Social media network size and semantic networks for collaboration in design

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Abstract: Social media are fundamentally based on communication networks containing friends, acquaintances, or others. Because communication is essential to collaboration on activities, we assume that those who have more contacts in work-oriented social media are more likely to be collaborative in their work behaviors. Design educators have been stressing of importance of collaboration in training recent cohorts of design students. Our goal was to empirically examine designers on the LinkedIn social media site in terms of how they describe collaboration and why. The results supported hypotheses that designers with larger networks of online contacts were more verbal, had higher collaborative word use, were more positive, were more evaluative, used more competence-oriented words, and had semantic networks for collaboration that were more complex, with greater discrimination, differentiation, and integration. Given the experiences of current young adults with social media, we further hypothesize that future design work will become increasingly collaborative.

Keywords: collaboration; semantic networks; social media; LinkedIn; design.

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1 Introduction

Collaboration has become expected for most kinds of funded academic research. Not surprisingly, at higher levels of funding, projects have more collaborators (Heffner, 1981). Collaboration in social media such as Facebook is evident in the content of photographs posted, with a high percentage showing group behaviors (Mendelson and Papacharissi, 2010). As seen by academics and non-academics alike, social media are by their nature largely based on people establishing and maintaining social networks and communicating collaboratively (Kaplan and Haenlein, 2010; Qualman, 2010). Users project highly managed (boyd and Ellison, 2008) profiles of themselves (Hogan, 2010). They also post comments, respond to others on common threads, tag electronic media content, and organize online and offline activities (boyd and Ellison, 2008).

Prior research has not examined the social meanings of workplace collaboration communicated in business social media and how this may be associated with the number of professional contacts individuals have there. This is our focus in the current research. It contributes to theoretical understanding of why having more social contacts in a work-oriented social medium may be associated with differences in how individuals describe their collaborations. We are not directly investigating whether those with more contacts have collaborated more. We do, however, build a case for such an assumption as we review the literature and develop hypotheses about differences in communication about collaboration that may be associated with having more professional contacts in a business social media site.

To test hypotheses we extracted text from the business social media site, LinkedIn.com. To increase internal validity in our cross-sectional design, we controlled for the type of work our sample members performed. The study selected individuals' profiles that described them as designers. Reasons included the following. Design processes are well developed. They are pervasive for processes, activities, and artifacts. Additionally, design is an established academic discipline (Koskinen, Zimmerman, Binder, Redstrom and Wensveen, 2011).

Given our main interest is in how designers encode messages about 'collaboration,' the data we analyzed were from their professional self-descriptions, in other words, autoethnographies about their work histories. The use of these profiles precludes direct measurement of the number of collaborations designers have had. So, we cannot test the hypothesis that those with more contacts have collaborated more. Instead, based on prior research, we developed and tested hypotheses about how designers with more contacts describe their collaborations. For this reason, we selected designers who included in their profiles the word 'collaborate' or one of its lexical variants. What we found for designers may later be generalizable to other occupations, if our findings are replicated in future research with other kinds of workers.

The overview of the remainder of this paper is as follows. Next we review relevant literature and formulate hypotheses. After this, we describe the methods, results, discussion, and conclusion.

2 Literature Review

2.1 Attributes of Collaborators Expressed in Autoethnographies

2.1.1 Trust

Global virtual teaming requires refined grains of collaboration. We therefore expect some aspects extend to collaboration more generally. One attribute of successful global teams that experts point to (Gluesing, 1998) is the need for high trust in others (Gibson and Manuel, 2003; Brown, Poole and Rodgers, 2004). Trust reduces social anxiety (Lee and Robbins, 1998). Social anxiety increases when people are unable to conduct much of their communication in a face-to-face mode, and are limited to media with reduced richness (Rice, 1992). One relevant effect of social anxiety is that it reduces communication (Leary, 1987). High social anxiety persons engage in more simple, self-justificatory patterns of thinking (Tetlock, Skitka and Boettger, 1989). On the other hand, lower social anxiety allows for more elaborated cognitions about communication and collaboration. Trust enhances this effect.

Trust has a virtuous circle. People generally more trusting of others view another person as more trustworthy when positive information about them is available (Yamagishi, 2001). Thus, when a person more positively describes previous collaboration, he is more likely perceived as trustworthy for future collaborations. As communication actually takes place, these positive behaviors promote further trust (Mellinger, 1956), and increase the probabilities of future collaborations. This is the reciprocal virtuous cycle of intensifying mutual trust.

Another aspect of trust is related to the social network structure in which participants are embedded. It has been found related to sentiment about others when problems arise (Burt, 1999). In the highly interlocking network, participants communicate exclusively within in a group whose members have strong emotional ties. When problems occur, they more likely blame individual network members. Trust is lower. In contrast, in a highly radial network (Laumann, 1973), participants mainly communicate with people who do not know each other. When problems arise, radial participants tend not to blame persons in the network. Instead they more likely attribute the difficulties to situational factors or to cultural differences among participants. Trust is higher.

Research also found that the word 'trust,' apparently associated with underlying distrust, was used more in online interlocking networks (Danowski, 1998). Larger social networks are less likely to be interlocking and more likely radial; network size and density (a measure of interlocking) are negatively correlated across a wide range of types of network actors (Faust, 2006). Individuals with larger social networks, therefore, are likely to be more trusting.

2.1.2 Empathy

Collaboration also requires a higher degree of empathy (Davis, 1983, 1996) than working alone. We conceptualize empathy as an attempt to reproduce the semantic associations that another person appears to have, and to respond based on this inferred semantic network. In this way, one can more likely see the world as the other sees it. We assume that the greater the number of participants, hence the greater their diversity, the greater the focal individual's

elaboration of empathic semantic networks. Orienting to more diverse others requires more diverse manifestations of empathy. Individuals with more radial networks use the word 'you' more relative to 'I,' compared to those with more interlocking networks (Danowski, 1986; Schaefer, 1988). This is a semantic measure of other-orientation and empathy (Danowski, 1986).

In contrast, those with less diverse networks are more likely to engage in assimilative projection, which is assuming that one's perceptions are the same as everyone else's. This is the opposite of empathy. Cameron (1947) states:

> The less practiced a person is in the social techniques of sharing the perspectives of others, the less opportunity he will have of finding out how different from himself other ordinary people can be. The less his opportunities for finding out and sharing in such individual differences, the more likely is he to extend assimilative projection farther than the actual conditions warrant. (p. 167).

2.1.3 Evaluative Communication

When individuals communicate online with more diverse others they produce more evaluative communication to help others navigate new information environments (Danowski, 1986; Schaefer, 1988). Evaluation statements use more adjectives and adverbs and other linguistic modifiers to express sentiment. If one is not concerned with presenting a positive image to others and is trusting of the receivers, one appears to communicate both more positive and more negative content, motivated by desires to accurately communicate so as to be most helpful.

2.1.4 Positivity

Nevertheless, the process of presenting oneself to other professionals, who may be potential future employers, carries a strong norm for positive sentiment. Not only does the presenter want to project positive images and demeanor, but to foster an impression of seeking additional positive social experiences. More positivity leads to being more trusted by trusting individuals (Yamagichi, 2002). In addition, there is a strong positivity value in corporate cultures: thinking positively, communicating positively, evaluating situations positively, and turning potentially negative situations into opportunities for success (Held, 2002). Accordingly, we expect designers with more professional contacts to use more positive words.

Positivity is associated with a wide range of desirable attributes of a flourishing social unit, ranging from individuals through groups in business organizations (Fredrickson and Losada, 2005). When positive communication occurs at a rate 2.9 times more frequently than negative communication, the system is at optimal flourishing. Values below a ratio of 2.9 are associated with languishing. Greater positivity is linked with more openness to new ideas, creativity, individual resilience in the face of obstacles and crises, strategic thinking, broader information processing strategies, variability in perspectives across organizational members, and organizational resilience in the face of threat (Sutcliffe and Vogus, 2003). Such characteristics would appear to be associated with more successful collaborations. These are additional

reasons why we expect designers with more contacts to use more positive words in their self-descriptions.

2.1.5 Experience

Another relevant finding about global teams is that they work best when participants have extensive relevant prior experience, resulting in higher expertise and competence (Henneman and Cohen, 1995). The same applies in choice of offline work group members (Hinds, Carley, Krackhardt and Woley, 2000). To have more individuals in one's social networks, to some extent one needs to have experienced similar activities to those of the others, including direct participation with them. LinkedIn asks users to specify where they have worked with an individual when a user attempts to add them as a contact. Thus, greater experience is associated with larger social networks in that social medium. More experienced individuals bring a more complex and refined semantic network about a domain they know. Collaboration does not work as well when some participants are inexperienced and require training. Rather, when all participants are coming to the collaboration with relevant expertise, communication is not mainly about training one another in some discipline. It is more likely about exchanging enough information to align semantic networks. This produces a common understanding so that participants can complete the collaborative work efficiently with optimal quality.

2.2 Semantic Network Complexity

Collaboration is most often a group communication process. Individuals who have collaborated more frequently in different groups develop a larger professional network. This is likely to be reflected on LinkedIn. Size of the contacts network is expected to be positively associated with collaboration and its representation in autoethnographic descriptions. As we have discussed, because larger networks are associated with more radiality, hence diversity of participants, the individual has likely developed a more diversified and elaborated communication repertoire. Accordingly, such designers are expected to have a richer semantic network about collaboration, one that is more complex.

   Semantic network complexity has three aspects: 1) semantic discrimination, 2) semantic differentiation,and 3) semantic integration. Discrimination is defined as having more unique cognitive elements in a domain (Bieri, 1955). In semantic terms, the individual has more unique words and word pairs in their linguistic network to describe some phenomena. Differentiation occurs as the individual categorizes or clusters these more diverse words pairs into subgroups (Schroder, Driver and Streufert, 1967). Words are clustered to increase the individual's flexibility in traversing the larger semantic network, as shown in the semantic connectionist literature (Collins and Luftus, 1975). Integration is the use of more higher-order connecting words, often more abstract, for the individual's linking of these subgroups. Two types of integrating nodes have been studied in the network literature (Tichy, Tushman and Fombrun, 1979). Bridge nodes are members of one group who connect with members of another group. Bridges are the most basic form of intergroup linkage. The other type of intergroup linker is the liaison node. Liaison nodes do not have a majority of with any one group. They link to many members of different groups, and to other liaisons (Jacobsen and Seashore, 1951; Weiss and Jacobson, 1955; Schwartz, 1977; Schwartz and Jacobson, 1977;

Richards and Rice, 1981). We posit that successful integration in semantic networks is more important for individuals with more complex and diverse networks. Their words have sufficient commonality in referents to those of a wider range of people. In short, this leads to more shared meaning.

2.3 Social Networks and Semantic Networks

Research has found that individuals with more radial social networks have a more elaborated linguistic code. They use this in adapting to more diverse others (Bernstein, 1964). A more elaborated linguistic code is an aspect of producing a more complex semantic network. Similarly, individuals with more radial networks are more extraverted. Pennebaker and King (1999) found in studying natural language text generation that more extraverted individuals used more positive words and more social processes words. Agreeableness was positively related to positive emotion. Given research we reviewed earlier, these attributes are expected to foster a more complex semantic network.

 There is a limit to the positive association of number of contacts and collaboration. Clifton (2011) finds that individuals with very high numbers of online contacts score higher on narcissism scales. This is particularly the case for individuals who have over 300 contacts in the Facebook social medium. Being in a more central network position is also associated with higher narcissism. Excessive positivity, which Losada (1999) specifies as at least 11.6 times more positive than negative, is another attribute of narcissistic individuals. Research has found that narcissistic individuals participate less in collaborative relationships (Cramer, 2011).

2.3 Hypotheses

So far, the literature has suggested that larger social networks are more diverse. To build these, individuals need to have trust. They are low in social anxiety, and have higher extraversion, empathy, positivity, and experience. Except for those who have more than 300 contacts on a social media network, individuals with more contacts are less narcissistic. Each attribute is posited to contribute to a more elaborated semantic network, built from more experience, diversified through contacts with more diverse others, and having more differentiation and integration as a result of exercising empathy.

 Because online resumes such as on LinkedIn are most often written in bullet form, they do not contain typical distributions of pronouns. We could not, therefore, test hypotheses about empathy, which using natural language requires computing ratios of pronouns 'you' to 'I,' or narcissism, which computes the ratio of 'I' to 'we' (Raskin and Shaw, 1988). The hypotheses we tested are the following:

1) Designers with more professional contacts use the word 'collaborate' or one of its lexical variants more.
2) Designers with more professional contacts describe their collaborations in more positive terms.
3) Designers with more professional contacts use more evaluative words in describing collaborations.

4) Designers with more professional contacts use more words to describe their general experience.
5) Designers with more professional contacts use more words to describe their collaborations.
6) Designers with more professional contacts describe their collaboration using more unique words (network discrimination).
7) Designers with more professional contacts describe their collaboration using more clusters of words (differentiation).
8) Designers with more professional contacts describe their collaboration with more words linking clusters together (integration).

3 Methods

3.1 Population

This study collected data about members of LinkedIn.com. According to its document "LinkedIn Facts," it is the world's largest online professional network with more than 100 million members in over 200 countries. More than half of the members are located outside the USA. LinkedIn claims that there were nearly two billion people searches in 2010 (http://press.linkedin.com/about/). Our specific population was designers. These were identified as members that had listed 'designer' in their employment history. The population of designers numbered 365,872.

3.2 Sampling

Textual searching was performed on LinkedIn profiles using an "advanced business" account. We searched in the job title field for members who had listed a position as "designer" and extracted complete profiles, which included their number of connections (contact persons). As to whether those who claim to be designers are actually designers, we relied on the assumption that people are truthful in listing their job titles. If someone lied about this, or about their collaborations, that introduced error in our analysis. On LinkedIn a profile is analogous to an offline resume, but rendered in an online social network. With an advanced business account, the full content of these profiles is available. One can conduct complex searches using key terms found in the full text of individuals' entries.

First we examined the population of designers, searching all of them for the extent to which they used a lexical variant of 'collaborate.' (See Table 1.)

Table 1. Lexical Variants of Collaborate Used by Designers

Collab…	Designers	Percent
...ed	10909	3.0%
...tion	7709	2.1
...ive	6544	1.8
…ate	5263	1.4

| ...ing | 3114 | 0.9 |
| ...or | 569 | 0.2 |

Of the 365,872 designers in LinkedIn, 34,108 used a 'collaborate' lexical variant, which was 9.3%. A question for future research is whether there is a norm against describing one's collaborative nature. It may be perceived as associated with leaking proprietary design information. Fear of stimulating others' thoughts that a highly collaborative person may be perceived as a security threat, thus reducing organizations' competitive advantage, may have accounted for some of the lack of mention of collaboration by designers.

3.3 Sample Description

Next we extracted a sample of 834 designer profiles proportional to the distribution of the 'collaborate' lexical variants for all designers. The LinkedIn searches appeared to produce random selections of individuals not in the searcher's own contact network. Only individuals with 2 link steps or more from the text collector were selected. Most were 3 steps removed. We searched for individuals whose current work profiles included "designer" and who used one of the lexical variants of 'collaborate:' collaborated, collaboration, collaborating, collaborator, collaborative, collaboratively.

For the sample of 834 designers mentioning a 'collaborate' lexical variant, we computed the median number of their contacts, which was 128. We split the sample into two groups at 128 contacts, an n=417 low-contacts subsample, and an n=417 high-contacts sample. There were only 7 of the 843 (0.83%) sample members having more than 300 contacts. Because the earlier research finding individuals with more than 300 contacts were narcissistic was on Facebook, not LinkedIn, we did not exclude these 7 individuals' data.

Given the focus of this research on the relationship between number of business social media contacts and descriptions of collaboration, there would be no point in studying designers who did not mention some form of collaboration. Nevertheless, a follow-up study could be done of what else is associated with numbers of contacts. As a side issue, its medium number of contacts could be compared to this one to see if the they were significantly different or not.

In addition to testing the semantic network complexity hypotheses that those with more connections have a more developed collaboration semantic network with more discrimination, differentiation, and integration, another of our goals was to analyze the semantic networks surrounding the lexical variants for 'collaborate,' performing word-centric network analysis. This would reveal possible differences in meaning for collaboration between high and low-contacts designers.

3.4 Text Analysis

Words appearing three word positions before and after each word in the texts were linked using WORDij 3.0 software (Danowski, 1993; 2010). Such a word windowing, proximity-basis for extracting word pairs has been adopted by other semantic network researchers including Diesner and Carley's (2004) AutoMap program, and Chen, Evans, Battleson, Zubrow, and Woelfel's (2012) CatPac program, to which Woefel added the proximity window

in 1993. Danowski (1982) and Monge and Contractor (2003) discuss alternative approaches to semantic networks.

In running the analysis, we combined profiles for low-contacts designers into a single file (29.6 MB) and did the same for high-contacts designers (50.8 MB). High-contacts designers wrote 72% more about themselves. This supported the hypothesis that high-contacts designers were more verbal.

We used WORDij's 3.0's WordLink program to convert all 'collaborate' lexical variants into the single unigram: 'collaborated.' Then WordLink identified proximate word pairs. Note that this is not a "bag of words" approach which would count words as paired that appeared anywhere in the same profile document. Rather, we identified word pairs within 3 word positions on either side of each word in the text. Earlier research (Danowski, 1993) tested different word window sizes against a criterion of change in network structures and found that networks including only adjacent words, a window size of 1 (w=1), or within two word positions of one another (w=2), resulted in network structures that were different. Moreover, including both adjacent words and those separated by another word along with words within 3 word positions (w=3) resulted in yet a different network structure. Subsequently increasing window size up through 32, however, yielded virtually identical network structures to the 3-word window setting. Diesner and Carley (2012) show similar results. Besides the validity of the 3-word window, it also has a practical advantage in producing smaller node adjacency files (Danowski, 1993; 2010b).

Other parameter settings dropped common function words using a standard stop-word list. We performed no stemming of words. As is supported by empirical research in natural language processing, we dropped frequencies of 1 and 2 for words and word pairs. We also dropped numerals. The word windowing was set to stop word pair identification at the end of each sentence, and restart at the beginning of the next sentence. We dropped punctuation within words and converted contractions. This identification of word-pair frequencies was performed once for the low-contacts group and once for the high-contacts group.

To test for differences in word-pair frequencies between the high and low-contacts groups, we ran WORDij's Z-Pairs program, which computed proportions for pairs, dividing each pair frequency by the total frequency across all pairs in the group. This normalized the data to remove the effects of each groups' different total numbers of word pairs and their frequencies. A very small constant of .00000001 replaced zero occurrences so that the tests could be performed because they require two non-zero proportions. The complete output of the z-tests is available from the author on request.

In making judgments about what word pairs indicated attributes of collaboration experience, experience generally, evaluations, and positivity, we used a qualitative approach that judged word pairs based on their most common usage in the work domain, according to the researcher's experience. Coders were not used to rate the word pairs. The reader can judge the validity of the word pair interpretations because they are presented in raw natural language form.

To produce semantic networks, WORDij's NodeTric program for node-centric network extraction was used. We set the program to find all links within three steps of the focal unigram, 'collaborated.' Semantic networks constructed from these word pairs for the two comparison groups are shown in Figures 1 and 2. Links with strengths less than 25 were dropped in both networks to improve visual clarity. Graphs were rendered in NetDraw

(Borgatti, 2002) by using the .net output files from WordLink. These were imported into UCINET (Borgatti, Everett, and Freeman, 2002) to prepare system files for NetDraw. WORDij has a better dynamic network graphing program, VISij, but NetDraw is more flexible in representing the results of structure computations and in changing the visual properties of nodes and links. We used the standard spring-embedding algorithm to create optimal layouts of the networks, thus aiding in visual comparison.

4 Results

Low-contacts designers used the term 'collaborate' or one of its lexical variations a total of 763 times. High-contacts designers had a total of 836 times. This resulted in a Chi^2 value of 3.33, p < .034. This difference was statistically significant. The hypothesis is supported.

It is noteworthy that the most significantly different word pair high-contacts designers used more designers was 'social—media,' while for the low-contacts designers it was 'freelance—designer." This finding is consistent with the theoretical explanation developed earlier that tied social media to collaboration networks. Presumably the freelancer is less likely to use social media because they mention it significantly less frequently.

4.1 Collaboration Experience

As Table 2 shows, the significantly higher frequency word pairs for the high-contacts designers contained two collaboration experience-related word pairs: 'co-worker—including', 'industry—co-worker'. They also used the word pairs: 'send—message' and 'social media'. These may indicate more collaboration but not necessarily. One could send a message to a client or other individual without collaboration taking place. 'Social media' could be used for collaboration but could also be a venue for which designers are creating some work output.

Low-contacts designers made significantly more reference to word pairs: 'making—contact'. This may be an indicator of collaboration, although the term could also refer to making contact with a client or other individuals with whom there is dyadic communication but not collaboration. Given the references to co-workers for the high-contacts designers but not for the low-contacts designers this result appears to be consistent with the hypothesis.

Table 2. Collaboration Process Word Pair Differences for Low and Low-contacts Designers
Z-test for Proportions   p < .01, frequencies > 3

Low-contacts Designers	High-contacts Designers	
making contact	social media	partners including
sales team	worked directly	clients partners
team establish	managed indirectly	co-worker senior
team line	co-workers partner	direct involvement
social online	speed networking	worked closely
group leader	team worked	senior interaction
team increase	open networkers	collaborative solutions
	account teams	collaborative center
	co-worker partner	complex problems
	power networking	creatives teams

manager co-worker	teams visualizing
executive team	conflict resolution
worked group	team responsible
worked indirectly	information interaction
collaborative tools	ability team
co-worker group	center innovation

4.3 Experience

For high-contacts designers the 'hiring' and 'managing' aspects shown in Table 3 indicated a higher position in the organizational hierarchy than for low-contacts designers. Low-contacts designers had 3 significant word pairs that appear associated with personal competence while high-contacts designers had 13. This was 4.3 times as many such words. It supports the hypothesis.

Table 3. Experience Word Pair Differences for Low and High-contacts Designers
Z-test for Proportions   p < .01, frequencies > 3

Low-contacts Designers	**High-contacts Designers**
assistant designer	worked directly
senior designer	hired designer
designer years	hired graphic-web
years designed	years computer
	hired coach
	experience lead
	years creative
	senior information
	senior interaction
	business years
	experienced work
	years working
	interaction years

4.4 Positivity

As seen in Table 4, high-contacts designers had 29 positive word pairs to 1 for the low-contacts designers: "top qualities." For high-contacts designers, among the most significantly higher proportion word pairs were: 'great—results', 'great—personable', 'results—personable', 'top—personable', and 'high—integrity'. These are four word pairs that appear to be positive in sentiment. Being 'personable' and having 'integrity' are also attributes that would appear to increase collaborative success should these designers be involved in more such activity. These may indicate greater extraversion promote more trust. High-contacts

designers used more evaluative words with greater positive sentiment. These results are consistent with the hypotheses.

Table 4. Evaluative Word Pair Differences for Low and High-contacts Designers
Z-test for Proportions   p < .01, frequencies > 3

Low-contacts Designers	High-contacts Designers	
top qualities	great results	great work
materials special	great personable	highly motivated
increase revenues	extra mile	research quality
qualities great	top great	pleasure working
qualities results	top results	results integrity
sales increase	personable good	improve research
team increase	great team	top integrity
creating special	personable integrity	wonderful person
	personable high	worked closely
	good creative	good fortune
	good hired	wonderful work
	good integrity	working pleasure
	open networkers	enjoyed working
	results creative	extremely working
	results high	great people
	great high	make great
		top high
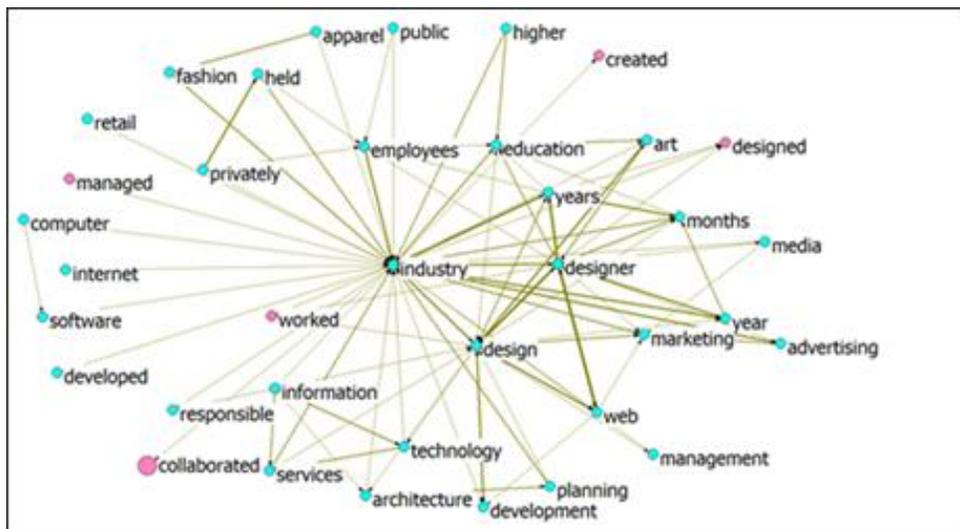
Figure 1. Low-Contacts Designers' Semantic Network for Collaboration
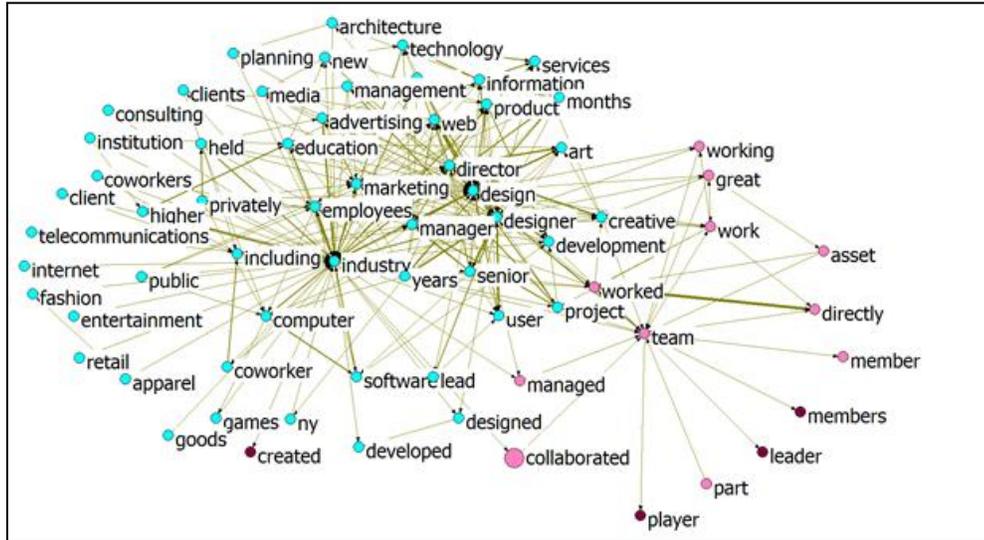
Figure 2. High-Contacts Designers' Semantic Network for Collaboration

4.5 Semantic Network Complexity

The next three results concern the complexity--discrimination, differentiation, and integration--of the semantic networks for collaboration. Figures 1 and 2 show graphically the networks for both high-contacts and low-contacts designers. To increase visual clarity we dropped word pairs less frequent than 25. Links that are darker indicate higher frequencies on a 1 to 4 ordinal scale. A quick comparison of the two figures reveals a more complex structure for the high-contacts sample. Only visualizing differences, however, is not as valid as making quantitative comparisons of network variables. We did, computing the semantic complexity measures on these data with word pair frequencies of 25 or more. Presented are the node-centric network for 'collaborated' and words linked up to three steps away. At these relatively high frequency limits of more than 25 for a pair, 'collaborated' had only one link in the low-contacts network, to 'industry,' while for the high-contacts group 'collaborate' linked not only to 'industry' but to 'team.'

4.5.1 Semantic Discrimination

The low-contacts designers had 39 word tokens, unique words, in their network while the high-contacts designers had 70. This is 4.3 times more semantic discrimination for the high-contacts designers, which is consistent with the hypothesis.

4.5.2 Semantic Differentiation

The Girvan-Newman group detection procedure in NetDraw found 2 groups in the low-contacts designer network and 3 groups in the high-contacts designer network. This is 50% more differentiation and supports the hypothesis. It is interesting to note that one of the groups contained the word 'collaborated' along with these: 'team, member, player, part, managed, work, worked, working, directly, great, asset.' Figure 2 shows the specific links among these words. It appears that one of the differentiated groups deals directly with collaborative team work. For the low-contacts group 'collaborated' does not have such a differentiated position.

4.5.3 Semantic Integration

The low-contacts designer network had 8 intergroup links among its 2 groups while the high-contacts designer network had 18 such links among its 3 groups. This is 50% more intergroup linkage and supports the hypothesis.

4.6 Additional Findings

In comparing the 401 significantly different word pairs at $p < .0000$ for the two designer groups, we observed that the low-contacts designers used more concrete terms. Low-contacts designers used a more common way of describing their collaboration. High-contacts designers had a more varied, i.e. entropic way of describing theirs, with many more alternatives but less abstract and more idiosyncratic ones.

5 Discussion

5.1 Summary Findings

Only 9.3% of designers in LinkedIn mentioned any lexical variants of 'collaborate' in their autobiographical profiles. This was a surprisingly low figure. Future research should investigate why this is the case.

The median number of professional contacts was 128 for designers who mentioned some form of 'collaborate.' High-contacts designers used a collaboration word significantly more than low-contacts designers. When describing collaboration, high-contacts designers had 72% more to say. They described the collaboration process in 4.6 times more detail, using evaluative words pairs 4.1 times more, positive word pairs 29 times more, and personal competence and experience word pairs 4.3 times more. As well, high-contacts designers had semantic networks that discriminated 79% more unique words. These were 50% more

differentiated into word groups. They were 50% more integrated through intergroup linkage. These findings supported the hypotheses.

5.2 Interpretation of Findings

The fact that only 9% of designers mentioned collaboration can be taken as an indicator of the scope of opportunity that exists to promote the benefits of collaborative design. This condition suggests that collaboration in design is most likely an innovative concept. On the other hand, it is conceivable that this is indicative of the tail end of the diffusion curve with a few remaining laggards who have yet to reject collaboration. Evidence such as the sponsorship of the Collaborative Innovation Networks (COINS) conferences by institutions of design learning would indicate the former interpretation is valid and the latter wrong.

That designers with more contacts had more complex semantic networks about collaboration may indicate that collaboration is more likely to be effective when there is a matching degree of semantic network complexity for individuals that wish to collaborate. Homophily on number of contacts and on semantic network complexity suggests that perhaps birds of a feather should collaborate together. A collaboration team with insufficient semantic similarity and other correlates of number of contacts is probably less likely to be as effective.

The support found for the hypotheses suggests that the reasoning provided from the review of literature, some of which was used for establishing chains of reasoning, but not directly measured in this study, may be sound. Future research that directly measures these explanatory variables would help determine whether the assumed conceptual soundness is empirically supported. We discuss this point further in the section on future research directions.

5.3 Limitations

Biographical information presented in resume form, even though perhaps more elaborated in the social medium of LinkedIn than in printed document exchange, is normatively restricted to brief descriptions and bullet and telegraphic language formats. This limits the depth of information available about designers' concepts of collaboration. A richer communication channel for querying respondents would include a method such as an open-ended survey question with follow-up probes. Or, with appropriate incentives researchers could ask respondents to write an essay giving their thoughts about and experiences with collaboration. Methods such as this would likely increase the richness of information and probably find more differences between designers with higher and with lower numbers of professional contacts. Researchers at the same time could gather other data on variables such as those we made inferences about but did not measure.

Another potential limitation is that we only sampled designers who used a lexical variant of the word 'collaborate.' There may be other terms with similar meanings that were not captured and hence these individuals were not sampled. Some of these we found associated with 'collaborate,' such as word pairs involving working in teams. Perhaps some members of the population describe working in teams but do not mention the word 'collaborate' or its variants in their profiles. This would under-report the proportion of the designer population that has been involved in collaboration, which we found to be 9.3%. Nevertheless, it would not

affect our results comparing differences between high and low-contacts designers' descriptions of collaboration when they have used lexical variants of 'collaborate.'

We studied only one professional group. Results may not be found in future research to generalize to other types of individuals. Another limitation is that we have only self-reported, highly managed, autobiographical information from participants. We do not know how well this correlates with actual behaviors. One can expect that in a social medium used to a considerable extent for job-seeking, individuals may spin their online resume's to fit industry norms, while in actuality they may not be close to them.

This study ignored time. Designers with varying lengths of tenure were combined. There may be developmental changes in descriptions of collaborative experiences that may be theoretically important, yet our design was unable to identify them. We also did not separate out those who had been designers at multiple positions.

Our findings, nevertheless, have face and predictive validity so this indicates that we identified significant patterns regardless of such limitations.

5.5 Directions for Future Research

Given our findings and the rationale in our theoretical section and review of relevant literature, we hypothesize for future research that high-contacts designers probably have higher trust, lower social anxiety, less neuroticism, less narcissism, more extraversion, more verbal fluency, more empathy, higher social capital, and present less self-justificatory information. The organizational position of designers may predict their later semantic production about collaboration, while the reverse is not as likely (Danowski, 2012). Preliminary evidence indicates that there is a causal flow from organizational structure to later semantic structure.

It would be useful to ask samples of designers, including those who say they have not collaborated, to describe what collaboration means to them using open-ended questions with probes, or having them write essays, followed by doing semantic network analysis on these data. A survey asking such questions could also develop closed-ended scales to measure various hypothesized correlates of different descriptions of collaboration, a technique called "property fitting." The concepts discussed at the outset regarding trust, experience, positivity, social anxiety, extraversion, neuroticism, narcissism, and empathy are examples of such variables for which reliable scales exist or could be developed. Scale variables could be correlated with word pair frequencies to test hypotheses linking collaborator attribute data to semantic network components. In addition, a number of these variables have been found to be reliably measured through open-source text analysis.

It is noteworthy that generational cohorts have been found to use the medium more throughout life that was most popular in their young adulthood (Danowski and Ruchinskas, 1983). This pattern may hold for social media and Generation Y. Because social media are fundamentally collaboratively-oriented, it may be the case that as current young designers age, they will bring generational change with them as to the importance of collaboration.

6 Conclusion

This paper contributes to greater theoretical understanding of why having more social contacts in a work-oriented social medium may be associated with differences in how individuals

describe their collaborations. An additional contribution is identifying some of the key individual attributes associated with their representations of their collaborations: verbosity, competence, positivity, and evaluative content. As well, this paper contributes to theory about the complexity of semantic networks about collaboration in relation to having larger social contact networks. Finally, there are methodological contributions in how we go about addressing these matters using a particular type of proximity-based semantic network analysis. We focus on differences in word pairs appearing close together in the text mined. Another contribution of this research is that we control for the type of work performed to establish increased internal validity in a cross-sectional design. Because design processes are well developed, are pervasive for processes, activities, and artifacts, and are linked with academic disciplines for design, we chose designers as the focus of the research.

Hypotheses were supported. High-contacts designers used a collaboration word more frequently than low-contacts designers. When describing collaboration, high-contacts designers had 72% more to say. They described collaboration process in 4.6 times more detail, using evaluative words pairs 4.1 times more, positive word pairs 29 times more, and personal competence and experience word pairs 4.3 times more. As well, high-contacts designers had semantic networks that discriminated 79% more unique words that were 50% more differentiated into word groups, and were 50% more integrated through intergroup linkage.

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