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Opinions of sports clinical practice chiropractors, with sports specialty training and those without, about chiropractic research priorities in sports health care: a centering resonance analysis

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Introduction: *A Canadian sports chiropractic research agenda has yet to be defined. The Delphi method can be utilized to achieve this purpose; however, the sample of experts who participate can influence the results. To better inform sample selection for future research agenda development, we set out to determine if differences in opinions about research priorities exist between chiropractors who have their sports specialty designation and those who do not.*

Methods: *Fifteen sports clinical practice chiropractors who have their sports fellowship designation and fifteen without, were interviewed with a*

Introduction : *Un programme canadien de recherche en chiropratique sportive n'a pas encore été établi. La méthode Delphi peut être utilisée pour atteindre cet objectif; cependant, l'échantillon d'experts qui participent peut influencer les résultats. Afin de mieux informer la sélection d'échantillons pour le développement futur du programme de recherche, nous avons entrepris de déterminer si des différences d'opinions sur les priorités de recherche existent entre les chiropraticiens qui sont spécialisés dans les disciplines sportives et ceux qui ne le sont pas.*

Méthodologie : *Quinze chiropraticiens spécialisés en sport ayant une désignation de spécialiste dans le domaine et quinze autres sans cette désignation ont répondu à un ensemble de questions normalisées sur les priorités de la recherche en chiropractie sportive. Les réponses données durant les entretiens ont fait l'objet*

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set of standardized questions about sports chiropractic research priorities. A centering resonance analysis and cluster analysis were conducted on the interview responses.

Results: *The two practitioner groups differed in their opinions about the type of research that they would like to see conducted, the research that would impact their clinical practice the most, and where they believed research was lacking. However, both groups were similar in their opinions about research collaborations.*

Conclusion: *Sports clinical practice chiropractors, with their sports specialty designation and those without, differed in their opinions about sports chiropractic research priorities; however, they had similar opinions about research collaborations. These results suggest that it may be important to sample from both practitioner groups in future studies aimed at developing research agendas for chiropractic research in sport.*

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KEY WORDS: chiropractic, sports, sports chiropractic, text analysis, discourse analysis, centering resonance analysis, research priorities

d'une analyse par recoupement et d'une analyse qui représente les termes dans un réseau qui met en évidence leur fréquence, leur importance et leur influence (centering resonance analysis).

Résultats : *Les deux groupes de praticiens ont exprimé des opinions divergentes quant au type de recherche qu'ils souhaitaient voir menée, à la recherche qui aurait le plus d'impact sur leur pratique clinique et aux domaines qui devaient faire l'objet de recherche. Cependant, les deux groupes avaient des réponses similaires sur les collaborations en recherche.*

Conclusion : *Les chiropraticiens spécialisés en sport ayant une désignation de spécialiste dans le domaine et ceux sans cette désignation ont des points de vue différents sur les priorités de la recherche en chiropractie sportive; cependant, ils avaient des opinions similaires sur les collaborations en recherche. Ces résultats suggèrent qu'il peut être important d'inclure des représentants des deux groupes dans les futures études visant à développer des programmes de recherche pour la recherche en chiropratique sportive.*

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MOTS CLÉS : chiropratique, sports, chiropratique sportive, analyse de texte, analyse de discours, centering resonance analysis, priorités de recherche

Introduction

In individuals aged twelve and older, 35% of reported injuries are attained through sport. Of these injuries, strains and sprains are very common, attributing to 48% of injuries in individuals aged 12-19, 58.3% in those aged 20-60, and 36.6% for those over the age of 65.[1] Chiropractors are experts in musculoskeletal health who are primary contact providers for these injuries. As evidence-based practitioners, research should continually inform a best practices approach to the evaluation and management of sports injuries.

Research agendas identify knowledge gaps, prioritize future research, and ensure that the research being conducted is clinically relevant. The first research agenda for health services related to chiropractic in North America was published in 1997[2], and was subsequently updated in 2006[3]. Similarly, in 2000 the Consortium for Canadian Chiropractic Research Centres (CCCRC) published the results of a two-day workshop purposed to define an agenda for chiropractic research in Canada.[4] More recently, a conference was held in 2009 to update and refine the previous research agenda conducted by the CCCRC.[5] The need for a chiropractic research strategy has also been internationally recognized as demonstrated by a summit hosted in Australia in 2010[6], and more recently Europe was successful in publishing their first research agenda using a Delphi procedure[7]. This international drive to formalize research plans emphasizes the importance for research to be strategically planned in order to increase the likelihood of successful implementation.

Sports chiropractic is a specialty within the chiropractic profession that may require a specialty-specific

research agenda that addresses the unique requirements for this area of study. An internet search of prominent sports chiropractic association websites in June 2016 that included the Royal College of Chiropractic Sports Sciences (Canada) (RCCSS(C)), International Federation of Sports Chiropractic, American Chiropractic Board of Sports Physicians, and American Chiropractic Association Sports Council did not identify any formal research agendas specific to sports chiropractic that have been published to date.[8–11]

The importance of advancing chiropractic research in sport in Canada cannot be understated. Recent analysis conducted on 2,040 respondents of the 2011 cross-sectional survey of the Canadian Chiropractic Resources Databank identified "sports injuries" and "rehabilitation" as a main area of practice that was associated with a higher number of physician referrals to chiropractors.[12] Despite calls to draft a Canadian research agenda for chiropractic research in sport, a coordinated attempt to conduct this task has not been formally planned.[13,14]

Previous researchers have utilized the Delphi survey method to obtain expert consensus to define research agendas.[7,15,16] However, the results of a Delphi study can be greatly influenced by the sample of experts included as subjects. Selecting the appropriate subjects is an important first step in the Delphi process.[17,18] It has been recommended that subjects should be individuals who are highly trained and competent within the specialized area of knowledge related to the target issue, and they should also consist of individuals who are primary stakeholders related to the research effort.[17] Prior to conducting a Delphi study, it may be necessary to first conduct exploratory work to understand the potential population who will be sampled from, and gain an understanding of any key issues arising from the topic area being studied.

In Canada, the sports chiropractic specialty is overseen by the RCCSS(C), and chiropractors who have obtained their fellowship through the RCCSS(C) are regarded as experts in the field. Intuitively, sports chiropractic fellows are a group of representative content area experts to sample from for a Delphi study. However, since many chiropractors who manage sports injuries and practice in sports health care settings do not have formal sports specialty training, it may be important to consider the opinions of these practitioners when developing research agendas as they represent a sizable stakeholder group in the field of sports chiropractic. Exploratory work investigating any possible differences or similarities between these groups of practitioners and their opinions about research priorities would be beneficial prior to planning a study to define a research agenda for sports chiropractic.

Presently, little is known about sports chiropractic practice and the opinions about chiropractic research priorities in sport in Canada. In 2010, Miners *et al*.[19] conducted a cross-sectional survey of fellows from the RCCSS(C) (formally known as the College of Chiropractic Sports Sciences (Canada)) to investigate their self-reported treatment practices and intended therapeutic outcomes when treating athletes. The majority of the respondents believed that their treatments could cause a direct improvement on an athlete's performance and the most commonly utilized therapeutic intervention performed in their treatment of athletes was spinal joint manipulation/mobilization. While this survey studied the practice characteristics and opinions of chiropractic sports fellows in Canada, little is known about chiropractors practicing in sports-based settings that have not completed a sports fellowship. It is plausible that the practice characteristics and beliefs of this group may differ from sports fellows.

Considering the lack of research investigating these two practitioner types (sports fellows and non-sports fellows) in Canada, and the importance of exploring the potential subject pool for a future Delphi study to define a sports chiropractic research agenda, our primary aim of this study was to determine if there is a difference in opinion between sports-based clinical practice chiropractors who have their sports specialty training and those without, regarding sports chiropractic research priorities. If differences in opinions are found to exist, then it may be important to sample from both practitioner groups when conducting a future Delphi study. A secondary aim of the study was to explore the discourse that arose from both groups when asked about their opinions about sports chiropractic research priorities.

Exploring practitioner opinions can sometimes be difficult due to the various methodologies available to the researcher. Survey methods can inform researchers about practitioner's opinions if there is sufficient a priori knowledge to draft valid survey questions, and the statistical analysis of group responses can be objectively compared. However, survey methods have limitations in the types of responses that can be collected, and they provide limited

opportunity for subjects to fully express their opinions. Qualitative interview studies using a grounded theory approach can certainly be utilized to explore practitioner opinions. Some limitations with this method include potential researcher bias while conducting open-ended interviews, making coding decisions, and making judgement of the magnitude of importance of identified emerging themes.[20–22] Also, group comparisons using this approach tend to still be qualitative.

Quantitative analysis and data mining of text data obtained from transcribed structured interviews may be a potential method that can provide insight to researchers about practitioner opinions, and determine if differences or similarities exist between the interview responses obtained from different practitioner groups. It should be noted that these methods are not meant to be substitutes for thematic analysis techniques. Quantitative text analysis provides a different approach to analyzing discourse that provides researchers with a tool that permits the use of various statistical tools to assess and quantify text data.[23] Centering resonance analysis (CRA) is a quantitative text analysis method that uses linguistics and centering theory to model text obtained from archival sources or discourse obtained from transcribed conversations as word networks.[24] CRA was developed in the field of communication studies, and it has been utilized to perform media content analysis, conversation analysis, and the study of organizational communication.[24–28] Recently, CRA has been applied to the chiropractic field to investigate the differences in wellness management strategies between broad and narrow scope chiropractors.[29] A benefit of utilizing CRA is that the text responses obtained from interviews can be analyzed individually or pooled and analyzed as group responses to inform researchers about the overall focus of the discourse that occurred within a group. Statistical techniques, such as a cluster analysis, can be used to determine if the text responses obtained from each respondent group can be objectively clustered based on the degree of similarity between texts. The application of CRA in exploring research opinions is novel. Consequently, a secondary intent of our study is to provide a use case of CRA within this setting to further our understanding of this method.

In order to better understand the research needs within the field of chiropractic in sport, an exploratory cross-sectional interview study was conducted to investigate the difference in opinions about sports chiropractic research priorities between sports clinical practice chiropractors who have their sports specialty designation and those who do not. We hypothesize that the opinions between these two practitioner groups will differ. Since there is limited research about the opinions of sports chiropractic research priorities, this study will serve as the first exploratory step in a larger undertaking to plan a future Delphi study to set a research agenda for chiropractic research in sport in Canada.

Methods

Fifteen licensed sports clinical practice chiropractors with their sports specialty designation and fifteen without were recruited into one of two groups – the sports specialty designation group (SS) or non-sports specialty designation group (NS). To be included in the study, subjects must: be a licensed Doctor of Chiropractic (DC), self-reportedly manage a minimum of ten sports-related cases per week in clinical practice, self-reportedly practice evidence-informed chiropractic, and have a minimum of five years of clinical practice experience. To be included in the SS group, subjects must also be a registered fellow of the RCCSS(C). Considering the aim of the present study was to obtain opinions regarding research, it was determined to be important to recruit practitioners who are regular users of research to inform their clinical practice. Therefore, one of our inclusion criteria included asking subjects to self-identify as a practitioner that practices evidence-informed chiropractic, which we defined as a practitioner who regularly uses research evidence to inform their clinical chiropractic practice.

Participants were recruited from a geographical region defined by a radius of 100 km using the Canadian Memorial Chiropractic College (CMCC) as the center point. Convenience and snowball sampling methods, such as sampling by the use of personal acquaintances, telephone directories, and reviewing public professional association registries were utilized. Considering the present study is exploratory, and to the authors' knowledge, there presently is no known method for determining a sample size for CRA, a research methodologist experienced in CRA recommended a sample size of 15 subjects per study group. In qualitative research, the collection of an adequate sample has been justified by determining the point at which data saturation has occurred.[30,31] As CRA is a novel appli-

cation to investigating opinions regarding research priorities, the authors present a method for determining data saturation taking account the structure of the CRA word networks. This is described below in the methods section following the description of CRA. Participant rights and safety were reviewed and approved by the CMCC Research Ethics Board.

Once informed consent was obtained, participants were given a sheet of paper containing four standardized interview questions pertaining to their opinions about sports chiropractic research priorities (Table 1). Question one was constructed to allow respondents to openly comment about the type of research they would like to see occur if there were no real or perceived barriers to research. The intent of question two was to elicit practitioner opinions about the type of research that they thought would directly impact their clinical practice. Question three was intended to compel practitioners to conduct their own needs assessment of what research needs to be conducted to advance the field, and the final question queried respondent's opinions about the types of research collaborations they deemed important. Participants were given ample time to review the questions prior to the commencement of the study. All interviews were conducted in person and the participant's responses were recorded using a digital voice recorder. To ensure that full responses were obtained from the participants, at the completion of responding to each question, the interviewer repeated the question to the subject, and informed them that they had the opportunity to add to their answer. Once the participant felt that their response was exhausted, the interviewer then proceeded to the next question.

All audio files from the interviews were transcribed into a text file for subsequent analysis. An a priori decision was made to remove any extraneous speech from the text file that occurred during audio recording that was judged by the research team, as determined by a majority vote of three out of four, to be irrelevant to answering the interview question. Examples of such irrelevant speech included "Can you repeat the question?", "That's a great question.", and words such as "um" and "uh". Individual text files of respondent interviews were separated by interview question, and then compiled into larger text files to represent aggregated group responses to each interview question. This yielded four text files per group representing the four interview questions, each containing

Table 1.
Standardized interview questions.

Questions	
1.	If there were no limitations, what type of research would you want to be conducted related to chiropractic and sports health care?
2.	What research relative to sports health care and chiropractic would impact your clinical practice the most?
3.	Where do you believe most of the research is lacking for sports chiropractic?
4.	What type of collaborations would you like to see occur in sports chiropractic research?

n=15 interview responses. For the SS group, the data files were SS Question 1 (SSQ1), SSQ2, SSQ3, and SSQ4. For the NS group, the data files were NSQ1, NSQ2, NSQ3 and NSQ4. A CRA of these text files was conducted with Crawdad Analysis Software (version 1.2) (Crawdad Technologies LLC, Chandler, Arizona).

CRA is a network text analysis method that uses linguistic theory to create word networks of a body of text by constructing a network of the noun-phrases to represent main concepts, their influence and their interrelationships within this word network.[24,25] This method is based on centering theory, which posits that speakers and writers construct and locate noun phrases within a stream of discourse in such a way as to create coherence.[32] In CRA, sentences are first parsed into noun phrases, and a network is constructed with nouns represented as nodes of the network. Once constructed, the *influence* of a word is measured by calculating the betweenness centrality of each word within the CRA network.[33] Betweenness centrality is a network measure that calculates how often a given node in a network falls along the shortest path between two other nodes in a network,[33,34] and provides a measure of how much a node within a network can control the amount of "flow" (which could be information, knowledge, meaning, etc.) through a network.[24,34] In regards to CRA text networks, where centering words are the nodes of the network, betweenness centrality represents the extent to which a particular centering word channels the flow of meaning through a network of centering words.[24] Word *influence* is a measure of the structural importance of the word within the discursive network. Words that are high in *influence* create coherence in text connecting

words within the network to mediate meaning.[24] Influence values are normalized between 0 and 1. While the average influence of words changes slightly due to text size, in general, influence values above 0.01 are considered significant, and values above 0.05 are considered very significant.[27]

CRA also provides a measure of word *resonance*, which is a measure of the structural similarity of two or more word networks. The more two texts frequently use the same words in influential positions, the more word *resonance* they have.[24] A cluster analysis can be conducted on the *resonance* of two or more word networks to determine whether a body of text can be clustered into distinct groups based on the degree of similarity within the text. Crawdad Analysis Software uses Wards hierarchal clustering method to group objects of interest with minimal information loss, where loss is described as the minimization of the sum of squares error.[35] Analysis algorithms for the generation of CRA word networks, the calculation of word *influence* and word *resonance*, and the reporting of face and representational validity for this text analysis method are described in detail in Corman *et al*.[24]

To answer our primary research question, which was to determine if there exists a difference in opinion regarding research priorities between the two study groups, CRA networks were generated for each of the 8 input text files (with each file representing each group's responses to each interview question), and a cluster analysis was conducted to determine if these text files could be clustered into distinct groups based on the degree of similarity within the text.

To investigate the effect of sample size on this approach, the cluster analysis was repeated using a sequentially ascending sample size of group responses to each question starting with text files that included 1 subject response, and progressively proceeded to text files that included 15 subject responses. Therefore, the cluster analysis was repeated 15 times, with each successive run adding data from another subject to the group responses to each interview question. The sequence for serially adding subjects to the analysis was randomized for each study group using a random list generator provided by the website random.org/lists.[36] Data saturation for this method of analysis was defined as the point where the cluster analysis results are found to be stable across sample size, where further addition of subjects does not change the cluster pattern.

To explore the discourse that arose from the interview responses from both groups, CRA networks and network visualizations were created for each of the 8 input text files that represented the group responses to each interview question. CRA network visualizations were qualitatively analyzed, and an influence analysis was conducted on each CRA network to identify influential nouns and noun pairs within the discourse. A decision was made to report the top 20 ranked influential nouns and noun pairs identified. To investigate the effect of sample size on the use of CRA to explore the discourse obtained from the interview responses, it must be recognized that CRA models text as word networks. In order to determine a point where data saturation of a CRA word network has likely to have occurred, one must determine the point at which the further addition of interview responses contributed from sequential subjects does not substantially alter the network structure. Word *influence* is calculated based on the betweenness centrality of a word within a word network, and it represents how often a given node in a network falls along the shortest path between two other nodes in a network.[24,34] As a result, word *influence* will change as the network size increases. Also, this metric does not provide a measure of the network structure. Word *resonance* represents a better measure to evaluate the effect of sample size on CRA as it provides a measure of the structural similarity between word networks.[24] A method was devised to compare the CRA word networks across sample sizes based on word *resonance*. Separate text files of interview responses with a sequentially ascending sample size were created for each interview question for each study group. A cluster analysis based on word resonance was conducted on the CRA networks generated from these text files. The same random sequence created for serially adding subjects to the previous analysis was used for this purpose. The result of this cluster analysis can determine how similar or dissimilar the structure of the CRA word networks are as sample size is increased. If the clustering pattern for each question clusters according to sample size, and demonstrates large clusters that include files with sequential sample sizes that saturate up to the maximum sample size of 15 subjects, then this may provide some evidence that further addition of subject data may not affect the overall CRA network structure

for each group's response to the interview question being analyzed. If the cluster analysis returns a pattern that does not follow a rationale grouping based on sample size, then one may conclude that the CRA network structure for each group's response to each individual question has not been saturated.

Results

Participant Demographics (see Table 2)

Twenty-one sports clinical practice chiropractors with their sports specialty designation and 30 without their specialty designation were recruited to participate in this study. A total of 15 participants in each group were enrolled, and all 30 participants completed the study. The participation rate was 71.4% and 50% for the SS and NS groups, respectively. The mean age and years of practice

Table 2.
Demographics of participants.

Demographics	Sports Specialty Designation Chiropractors	Non-Sports Specialty Designation Chiropractors
Participants recruited	21	30
Participants interviewed	15 (14:1, male:female)	15 (12:3, male:female)
Participation rate	71.4%	50%
Age (mean +/– SD)	41.4 +/– 5.5	41.8 +/– 9.4
Years of practice (mean +/– SD)	15.9 +/– 8.3	12.8 +/– 7.4
Number of participants with formal research experience (masters, PhD or chiropractic residency program)	15 (100%)	2 (13%)

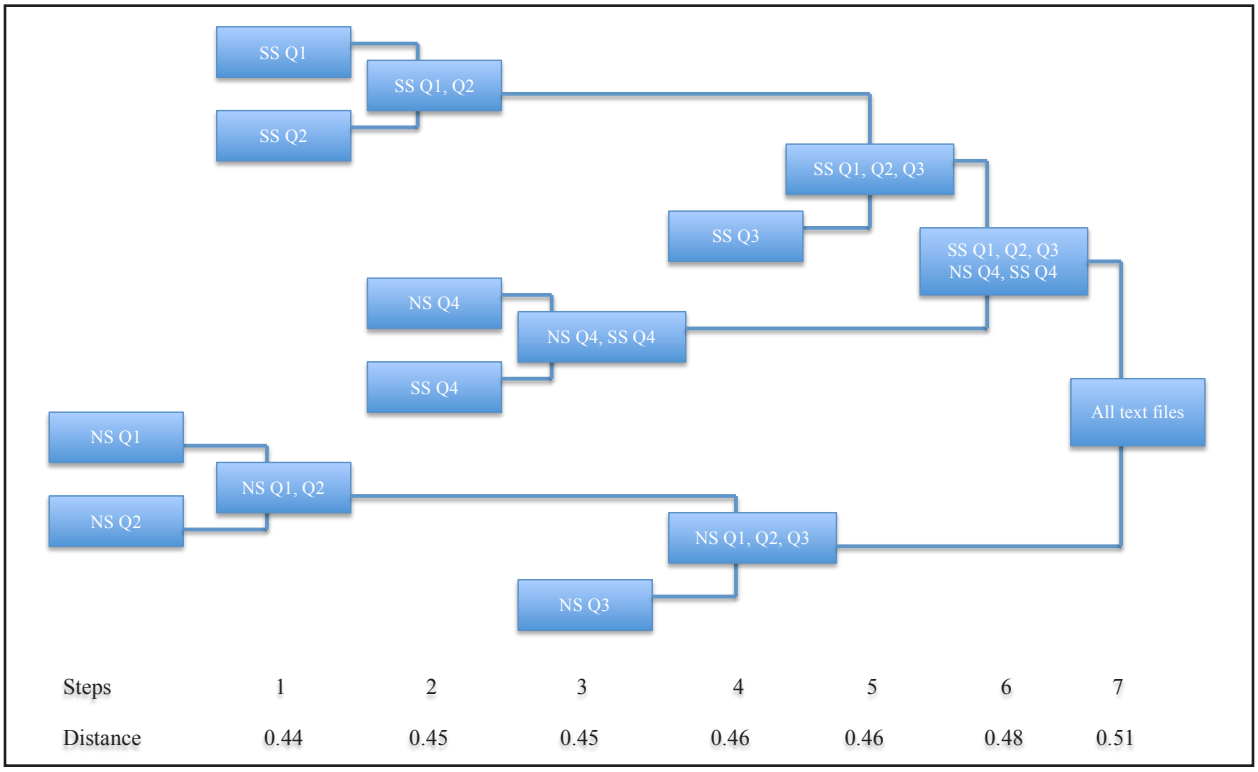

Figure 1.
Hierarchical clustering dendrogram.
A cluster analysis was conducted on the eight CRA word networks generated from the eight input text files representing the aggregated group responses to each interview question. A distinct clustering pattern is observed. Note that questions one, two and three clustered by study group and question four clustered by question. When interpreting a dendrogram, the strength of similarity between objects is strongest on the left and decreases at each step to the right.

Table 3.
Effect of sample size on the cluster analysis of group responses to interview questions.

Cluster Analysis	Sample Size Per Group (n)	Group Clusters For Each Cluster Analysis		
1	1	NSQ1, NSQ4, NSQ3, NSQ2	SSQ1, SSQ2, SSQ3, SQ4	
2	2	NSQ2, SSQ3, SSQ4	NSQ1, NSQ4, NSQ3	SSQ1, SSQ2
3	3	SSQ3, SSQ4, NSQ2	NSQ1, NSQ4, NSQ3	SSQ1, SSQ2
4	4	SSQ1, SSQ2, SSQ3, SSQ4	NSQ1, NSQ4, NSQ3, NSQ2	
5	5	SSQ3, NSQ2, SSQ4	NSQ1, NSQ4, NSQ3	SSQ1, SSQ2
6	6	NSQ1, NSQ4, NSQ3, SSQ4	NSQ2, SSQ3	SSQ1, SSQ2
7	7	NSQ1, NSQ2, NSQ3	NSQ4, SSQ4	SSQ1, SSQ2, SSQ3
8	8	NSQ4, SSQ4, NSQ3	NSQ1, NSQ2	SSQ1, SSQ2, SSQ3
9	9	NSQ1, NSQ2, NSQ3	NSQ4, SSQ4	SSQ1, SSQ2, SSQ3
10	10	NSQ1, NSQ2, NSQ3	NSQ4, SSQ4	SSQ1, SSQ2, SSQ3
11	11	NSQ1, NSQ2, NSQ3	NSQ4, SSQ4	SSQ1, SSQ2, SSQ3
12	12	NSQ1, NSQ2, NSQ3	NSQ4, SSQ4	SSQ1, SSQ2, SSQ3
13	13	NSQ1, NSQ2, NSQ3	NSQ4, SSQ4	SSQ1, SSQ2, SSQ3
14	14	NSQ1, NSQ2, NSQ3	NSQ4, SSQ4	SSQ1, SSQ2, SSQ3
15	15	NSQ1, NSQ2, NSQ3	NSQ4, SSQ4	SSQ1, SSQ2, SSQ3

Note: the overall clustering pattern remained stable after a sample size of 9 subjects per group, indicated by the darker shading.

between both groups were similar. However, the number of participants with formal research experience differed between the groups with 100% of the SS group and 13% of the NS group reporting formal research experience, which was defined as previous participation in a masters, PhD or chiropractic residency training program.

Cluster Analysis

The cluster analysis (Figure 1) revealed that the CRA networks generated from the input text files clustered by study group for questions one, two and three, indicating that the SS and NS groups differed in their responses to these questions. Questions one and two, that asked respondents about the type of research they wanted to be conducted in the field and the type of research they thought would impact their clinical practice the most, clustered by study group at steps one and two. This revealed that questions one and two elicited similar responses within each study group. Question three, that asked respondents where they believed most of the research is lacking in the field, clustered by study group at steps four and five of the analysis, revealing that question three elicited different responses compared to questions one and two from participants within their own group, but the responses still differed between groups. Interestingly, the word networks for question four clustered by question and not by study group at step three of the analysis, revealing that both groups responded similarly to question four, which asked respondents about the types of collaborations they would like to see occur in sports chiropractic research. The results from the 15 repeated cluster analyses with a sequentially ascending sample size revealed that the main clustering pattern was stable from the inclusion of data from 9 subjects onward (Table 3). This provides some evidence that this method of analysis reached data saturation at 9 subjects per study group, and the further addition of subjects will not likely change the overall clustering pattern.

CRA Network Visualizations and Influence Analysis

CRA network visualizations (Figures 2 to 9) and word influence analyses (Tables 5 to 8) were conducted for each text file that contained the group responses to each

Table 4.
Cluster analyses of text files with different sample sizes for each interview question.

Cluster Analysis	Question Per Group	Cluster Grouping of Text Files With Different Sample Sizes			
1	NSQ1	1,2,3	4,5,6,7,8,9,10	11,12,13,14,15	
2	NSQ2	1,2,3	4,5,6	7,8,9,10	11,12,13,14,15
3	NSQ3	1,2,3	4,5,6,7,8	9,10,11,12,13,14,15	
4	NSQ4	1,2,3	4,5,6	7,8,9	10,11,12,13,14,15
5	SSQ1	1,2,3,4,5,6	7,8,9,10,11	12,13,14,15	
6	SSQ2	1,2,3,4,5,6	7,8,9,10,11	12,13,14,15	
7	SSQ3	1,2,3,4,5,6	7,8,9,10,11	12,13,14,15	
8	SSQ4	1,2,3,4,5,6	7,8,9,10,11	12,13,14,15	

Each number represents a text file that contains the corresponding amount of subject responses to the interview question.

interview question. In order to interpret the findings of a CRA, it is important to first assess the visualization of the CRA word network, and then utilize the results of the influence analysis to identify the key areas of focus that occurred within the discourse. Since CRA networks typically contain hundreds of word connections, the CRA visualization that is constructed by Crawdad Analysis Software provides a visualization of a sub-network based on the most influential words in the document. Typically, nodes in the network with influence values above 0.015 are shown, which generates CRA network maps that include approximately 20 to 30 nodes per visualization. To interpret CRA network diagrams, the primary influential nouns are found in red, the secondary influential nouns are in yellow, and tertiary influential nouns are not assigned a colour. The lines in the map depict links between the words, with darker lines depicting stronger ties in the network. The most influential words tend to be located near the top of the diagram, and the lower portion of the graph contains less influential words.[37] The interpretation of the CRA network visualizations and influence analyses are presented below in relation to their corresponding interview question with selected excerpts from the discourse that highlight the CRA results.

The results of the analysis to investigate the effect of sample size on the structure of the CRA networks generated for the group responses to each interview question is found in Table 4. For both groups, across all questions, the files clustered by sample size. The cluster analysis illustrates the evolution of the similarity between CRA word network structure as sample size increases. For the SS group, the CRA word networks that included data from 12 subjects onward were grouped similarity based on word resonance. For the NS group, the CRA word networks that included data from as low as 9 subjects onward, and as high as 11 subjects onward were grouped similarly. This systematic grouping of CRA word networks over sample size provides evidence that the CRA word networks are not changing substantially in structure from sample sizes as low as 9 subjects onward and as high as 12 subjects onward, depending on the group or individual question. This provides some evidence that the inclusion of 15 subjects per study group for the present study led to stable CRA word network structures.

Question 1: If there were no limitations, what type of research would you want to be conducted related to chiropractic and sports health care?

The CRA network visualization for the NS group (Figure 2) for this question revealed that the primary influential words in the network diagram were *injury*, *chiropractic*, *research*, *care* and *athlete*. The secondary influential words within the network were *sports*, *chiropractor*, *good*, *treatment*, *knee*, *study* and *performance*. Notable word network connections within the CRA visualization that involved the primary and secondary

influential words included *chiropractic-injury-care*, *injury-sports-care*, *injury-sports-therapy*, *injury-general*, *chiropractic-treatment*, *research-chiropractor-athlete*, *research-good-treatment*, *research-great*, *injury-athlete-performance*, and *chiropractic-treatment-performance*. The top 5 word-pairings of the influence analysis (Table 5) were *chiropractic-care*, *research-good*, *injury-care*, *chiropractic-sports* and *injury-sports*. Other interesting influential word pairings included the pairings *injury-general*, *care-performance*, *athlete-performance* and *care-sports*.

Interpreting both the CRA network visualization and influence analysis collectively, the central focus of the discourse generated from the NS group in response to this question included discussions about the research of chiropractic care of sports injuries related to athletes. The NS group also had discussions about chiropractic care as it relates to athletic performance within the discourse; however, it seemed to be a secondary focus within the word network.

Below are selected excerpts from the discourse generated from the NS group:

> "I would think that we would want to look at something in terms of treatment, looking at the effects of chiropractic care, and if that includes soft tissue therapy and rehab, that we would be able to have a multimodal approach to sports injuries, whether its musculoskeletal or post-op, or however the injuries occurred."

> "Research on the efficacy comparing outcomes to physiotherapy, medication, etc. Also awareness as to whether or not people are aware that chiropractors treat sports injuries and treat them well and effectively. There is a lack of awareness with respect to patients that come in with spinal care that aren't aware that we can also deal with a sprained ankle or twisted knee."

> "I also think it would be exciting to increase quality evidence of performance care. So how seeing chiropractic, aside from anecdotally, can help athletes function through the season, if we can actually see improvements that are maintained in performance, and if we can see preventative care relating to performance care, so by decreasing injuries throughout a season for example, if we can then improve the performance of a team or an individual athlete."

The CRA network visualization for the SS group (Figure 3) revealed that the primary influential words in the network were *sports*, *performance*, *research*, *chiropractic* and *chiropractor*. These words were the most connected nodes within the word network. The main word pairings for the word *sports* were *sports-chiropractic*, *sports-chiropractor*, *sports-performance*, *sports-research*, and *sports-athlete*. The main word pairings with the word *research* were *sports-research* and *research-chiropractic*. The secondary influential words within the network were *care*, *athlete*, *manipulation*, *various*, *trial*, *area*, and *treatment*. As can be seen by the CRA network visualization, many influential network connections were observed with the word *performance*, such as *performance-effect*, *performance-chiropractic-care-athlete*, *performance-chiropractic-manipulation*, and *performance-chiropractic-treatment*. The influence analysis (Table 5) revealed that the word *performance* was the third most influential word identified, and it was paired 6 times within the top 20 influential word pairs with the pairings being *sports-performance*, *performance-chiropractic*, *performance-manipulation*, *performance-care*, *performance-effect*, and *performance-chiropractor*. The position and connectivity of the word *performance* in the CRA network revealed that discussions about performance were a central focus of the SS group's discourse in response to this question. Referring again to the CRA network visualization, there were strong links between the words *sports-chiropractic-care-athlete* within the network. This provides evidence that the discourse arising from the SS group involved discussions about sports chiropractic care of athletes as related to research. The word *manipulation* was a secondary influential word and it has many strong ties within the CRA word network, as can be visualized on the lower left quadrant of the CRA network visualization for the SS group (Figure 3). *Manipulation* was paired with the words *performance-manipulation*, *manipulation-extremity*, *manipulation-tissue*, *manipulation-soft*, *manipulation-spinal*, and *manipulation-effect*. Clearly, the SS group responses involved discussions regarding manipulation. Also of interest, the

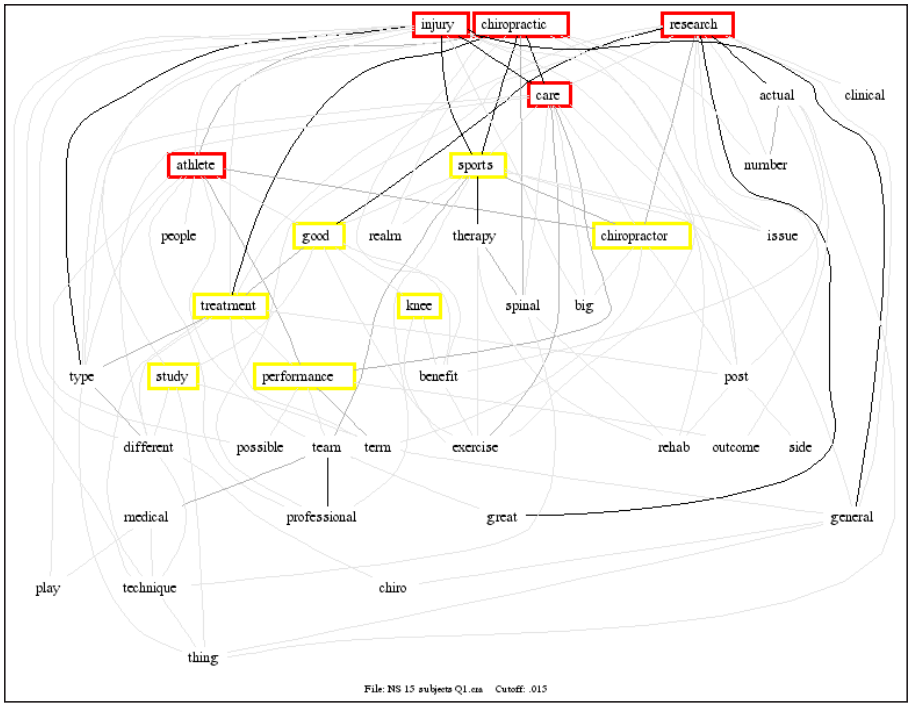

Figure 2.
CRA visualization for question 1, NS group

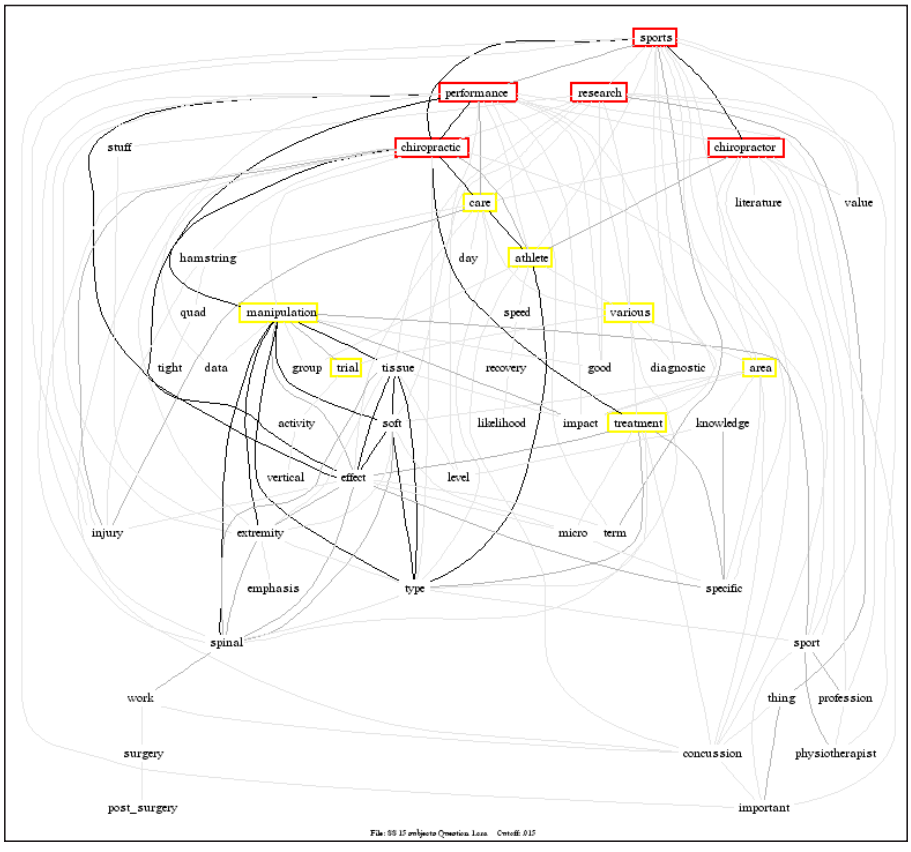

Figure 3.
CRA Visualization for question 1, SS group.

Table 5:
Influence Analysis for Question 1
Question 1: If there were no limitations what type of research would you want to be conducted related to chiropractic and sports health care?

NS Group				SS Group			
Words	**Influence**	**Pairs**	**Influence**	**Words**	**Influence**	**Pairs**	**Influence**
research	0.260	chiropractic | care	0.222	sports	0.166	sports | chiropractic	0.120
chiropractic	0.159	research | good	0.078	research	0.151	sports | chiropractor	0.106
injury	0.158	injury | care	0.066	performance	0.148	tissue | soft	0.052
care	0.140	chiropractic | sports	0.049	chiropractor	0.106	sports | performance	0.049
athlete	0.115	injury | sports	0.049	chiropractic	0.103	performance | chiropractic	0.046
sports	0.078	chiropractic | athlete	0.037	care	0.095	performance | manipulation	0.036
good	0.075	research | care	0.036	athlete	0.081	chiropractic | care	0.029
treatment	0.066	research | chiropractor	0.033	manipulation	0.080	performance | care	0.028
chiropractor	0.063	chiropractic | treatment	0.032	various	0.059	sports | research	0.025
study	0.054	research | actual	0.027	treatment	0.054	care | athlete	0.023
knee	0.052	injury | type	0.022	area	0.053	manipulation | extremity	0.020
performance	0.051	injury | general	0.019	trial	0.050	performance | effect	0.019
post	0.049	research | great	0.018	tissue	0.047	manipulation | tissue	0.019
type	0.047	injury | athlete	0.018	soft	0.044	chiropractor | athlete	0.017
term	0.042	research | treatment	0.017	effect	0.042	chiropractic | athlete	0.017
general	0.040	athlete | chiropractor	0.015	stuff	0.042	chiropractic | treatment	0.017
actual	0.035	care | performance	0.014	extremity	0.041	manipulation | soft	0.017
team	0.033	research | post	0.013	type	0.038	research | chiropractic	0.016
people	0.028	athlete | performance	0.012	good	0.037	performance | chiropractor	0.016
number	0.028	care | sports	0.011	activity	0.035	sports | athlete	0.014

word *effect* had many strong links within the lower left quadrant of the network visualization, and was also an influential word identified from the influence analysis. The word pairings and network connections involving this word included *performance-effect*, *soft-tissue-effect*, *chiropractic-treatment-effect*, and *manipulation-effect*. Some notable tertiary words of the CRA network visualization included *surgery*, *post-surgery*, *concussion*, *hamstring*, and *recovery*.

Taking into account both the CRA network visualization and influence analysis, the SS group's discourse was centered around discussions about research regarding sports chiropractic in the care of athletes, the study of performance as it relates to chiropractic and chiropractic manipulation, and the effects of manipulation and soft tissue therapy. The discussions regarding performance and manipulation were main areas of focus within the discourse. There were also some discussions regarding surgery, post-surgery, concussion, and recovery.

Below are selected excerpts from the SS group's discourse for this question:

> "There are a couple of areas that would be of some benefit. One big one is how chiropractic care benefits performance in an athlete. So being able to show that certain parts of what we do if it's SMT or joint manipulation, soft tissue therapy and how they can transition from treatment from office to performance related marker on the field or in the sport that they do."

> "So we need more research to demonstrate that whether it's some sort of spinal manipulation or extremity manipulation or a soft tissue type approach or even a rehabilitation approach that is effective in actually managing or treating a condition. And then, as an extension on to that, if it is ac-

tually helpful in performance care or performance enhancement."

"Well, certainly I would like to see more research being done on sports performance and that related to either possibly manipulative maneuvers, so manipulation and sport performance, certainly maybe even more data on manipulation, possibly extremity manipulation on range of motion, again more studies regarding soft tissue therapies and their effects on soft tissue responses to soft tissue therapy. We certainly need work being done in concussion treatments as well, possibly cervicogenic headaches or neck pain related to concussion are also important."

"The same thing would go with some of the peripheral joint stuff we do, the extremity manipulation we do as sport chiropractors specifically in the feet, wrist and hand with various types of athletes seeing what the actual mechanism that is occurring as to why it feels better when we do that and relating that back to performance."

"Our biggest limitation in terms of the sports practice is the effect we can have on soft tissue. So research in and around changes say with imaging for example on tendinopathy, tendinosis, small tears, micro tears with either soft tissue by hand or with soft tissue assisted devices and/or more in depth research on tendon repair or ligament repair under load with soft tissue or exercise."

"I would like to see more research into things that are within our scope of practice but including things such as post-surgical work, although we don't do surgery, we manage post-surgical cases."

The cluster analysis revealed that the responses to question one clustered separately between the NS and SS groups. The main differences between the two groups can be seen from the differences outlined in their CRA word networks and influence analyses. The NS group's word network had a primary focus on discussions about research regarding injury care, and they had a secondary focus on discussions related to sports and performance. In contrast, the SS group's CRA word network had a primary focus on the discussion of sports chiropractic and performance, and the effect of manipulation within their word network. Interestingly, the word injury was not identified as an influential word in the SS group's influence analysis. These differences most likely led to the two groups clustering separately for this question.

Question 2: What research relative to sports health care and chiropractic would impact your clinical practice the most?

The CRA network visualization for the NS group (Figure 4) identified the words *research*, *sports*, *thing* and *practice* as primary words in the network. The influence analysis (Table 6) revealed that the word *research* was highly influential within this CRA network, and the influential word pairings with this word included *research-thing*, *research-type*, *research-sports*, *research-care*, *research-chiropractic*, *research-injury*, *research-clinical*, *research-chiropractor*, *research-pattern*, *research-approach*, *research-area*, *research-different*, *research-manipulation* and *research-mobility*. The influential word *thing* was a surprising finding. It was paired with *research-thing* and *thing-practice*. Referring back through the transcribed interviews, the word *thing* was frequently used in speech by the respondents as a pronoun, such as "…things like that would be a huge gain for us from a profession standpoint". The pairings with the word *sports* included *research-sports*, *sports-chiropractic* and *sports-injury*. It was not surprising that the word *practice* was an influential word with network connections, such as *practice-clinical-impact,* since many respondents often answered the question by repeating part of the question back in their response making reference to "…research that would impact my clinical practice". Referring back to the visualization of the CRA word network, secondary influential words included *chiropractic*, *chiropractor*, *injury*, *care* and *type*. Notable connections in the CRA network visualization included *sports-injury-care*, *chiropractic-care-injury-sports*, *sports-professional*, *chiropractic-care-performance*, and *research-effectiveness*. While only identified as tertiary words in this network, there were many network connections between the words *care* and *performance*. Some interesting tertiary words in the CRA network included *adjustment*, *manipulation*, *modality*, *post-surgical*, *soft tissue* and *concussion*.

From both the CRA network visualization and influence analysis, when asked about what type of research would impact their clinical practice, the discourse from the NS group primarily focused on discussions about chiropractic care and sports injury care as it relates to clinical practice. Discussions about chiropractic and injury care related to performance, and research about effectiveness were secondary and tertiary focuses within the discourse. There was some discussion about professional sports and athletes. Some respondents seemed to have discussions about manipulation, mobility, modalities, post-surgical care, soft tissue and concussion.

Below are select passages from the discourse of the NS group:

> "If there was more specific research relative to chiropractic and sports injuries for spine and extremities it could have an impact on clinical practice. Different outcomes or different approaches to care could change clinical practice."

> "Improved diagnostic algorithm for sports injuries would be beneficial as well as more specific treatment protocols."

> "I want to know with specific injuries – I'm looking at tendinosis, I'm looking at mobility issues, I'm looking at post-surgical fracture healing – How do I get the athlete back to performing as quickly as possible and efficiently as possible using chiropractic care."

> "I'd like to see where the evidence shows our full scope of practice of showing joint manipulation and how it could change a throwing pattern, how it can change in SI and hip patterns in a hurdler. Things that I would do when I go out and actually treat in practice. I would want to see that be put into quantitative evaluation because you can see it anecdotally, but there is nothing out there that says it. The only research I would like to see would be looking at the actual practically of it. I would like to see how MSK and joint manipulations can work in a fundamental sports environment."

The CRA network visualization for the SS group is found in Figure 5 and the influence analysis is found in Table 6. The primary influential words identified in this visualization were *research*, *injury*, *athlete*, *treatment* and *patient*. Notable network connections and word pairings utilizing these words were *research-prevention*, *injury-prevention*, *injury-treatment*, *injury-care*, and *athlete-patient-outcome*. Secondary influential words were *orthopedic*, *specific*, *tissue*, *outcome*, *care*, *thing*, *important*, *chiropractic*, *sports*, *clinical* and *practice*. Network connections from the CRA visualization involving these secondary words were *research-specific-outcome*, *treatment-tissue-therapy-soft*, *orthopedic-assessment,* and the links of the word *effectiveness* with the words *treatment* and *research*. Similar to the NS group, the words *clinical* and *practice* were secondary influential words with the connection *clinical-practice-impact,* and reflected the tendency of the respondents to repeat back parts of the question when responding. In terms of the word *orthopedic*, upon reviewing the interview transcripts, respondents referred to the use of the word *orthopedic* in relation to orthopedic surgeons and orthopedic assessment. Amongst the tertiary words identified from the CRA visualization, notable words were *assessment*, *functional*, *conditioning*, *effect* and *effectiveness*.

In response to the question about the type of research that would impact clinical practice, the SS group's discourse tended to focus primarily on research about injury treatment and injury prevention for athletes. The secondary focus from the SS group's discourse involved discussions regarding soft tissue therapy, orthopedics, and specific outcomes. Some respondents discussed assessment, effect and effectiveness.

Selected excerpts from the SS group's discourse for this question are found below:

> "I think that the research that would be most relative to my clinical practice would be more research that demonstrates the effectiveness of the treatment that we have to offer. I've done a number of presentations to CASEM and to different events where say there is orthopedic surgeons in attendance and their suggestion to me is to just be able to provide them research evidence that our intervention is effective for a given sports diagnoses, and that would be what they need to see to increase their referrals."

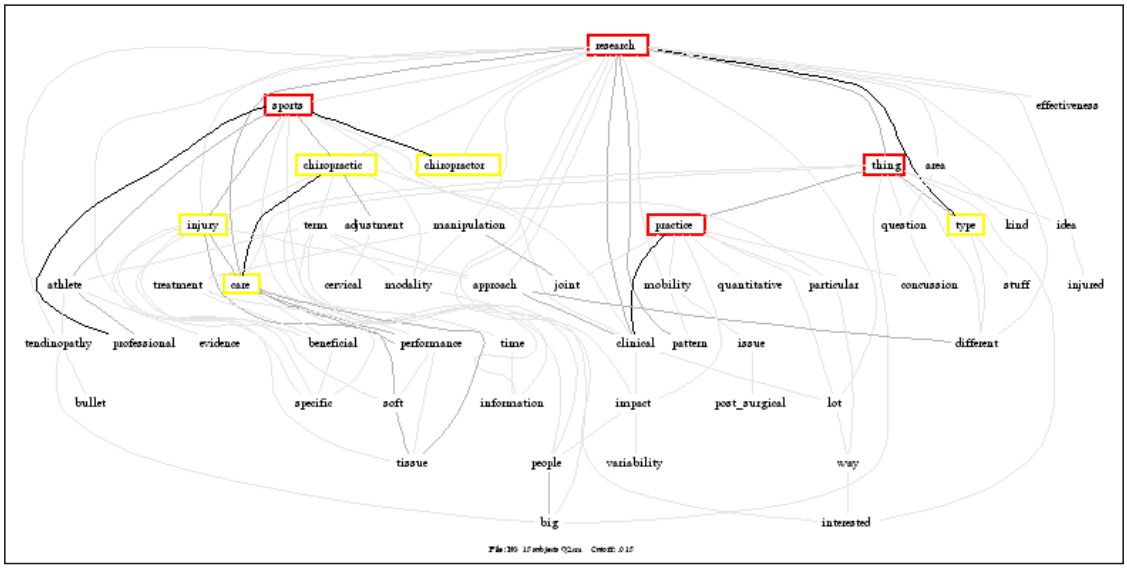

Figure 4.
CRA visualization for question 2, NS group.

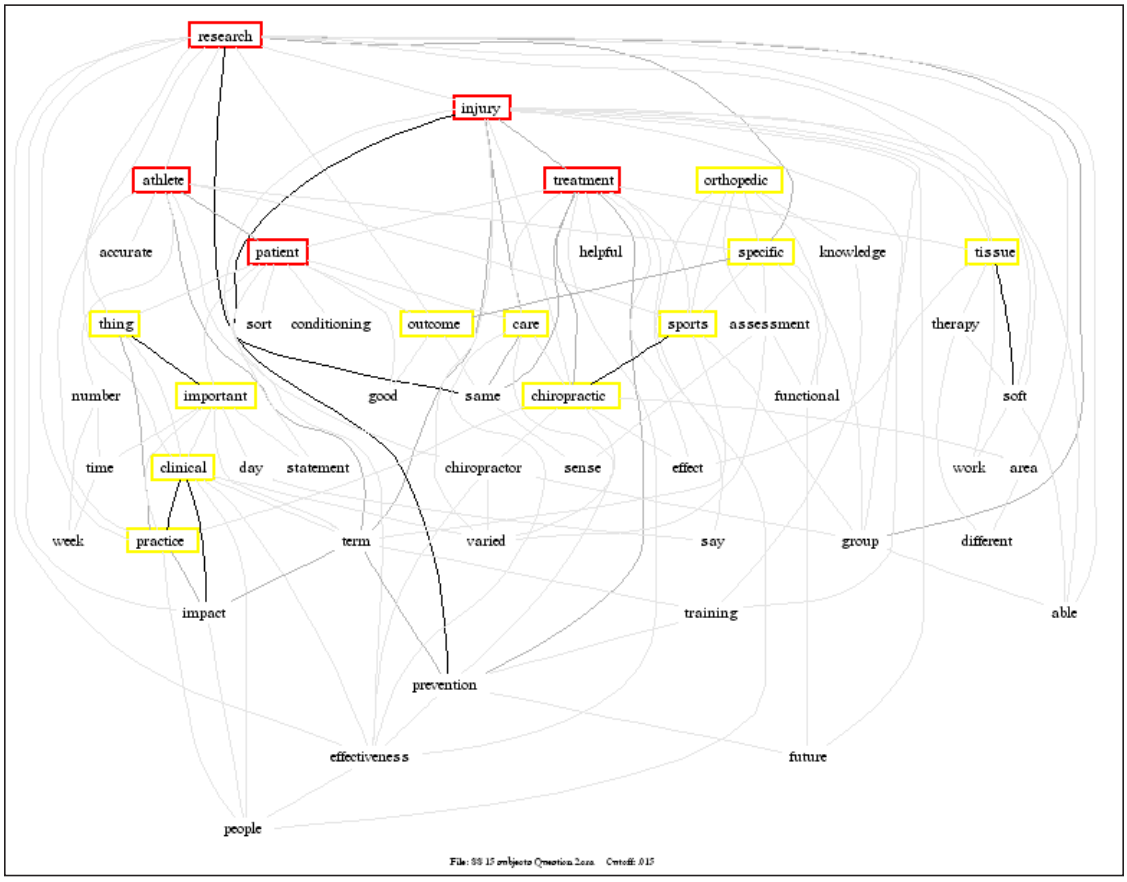

Figure 5.
CRA visualization for question 2, SS group.

Table 6:
Influence Analysis for Question 2
Question 2. What research relative to sports health care and chiropractic would impact your clinical practice the most?

NS Group				SS Group			
Words	**Influence**	**Word Pairs**	**Influence**	**Words**	**Influence**	**Word Pairs**	**Influence**
research	0.411	research | thing	0.118	research	0.210	injury | treatment	0.043
thing	0.143	research | type	0.094	injury	0.157	research | specific	0.035
sports	0.125	research | sports	0.051	treatment	0.136	research | injury	0.033
practice	0.104	research | care	0.049	athlete	0.127	injury | prevention	0.030
chiropractic	0.080	research | chiropractic	0.033	patient	0.103	research | athlete	0.027
injury	0.076	research | injury	0.031	care	0.087	injury | care	0.027
chiropractor	0.068	research | clinical	0.031	orthopedic	0.087	athlete | patient	0.026
care	0.059	thing | practice	0.030	specific	0.083	clinical | practice	0.022
type	0.057	research | chiropractor	0.028	sports	0.069	research | same	0.018
term	0.049	sports | chiropractor	0.026	tissue	0.062	treatment | chiropractic	0.016
approach	0.047	research | pattern	0.022	chiropractic	0.060	Injury | term	0.014
area	0.045	sports | chiropractic	0.020	thing	0.056	treatment | patient	0.014
different	0.044	practice | clinical	0.020	important	0.055	research | tissue	0.013
manipulation	0.044	research | approach	0.019	clinical	0.054	research | thing	0.012
athlete	0.043	sports | injury	0.019	outcome	0.053	treatment | care	0.012
modality	0.042	research | area	0.018	practice	0.051	athlete | term	0.012
mobility	0.041	research | different	0.018	term	0.045	sports | chiropractic	0.012
evidence	0.039	research | manipulation	0.018	knowledge	0.044	research | clinical	0.011
tendinopathy	0.039	research | mobility	0.017	chiropractor	0.042	research | outcome	0.011

"I probably have to say, probably performance, like pre-performance care and injury prevention and effectiveness. So if we can show our effectiveness, then people will seek us out to do treatments. And I guess further research on effective treatments can inform us on what to do in treating patients. That would probably impact my practice the most."

"On the efficacy of chiropractic care in regards to athletic injuries would be the most important. Also, the effects of chiropractic care on performance, specifically, on speed and agility, reaction and prevention of injuries."

"Because I work primarily with shoulders, I think specific research looking at insuring the validities, specificities, sensitivities, positive/negative predictive value of specific functional and orthopedic assessments tools, whether that's things like visually assessing a scapula-humeral rhythm, objective orthopedic tests with labral tears, things like that are important. So being sure that I am being diagnostically accurate when I am treating an athlete. Looking at how is my treatment effecting performance, prevention of injury, treatment of injuries, and prevention of future injuries after they have been injured. So diagnosis, treatment, and prevention."

"Research based on specific interventions to provide specific outcomes. I think at the end of the day that's the most important thing to the patient, and so any sort of high quality trials, so prospective studies, opposed to retrospective or case series, or anything along those lines, but to establish specific defined interventions for specific health outcomes to try and make patients better. I think that's by and large the most important thing to clinical practice specifically."

The cluster analysis revealed that the two groups clustered separately for this question. The CRA word network

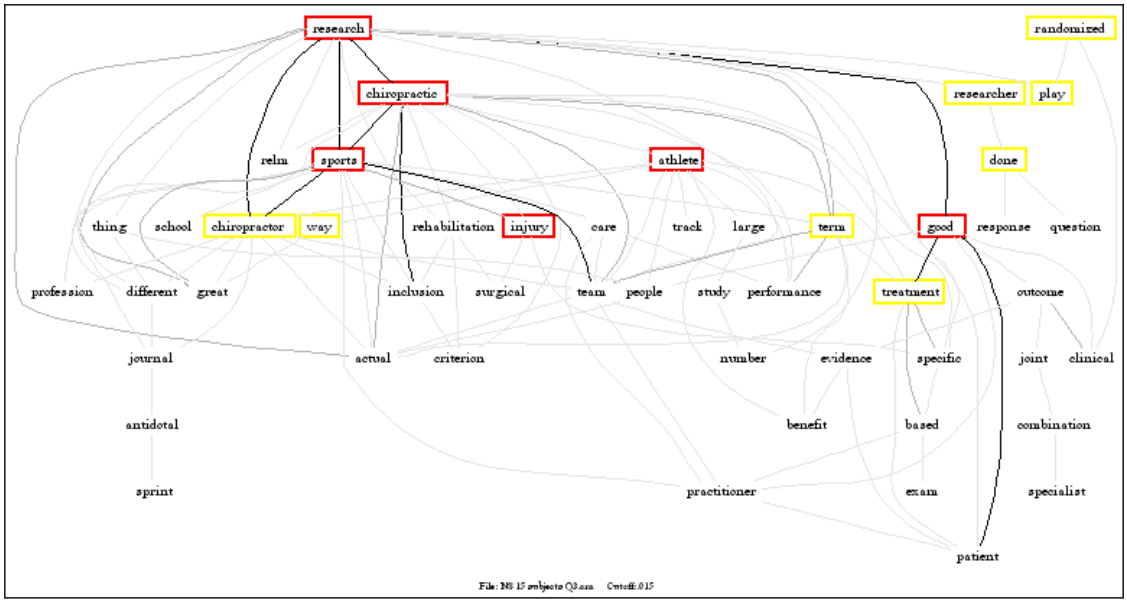

Figure 6.
CRA visualization for question 3, NS group.

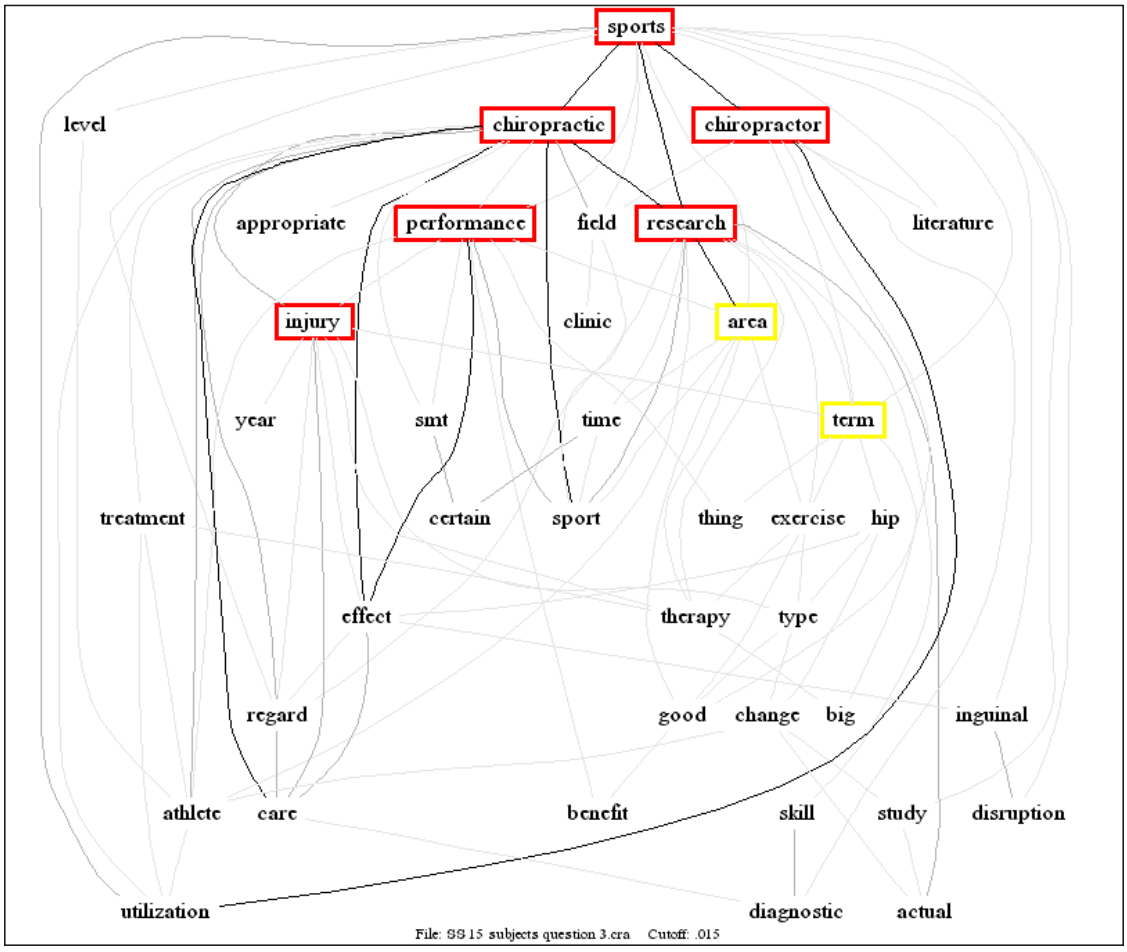

Figure 7.
CRA visualization for question 3, SS group.

Table 7:
Influence Analysis for Question 3
Question 3: Where do you believe most of the research is lacking for sports chiropractic?

NS Group				SS Group			
Words	**Influence**	**Word Pairs**	**Influence**	**Words**	**Influence**	**Word Pairs**	**Influence**
research	0.310	research | sports	0.337	sports	0.289	sports | chiropractic	1.138
chiropractic	0.210	chiropractic | sports	0.327	chiropractic	0.208	sports | chiropractor	0.387
athlete	0.174	research | chiropractic	0.196	research	0.203	sports | research	0.234
sports	0.155	research | good	0.098	performance	0.115	chiropractic | research	0.211
good	0.106	research | chiropractor	0.095	injury	0.108	research | area	0.083
injury	0.103	sports | chiropractor	0.057	chiropractor	0.103	chiropractic | injury	0.045
term	0.074	research | term	0.046	term	0.092	sports | performance	0.033
way	0.063	chiropractic | athlete	0.037	area	0.058	chiropractic | effect	0.032
researcher	0.063	sports | injury	0.032	thing	0.045	sports | term	0.026
chiropractor	0.061	chiropractic | term	0.031	hip	0.044	chiropractic | performance	0.024
randomized	0.055	sports | team	0.031	exercise	0.043	chiropractic | sport	0.023
play	0.052	chiropractic | injury	0.022	level	0.041	research | term	0.019
treatment	0.051	chiropractic | team	0.021	effect	0.038	sports | area	0.017
done	0.050	research | researcher	0.019	time	0.037	performance | effect	0.017
care	0.050	research | play	0.016	literature	0.037	chiropractic | care	0.014
team	0.050	good | treatment	0.016	regard	0.032	chiropractic | regard	0.013
specific	0.049	research | team	0.015	type	0.030	sports | level	0.012
rehabilitation	0.047	research | specific	0.015	field	0.030	chiropractic | field	0.012
based	0.046	research | great	0.015	skill	0.028	performance | injury	0.012

for the NS group focused on research about sports injury care and chiropractic care related to clinical practice. There was a secondary focus of the NS group's discourse related to injury care and performance. The SS group's discourse had a focus on injury treatment, but also had a focus related to research regarding injury prevention, where the NS group's CRA did not reveal any influential discussions about injury prevention. There was also a secondary focus to the SS group's responses on discussions about soft tissue therapy, orthopedics and specific outcomes. These differences in word network structure between groups most likely led to the two groups being classified separately by the cluster analysis.

Question 3: Where do you believe most of the research is lacking for sports chiropractic?

The CRA network visualization (Figure 6) and influence analysis (Table 7) for the NS group revealed that the primary influential words were *research*, *chiropractic*, *sports*, *athlete*, *injury* and *good*. Influential network connections involving the primary influential words included *research-sports-chiropractic*, *research-sports-injury*, *research-chiropractic-inclusion*, *research-chiropractic-athlete*, *research-good-treatment*, *research-sports-team*, and *research-chiropractic-rehabilitation*. The network connections between the primary influential words *research-chiropractic-sports* had strong ties within the network, and this is evidenced by the influence analysis (Table 7) where the top three pairings were *research-sports*, *chiropractic-sports* and *research-chiropractic*. The secondary influential words in the CRA diagram were *chiropractor*, *way*, *term*, *treatment*, *randomized*, *researcher*, *play* and *done*. Network connections that included these words were *research-good-treatment*, and *treatment-specific,* and *randomized-play-research*. Upon reviewing the transcriptions from the NS group, there was some discussion regarding randomized clinical trials involving return to play. The secondary influential word

term was surprising, and upon reviewing the discourse, subjects would use of the word *term* in statements such as "…in terms of performance". Tertiary words that were identified were *rehabilitation*, *surgical*, *performance*, *clinical*, and *outcome*. Notable network connections that included these tertiary words were *research-rehabilitation-surgical*, *sports-care-performance*, and *randomized-clinical-outcome*.

Summarizing the interpretation of the CRA visualization and influence analysis, in response to this question, the discourse from the NS group centered on discussions regarding research about sports chiropractic in the treatment of injury for the athlete. There was some discussion about randomized clinical trial research looking at outcomes about return to play. Some respondents discussed performance care, rehabilitation related to surgery, and research related to chiropractic and teams.

Selected excerpts from the discourse of the NS group for this question included:

> "Specifically to chiropractic management of sports injuries. There's probably not a lot of specific research in that area. There is research on how to treat an ankle sprain, how to treat and rehabilitate an ACL injury, post surgical rehabilitation, all that research is there, but there is not enough research indicating that chiropractors are capable of doing this or applying the appropriate care that is necessary. Without that research out there it doesn't trickle down to the medical practitioners, to the patients, to the general population. The research is there and ongoing but the link that chiropractors are applying it is missing."

> "…so if we know that the natural history of an injury is 4-6 weeks, is the inclusion of sports chiropractic adding some kind of benefit in terms of decreasing the time lost. The actual chiropractic manipulation, does the inclusion of chiropractic manipulation enhance the recovery of a sporting injury?"

> "Difficult to narrow down to one thing, there is lots of research going on in chiropractic but not sports chiropractic. The effect of chiropractic care on preparing athletes pregame, for example. Is there any benefit to treating athletes before a game, after a game or treating athletes at all. Looking at chiropractic as a performance enhancing adjunct to an athlete."

> "So I think over the whole, again, return to play, is a big area, but seeing high quality research in return to play, so randomized trials, even cohort studies would be helpful there. And then, similar with performance based care, so moving out of just sort of I publish what I've done with one athlete, we need to be working on a much larger scale, so that then leads to a lack of funding and a lack of training in terms of how to publish and produce this research."

> "Pre and post surgical. Even if you look at lumbar discectomy or laminectomy there isn't much in the sports chiropractor world. There is some for general chiropractic, but not for sports chiropractic. Sports chiropractic would focus more on soft tissue work and functional rehabilitation. Which is where we don't have much for."

> "In terms of athletic performance, in terms of integration of chiropractic with sports teams. Most chiropractors that work with athletes and teams, there is a lot, but there is a very few that are fully integrated into teams, so if there was research into how chiropractors could be implemented into a team and their role in the team as one of the primary care practitioners on that sports team, if the evidence was there, I think that would help our cause and help us with our chunk of the pie in terms of treatment for athletes specifically. In terms of chiropractic's role in the integration with the sports medical team and with actual teams directly."

Assessing the CRA visualization (Figure 7) and influence analysis (Table 7) for the SS group, the primary influential words identified were *sports*, *chiropractic*, *chiropractor*, *performance*, *research* and *injury*. *Performance* was found to be a highly influential word in this network, and was the fourth highest influential word in the influence analysis. Influential word pairings for this word were

sports-performance, chiropractic-performance, performance-effect and performance-injury. The network connections with the word *performance* included *performance-SMT*, *performance-effect-care*, *sport-performance*, and *performance-benefit*. A strong link within the network existed between the words *effect* and *chiropractic*, with the word *effect* being identified as a top 20 influential word. Another strong connection in the network visualization was between *sports-chiropractor-utilization*.

Summarizing the interpretation of the CRA, the SS group had a word network that was most focused on discussions regarding sports chiropractic research and the effect of chiropractic care on performance. There was also some discussion about sports chiropractic research on injury and utilization of sports chiropractors.

Notable excerpts from the discourse of the SS group included:

> "And really, I think really a little bit more in the treatment of the biomechanics of a patient for injury prevention. So, if you can look at their mechanics separate from what they have came in for. But treatment of mechanics, is that helpful for performance or for prevention?"

> "The effect of manipulation on performance, the effect of chiropractic in general on performance and the effect on speed and reaction."

> "Most concerned with research to say that our skill set can influence, predict, or somehow manage performance or biomechanics and then prevent further injuries."

> "Definitely, manipulation on performance. I think performance is one thing that we don't know either."

> "…obviously there is limited research on pretty much everything we do for athletes including manipulation, soft tissue therapy, so looking at just how does treatment effect natural history, performance and all those same factors I talked about before. I think it is really tough to research this topic."

> "Most lacking in area of performance, because a previous study by Dr. Miners, he surveyed the sports fellows, and we all said we are aiding in performance, but there are no objective measures that we can use to say that if we do X, then the outcome will be Y."

> "If the ultimate goal is to increase utilization of sports chiropractors and inclusion of sports chiropractors, then I think tracking the utilization of athletes of chiropractic treatment, whether it is at a game where it would be easy to do because all the data is there, they keep track of where you are and what sport they are in and how many times they saw a certain practitioner. This could lead to inclusion of more sports organizations and from there you could do other research. Bigger picture to have inclusion would be the most impactful and there is not much of this done."

The cluster analysis revealed that the two groups clustered separately for this question that asked respondents where they felt research was lacking in sports chiropractic research. The NS group's word network revealed a primary focus in the discourse regarding research about sports chiropractic and injury for athletes. There was also a secondary focus regarding randomized clinical trial research investigating return to play. In contrast to the NS group, the SS group's CRA word network revealed a primary and highly centralized focus on discussions about research investigating sports chiropractic and its effect on performance. There was also a focus on discussions about utilization of sports chiropractors. Interestingly, the SS group's word network did not reveal any influential discussions regarding return to play.

Question 4: What type of collaborations would you like to see occur in sports chiropractic research?

The primary influential words identified in the CRA network visualization (Figure 8) and the influence analysis (Table 8) for the NS group were *sports*, *collaboration*, *chiropractor*, *good*, *thing* and *people*. The secondary influential words were *research*, *physiotherapist*, *chiropractic*, *patient*, *able* and *area*. Analyzing the network visualization, the strong links between the primary and secondary influential words *sports-chiropractor-collaboration-physiotherapist* was central to the word network.

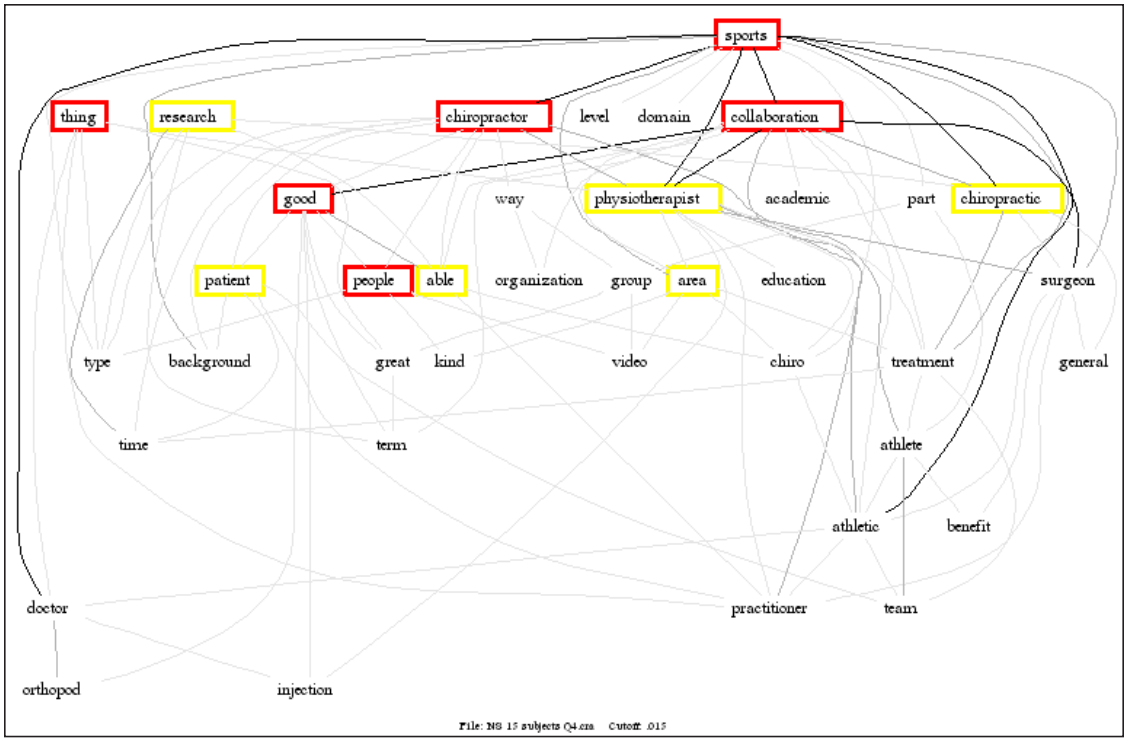

Figure 8.
CRA visualization for question 4, NS group.

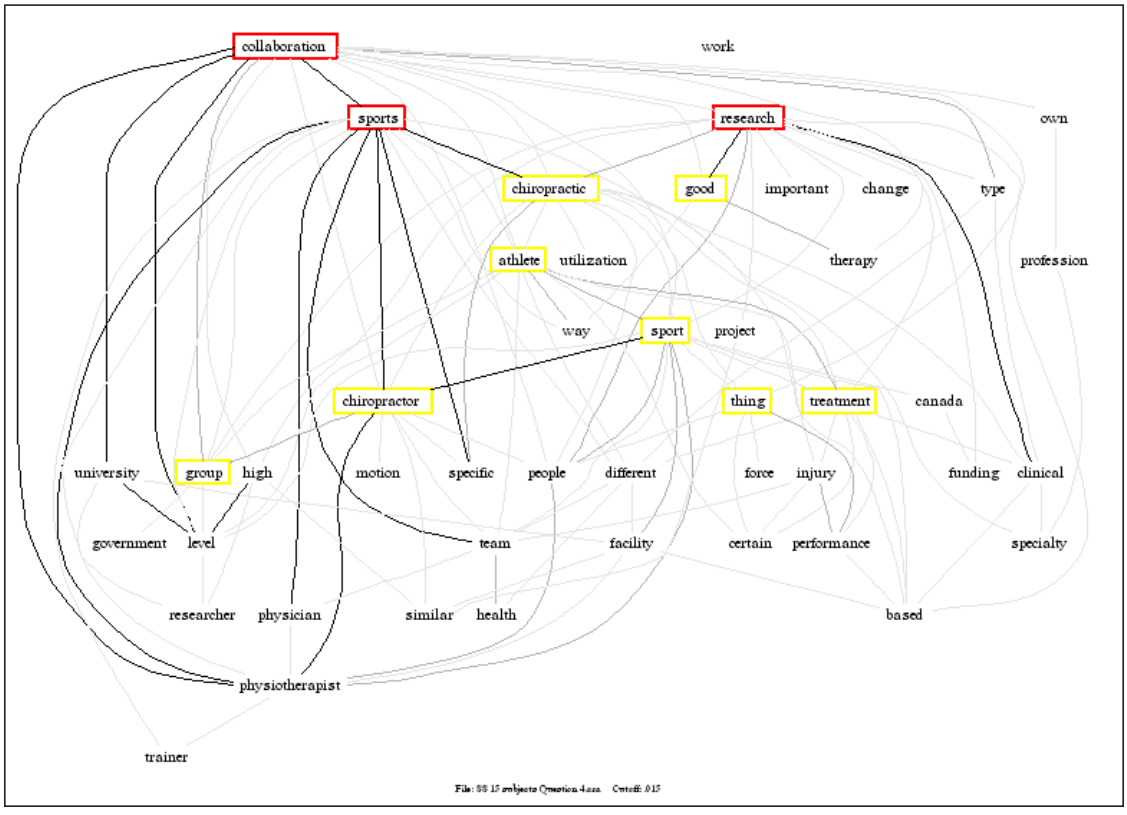

Figure 9.
CRA visualization for question 4, SS group.

Table 8:
Influence Analysis for Question 4
Question 4: What type of collaborations would you like to see occur in sports chiropractic research?

NS Group				SS Group			
Words	**Influence**	**Word Pairs**	**Influence**	**Words**	**Influence**	**Word Pairs**	**Influence**
sports	0.260	sports | chiropractor	0.231	collaboration	0.209	collaboration | sports	0.104
collaboration	0.166	sports | collaboration	0.216	research	0.197	sports | chiropractic	0.098
chiropractor	0.127	sports | chiropractic	0.099	sports	0.166	sports | chiropractor	0.098
good	0.110	sports | physiotherapist	0.075	chiropractic	0.098	collaboration | research	0.041
thing	0.106	collaboration | good	0.055	athlete	0.079	research | chiropractic	0.039
people	0.101	collaboration | physiotherapist	0.048	sport	0.075	research | good	0.032
physiotherapist	0.096	sports | area	0.031	chiropractor	0.066	sports | physician	0.029
research	0.083	collaboration | surgeon	0.029	treatment	0.059	sport | chiropractor	0.025
chiropractic	0.064	sports | treatment	0.025	thing	0.057	collaboration | university	0.024
able	0.062	sports | athletic	0.025	good	0.053	collaboration | group	0.021
area	0.060	chiropractor | physiotherapist	0.025	group	0.050	collaboration | chiropractic	0.020
patient	0.051	sports | surgeon	0.023	injury	0.046	collaboration | type	0.018
treatment	0.048	sports | doctor	0.022	type	0.042	collaboration | athlete	0.017
surgeon	0.044	collaboration | chiropractic	0.021	people	0.040	collaboration | level	0.017
level	0.042	sports | background	0.016	university	0.038	sports | team	0.017
type	0.041	chiropractor | good	0.014	different	0.035	collaboration | sport	0.016
kind	0.039	good | able	0.014	team	0.035	research | people	0.016
chiro	0.037	chiropractor | people	0.013	physician	0.034	research | sport	0.015
part	0.034	sports | level	0.011	therapy	0.031	sports | physiotherapist	0.015

In fact, the word *physiotherapist* was a secondary influential word and the influence analysis identified the word pairs *sports-physiotherapist*, *collaboration-physiotherapist*, and *chiropractor-physiotherapist* within the top 20 influential pairs. Other strong ties within the network visualization were *sports-surgeon*, and *sports-doctor-orthopod*. The influence analysis identified *surgeon* as a top 20 influential word and the word pairs *collaboration-surgeon* and *sports-doctor* were identified as a top 20 influential word. The primary influential word *collaboration* also had a strong tie to the tertiary word *athletic*. When cross-examining the word *athletic* with the NS group's discourse, the NS group regularly referred to collaborations with athletic trainers. The word *good* was central to the network, and it was paired with words such as *collaboration*. When analyzing tertiary words identified in the network visualization, the words *organization* and *academic* had connections to the word *collaboration*.

Summarizing the findings of the CRA for the NS group, in response to the question regarding research collaborations in sports chiropractic, the NS group's discourse centered around discussions about collaborations with physiotherapists, sports doctors, sports surgeons, and athletic trainers. There were also discussions about collaborations with organizations and academics. The group also thought that these collaborations were likely good things for sports chiropractic.

Notable excerpts from the discourse of the NS group included:

> "More collaboration with not only physiotherapists, but also with orthopedic surgeons perhaps, and trying to see if some of the techniques that we use or are taught, [they] see their benefits, and particularly with surgeons."

> "Pretty much all of them, MD with chiro, PhD in a certain area of sports injury and chiro, definitely adding in multiple disciplines, so having athletic therapists, physiotherapists, kinesiologists, and chiros work together to develop a plan to increase the effectiveness of the sports treatment."

"More collaboration with orthopedic surgeons and sports medical doctors. Chiropractors still have a ways to go with getting into those groups."

"Sport doctors and orthopods would be a good collaboration."

"Collaborations with orthopedic surgeons, medical practitioners, athletic therapists, and physiotherapists. General awareness across those populations that chiropractors are an integral part of treating sports injuries."

"I think this is a push in general with chiropractic research, is that integrated model, with working alongside physiotherapists, sports medicine doctors, strength and conditioning coaches. I think it needs to be there, it's there to a point, but you typically see the chiropractor on the side, they aren't officially with the team. You know, the more we can collaborate with other providers, the better feel they get for what we can do and what our scope can be, and what benefits we can add to an athlete and to an athletic team."

"I would probably think and love it to take place from a range of grass roots all the way to pros, with the formal collaborations with those respective governing organizations. Let's say for example, if it's hockey it could be done with a major hockey organization, let's say if it's inside of minor hockey, you can build the roads to kind of do something at a GTHL level, right across a major-minor organization, right through all the way up."

"On the academic side, seeing more sports chiropractors that are integrated into the university setting, whether its teaching courses in athletic care, or into the actual athletic sports care models that are in universities as well. Adding a bit to the academic collaboration as well too, in terms of research and being recognized as part of kinesiology programs or physical education programs."

"I think that the collaboration needs to be done at major recognized universities. It's hard to publish and do things without that backdrop, but absolutely there are the people that are in place now that have the academic swag and the resume that is bullet proof. But really in the spine and at an occupational level. Not in the sports realm. So there is no one that is really sport based."

The CRA visualization (Figure 9) and influence analysis (Table 8) of the SS group's responses revealed that the primary influential words were *collaboration*, *sports* and *research*. Upon visualizing the CRA diagram, strong ties within the word network exist between the words *collaboration-sports-physician*, *collaboration-sports-team*, *collaboration-university-researcher*, *collaboration-physiotherapist*, and *collaboration-level-high*. The influence analysis of the top 20 influential word pairs identified the word pairs *sports-physician*, *collaboration-university*, *collaboration-athlete*, and *sports-physiotherapist*. Other interesting network connections involving secondary and tertiary words included *sport-canada-funding* and *research-funding*. The word *trainer* was identified as a tertiary word in the CRA network diagram, and when scanning the transcriptions from the interview responses, its use was often related to the term athletic trainer. In summary, the discourse analyzed from the SS group's responses revealed that it focused on discussions about collaborations with sports physicians, teams, university researchers, physiotherapists and athletic trainers. There were also some discussions about research funding related to sport in Canada and discussions about the government.

Selected excerpts from the interview responses from the SS group included:

"Universities, I think we need full time researchers. We need to partner with full time academic researchers to get some grants and run some research, so we definitely need that. I think we also need to collaborate with sports physicians, anyone in that care team. I think collaborative research is probably the best way to go."

"I'd like to see more collaboration at the university level, with sports chiropractors."

"PhD, chiropractors, physiotherapist, medical doc-

tors, and a facility such as a University to oversee everything.

"More collaboration with physiotherapists, because those are the people we are sharing the same ground with."

"I think more collaboration with larger sport-based facilities, similar to what they have done in baseball down in St. Andrews in the states where they have a huge orthopedic facility where they have orthopedic surgeons, sports medical doctors, physiotherapists, PhD's all assessing all of the factors such as performance, treatment, prevention and diagnosis."

"An additional thing would be looking to get Sport Canada funding for research. They are the funding agency for anything sports in Canada, and it's usually disseminated within various pre-arranged funding mechanisms, such as say an NSO, or an association, that's perhaps the Ontario Soccer Association or the Canadian Soccer Association. But I don't see a whole lot of collaboration between sport chiropractors working with funding from groups like that. Funding is available for research projects."

In response to this question regarding research collaborations, both study groups clustered similarly, providing evidence that the word networks of interview responses for both groups were similar. The CRA visualizations and influence analyses revealed that the discourse from both groups centered on research collaborations with physiotherapists, sports physicians, university and/or academic researchers, athletes, and teams. The similarity of the word network structures of both groups provided some evidence that both groups had similar discourse when asked about research collaborations in sports chiropractic.

Discussion

A main finding in this study was that the cluster analysis revealed the NS and SS groups differed in their responses to questions one, two and three; but had similar responses to question four. Question one asked respondents about the type of research they would like to see conducted in sports chiropractic. In response to this question, the NS group had a primary focus on discussions about research related to chiropractic care of sports injuries, and had a secondary focus on chiropractic care as it relates to sports performance. The SS group's responses were primarily centered on discussions about the effect of sports chiropractic, manipulation, and soft tissue on performance. In response to question two that queried the type of research participants thought would impact their clinical practice the most, the NS group primarily discussed research about chiropractic care and sports injury care as it related to clinical practice. In contrast, the SS group was more focused on discussions about injury treatment and injury prevention for athletes. When responding to question three that asked respondents where they believed research was lacking with respect to chiropractic research in sports health care, the NS group's discussion centered on sports chiropractic in the treatment of athletic injuries, while the SS group was predominantly focused on the effect of sports chiropractic care on performance. However, when analyzing the group responses for question four that asked participants about what type of research collaborations they would like to see occur in sports chiropractic research, both groups were similar in their discourse identifying collaborations with physiotherapists, sports physicians, universities, academic researchers, athletes and teams to be important collaborations.

The ability of CRA to analyze interview responses by creating word networks of transcribed interview data provided insight into the differences in the discourse generated from both groups when asked about their opinions regarding research priorities. While the NS and SS groups clustered separately for questions one to three, there were some similarities between both groups in their discourse. The SS group had a primary focus on the effect of sports chiropractic on performance for both questions one and three. While primarily centered on discussions about chiropractic care of sports injuries, the NS group did have some discourse regarding the topic of chiropractic care and performance; however, their discussions on this topic had a secondary or tertiary focus within their word networks. Since CRA models discourse based on the network relationships of words within noun phrases, the secondary and tertiary focus on performance within the NS group meant that the frequency of occurrence of the word *performance* and its co-occurrence with other influential

words was much less prominent than in the SS group's discussions. As a result of these differences between practitioner groups, a future study seeking to obtain consensus from experts to define a research agenda for sports chiropractic should recruit experts from both practitioner groups to ensure that the opinions from both stakeholder groups are adequately represented.

A potential confounder that may contribute to the contrast of opinions between study groups could be the baseline difference between study groups in the number of individuals with formal research experience (100% for the SS group versus 13% for the NS group), as defined as previous participation in a Master's, PhD or chiropractic residency program. It is not surprising that 100% of the SS group had previous formal research experience, as completion of a chiropractic sports sciences residency is a requirement to obtain a chiropractic sports specialty designation in Canada. A disparity in research experience can potentially lead to differences in the ability to judge the practicality and methodology of research, which can potentially contribute to the difference in opinions between groups regarding research priorities. It is also possible that the differences in opinions between these two groups could be related to the possible contrasting practice styles and clienteles that may exist between the two practitioner types. In efforts to minimize the effect of these confounders, we attempted to recruit participants into the study who had similar sport-focused clinical practices by only including practitioners who self-reportedly manage a minimum of ten sports-related cases per week in clinical practice. Despite our intent to recruit practitioners with similar sport-focused clinical practices, it is still possible that there exist differences in practice styles and/or clientele between study groups. The language attained by the SS group, by virtue of their sports specialty training, could also contribute to the differences in discourse between the two study groups. While this is certainly a possibility, the CRA networks from the SS group did not reveal any specific language that the authors judged to be interpreted as being noticeably distinct from the vocabularies of non-sport specialty designation chiropractors. Future research investigating the practice styles, clientele and language used between both practitioner types could provide more insight into the impact of these confounders to the present study's results.

To date, there is limited research on the opinions of sports clinical practice chiropractors. Miners *et al*.[19] surveyed fellows from the College of Chiropractic Sports Sciences (Canada) to investigate their opinions on intervention practices and intended therapeutic outcomes when treating athletes. The authors found that 73% of respondents stated that they treat asymptomatic athletes with the specific goal of enhancing sport performance. Moreover, a "chiropractic treatment", as defined by the respondents, would most commonly include some combination of spinal or extremity manipulation/mobilization, specific soft tissue therapy, and exercise/rehabilitation/sports specific training prescription. The most anticipated outcomes following the treatment of athletes reported in this survey study was the goal of affecting athletic performance. The results of our present study, that identified the effect of chiropractic treatment on performance as a primary focus of the SS group's discourse, is consistent with the previous work from Miners *et al*.[19] Investigating the effect of therapeutic interventions on sport performance can often be challenging due to the potential small effect sizes and ceiling effects that can be encountered when studying a highly skilled population. Future work in this area should investigate methodological approaches to study the effect of chiropractic treatment on sport performance.

The present study is unique in that it is the first to utilize CRA to investigate practitioner opinions regarding research priorities. CRA allowed us to analyze the interview responses as a group of pooled responses, and permitted a quantitative comparison of the discourse generated from both groups based on the similarity and structure of their word networks. By modelling discourse as word networks, CRA provided an objective overview of the most influential discourse that occurred within each group. The visualization of the CRA networks and influence analyses assisted in objectively assigning a measure of importance to identify key areas of discussion identified within the discourse.

While CRA has its advantages, it is not without its limitations. CRA constructs word networks using noun phrases, which is defined as a noun plus zero or more additional nouns and/or adjectives. This methodology identifies the subject or object of a sentence, and the subsequent network constructed of these words represent the text's main content. As a result, CRA intentionally excludes verb phrases, which are the "action" compon-

ents linking different noun phrases.[24] Given the aim of the present study was to identify practitioner "opinions", which is a noun, our use of CRA is justified. Despite this rationale, it is still possible that the verb phrases within the interview responses may impart some useful information. By modelling text as a network of noun phrases, CRA provides an objective overview of the key areas of focus that occurs within the text. However, it should be noted that it does not provide a detailed account of all areas of focus within a text. This is especially true if certain areas of a text are determined to be minor contributors in creating coherence within the text by the computational linguistics methods deployed by CRA. Also, while it objectively identifies influential words and their connections, the end user is still required to make some form of subjective interpretation of the CRA network visualization and linkages of the words identified. Furthermore, certain artifacts of speech, such as the use of pronouns to refer to subjects and objects of sentences, may affect how discourse is indexed in CRA. This was evidenced by the surprising finding of the words "thing" and "term" being identified as influential words in our analysis. Moreover, discourse often can contain secondary or hidden meanings, such as the use of metaphors. Quantitative text analysis systems may not be sensitive enough to identify all of the subtleties within language that convey meaning, and in such cases, a human may be required to interpret these hidden meanings. Given these limitations, it should be reinforced that CRA should not be viewed as a substitute for a thematic analysis.

Another method that could be used to investigate practitioner opinions is grounded theory. While there have been criticisms that researcher bias is still present in this qualitative methodology, grounded theory does have its advantages. It can provide an in depth analysis of all aspects of the discourse collected; a researcher can identify all themes that are judged to have occurred within the discourse – no matter how small or insignificant they may be; and since humans are interpreting the responses, secondary or hidden meanings of the discourse may be better interpreted. Future investigations could apply a grounded theory approach to exploring practitioner opinions about research directives for the field of sports chiropractic. In fact, little is known about the differences between quantitative text analysis and grounded theory approaches. Future research could analyze the same dataset using both methods, and systematically compare the output from both approaches. Another limitation of the present study includes the use of convenience and snowball sampling from a defined geographical region. Consequently, our results may not be generalizable to other practitioner populations from different locations. Future work can consider expanding this study to larger and more diverse populations using random sampling.

Reflecting on our experience applying CRA to our present study, we found the cluster analysis conducted on the CRA word networks useful in answering our primary research question that sought to determine if differences existed in the discourse between sports clinical practice chiropractors with their sports fellowship and those without when asked about their opinions about research priorities. Considering CRA's methods do not identify all areas of focus within a text, our use of CRA to explore the discourse was likely not as detailed as if we had conducted a thematic analysis. However, CRA provided an objective method for identifying important areas of focus within the discourse analyzed. In our opinion, the decision to utilize CRA to analyze data should reside in the researcher's judgement of whether the method can adequately answer the precise research question under investigation while balancing the method's limitations. As a result of our experience, we believe that this method may be useful if used in conjunction with a thematic analysis in the opinion gathering phase of a future Delphi study aimed at defining a research agenda for sports chiropractic in Canada.

Conclusion

CRA revealed that sports clinical practice chiropractors with their sports specialty designation and those without, differed in their opinions about chiropractic research priorities in sports health care pertaining to the type of research that they would like to see conducted, the research that would impact their clinical practice the most, and where they believed research was lacking. Interestingly, both groups of practitioners were similar in their opinions about the type of research collaborations they would like to see occur. These results suggest that it may be important to recruit experts from both of these sport practitioner groups in future Delphi studies aimed at developing research agendas for chiropractic research in sport.

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