic community has been something worth reflecting on. This problem should be addressed after a series of proof of representability and robustness in its unique form followed by iterative applications in various social research cases.

Reflecting my personal experiences utilizing and improving the methodology and computerized system in various fields including the live broadcasting of opinion polling, frame analysis of presidential debates, political consulting, real-time monitoring of social media and blogs, analysis for public relations, textual analysis of FGI transcripts for consumer research and new product design, etc. as well as academic researches, the converging point that makes the audience finally accept the novel methodology has been the utility. As Nietzsche astutely pointed out, the proved utility eventually makes it a norm. While the quality of Actor-Network in real world determines the temporality of acceptability, the utility will spread over time.

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