Recent Themes for Christians in Science Journals: A Centering Resonance Analysis

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This paper identifies the main themes discussed from 2011 to 2015 by the articles published in Perspectives on Science and Christian Faith (PSCF) *and* Science and Christian Belief (S&CB). *Centering Resonance Analysis (CRA) was used to analyze the content of the 113 abstracts. The resulting word networks were agglomerated in twenty groups of articles by Hierarchical Clustering Analysis (HCA). Each discursive cluster was then characterized and its main theme labeled in terms of its most important words. The thematic emphasis of each journal and their combined publishing trends over time were identified. Suggestions of other possible contributions from text analytics are pointed out, as an encouragement to further technical work in this field. Thus, this paper contributes both as an introductory resource for the recent academic discourse on science and Christian faith, and as a starting point to an informed discussion about the future of this evolving research area.*

In most fields of study, periodic bibliometric analysis is conducted to update the state of knowledge in the area and identify its trends. This kind of analytical study is helpful to give an overview of research directions in a way that would be otherwise difficult to do—that is, without computer assistance. Therefore, quantitative literature analysis adds value to more in-depth qualitative bibliographical reviews and helps researchers position themselves in the field and identify knowledge gaps.[1]

Nevertheless, in the "science and faith" (sci/faith) field of study, there seem to be no computer-assisted analytical reviews. Indeed, there is a lack of literature review articles in general in this area. Most of the state-of-the-field overviews are published in textbooks and are usually quickly outdated because of the constant publication of new relevant articles in specialized journals. This is especially true for the dialogue between science and Christian faith. We could not find a single sci/faith literature overview article in any of the two main journals of Christians in science associations: *Perspectives on Science and Christian Faith (PSCF)* of the American Scientific Affiliation (ASA) and *Science and Christian Belief (S&CB)* of Christians in Science UK (CiS).

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Thus, this article aims to address this gap, by presenting an initial bibliometric study of the article abstracts recently published in these two journals. We hope to provide a preliminary picture of the contemporary Christian sci/faith academic dialogue as an encouragement for newcomers and for others interested in mapping the state of this research area—and its main trends. Therefore, in what follows, we present the data, analytical procedures, and results of this initial attempt to depict recent discursive clusters for Christians in science journals.

Data

We analyzed the abstracts of the 113 articles published in *PSCF* and *S&CB* from 2011 to 2015. We have focused the analysis on abstracts, since they are supposed to competently present a summary of the content of the paper and its highlights. Moreover, it would be unfeasible to include the complete papers due to the time required to manually preprocess the texts in order to appropriately analyze them using the analysis method that was chosen.

We did not analyze any document type other than "article." Editorials and letters to the editors were excluded since they tend to replicate content highlights from the corresponding articles. Correspondences (or debates) do the same, repeating each other—and, thus, could duplicate content importance in the analysis. Book reviews represent content that is external to the journal's own research.

PSCF and *S&CB* were selected because we were interested in peer-reviewed academic journals specifically focused on the relation between Christian faith and the sciences. Therefore, we did not include journals that relate science and religion in general, or that include faiths and beliefs other than Christianity, as for example, *Zygon* and *Theology and Science*.

We chose the five-year time span from 2011 to 2015 because, by the time of data collection (mid-2016), it corresponded both to the "recent issues" of the *PSCF* homepage and to the "subscribers only" *S&CB* content. During this period, *PSCF* published quarterly with an average of 4.05 articles per issue, while *S&CB* published semi-annually with 3.20 articles per issue. The result was 81 *PSCF* and 32 *S&CB* article abstracts in our database. Extending the time span further into the past would have compromised our emphasis on "recent" themes and would have added more texts—it would have been impracticable to manually preprocess these in a timely fashion.

Analysis

Centering Resonance Analysis (CRA) was used to analyze the data. CRA is an innovative text analysis method[2] based on Centering Theory.[3] This prominent linguistic theory posits that discourse coherence is built through the connection of "centers," which are taken to be the utterances' subjects and objects that have either a forward or a backward referent in the text. According to this perspective, only noun phrases (i.e., nouns and their qualifiers, such as adjectives) are unambiguous enough to enable this weaving of meaning in a discourse. In contrast, verb phrases are context dependent and, thus, are ambiguous semantic elements.

This theoretical background provides CRA with the operational rules used to select conceptually relevant words from a text and link them in a theoretically informed way. Specifically, the technique's algorithm first selects the noun phrases of a text; next it connects all the words pertaining to each noun phrase; and then it connects the last word of a noun phrase with the first word of the subsequent noun phrase. For example, "this sentence shown between double quotes would result in the following connections": sentence–double–quotes–following–connections, and the noun phrase "science and Christian faith," would result in a triangle of undirected connections: science–Christian, science–faith, and Christian–faith.[4] The underlying premise is that this method of linking words reflects the coherence-oriented centering process done (consciously or unconsciously) by the speaker or writer.

Moreover, recurring words are merged into a single network node that inherits all the word's connections. For example, if we analyzed the previous sentence, we would receive the following results: a single node labeled "word"[5] would be connected to "recurring" (same noun phrase of its first occurrence), to "single" (first word of the next noun phrase), to "node" (last word of the noun phrase that precedes its second occurrence), and to "connections" (same noun phrase of its second occurrence). Hence, different from other content analysis procedures, the construction of word networks is not restricted by typical software limitations (e.g., size of the software window used to analyze each excerpt

of the text) or subjective choices of words and links. On the contrary, given an input text, the Natural Language Processing (NLP) extension of the *visone* network analysis software creates the word network, using the embedded CRA theoretical rules and the Stanford Lexicalized Parser,[6] and automatically identifies the noun phrases of each sentence.

However, as the parser is stochastic in its semantic classification of each term in a sentence, it can make mistakes. Therefore, the process is not completely automated, since various kinds of text preprocessing procedures may be needed for the parser to be able to correct its initial misunderstandings. Pronoun disambiguation (e.g., "we" may correspond to "biologists" in an abstract) and plural stemming (e.g., "biologists" could be changed to "biologist," in order to merge both its singular and plural forms) are examples of common preprocessing requirements.[7] These examples illustrate the fact that, although there is computer assistance to execute the procedures, human interpretation and choice are fundamental parts of the analysis and, more clearly, of the inferences drawn from the results.

Nevertheless, the most distinctive feature of CRA is that word importance is measured, not simply as word occurrence, but as word "betweenness"—that is, the discursive coherence-building power of each word in a word network context.[8] In other words, "betweenness" indicates the importance of a word in connecting each pair of words in a word network and, thus, it is a measure of the centrality of a word in the flux of meaning of a discourse. As occurrence is not necessarily highly correlated to importance, CRA corrects the main problem of earlier frequency-based content analysis procedures. It enables the researcher to identify truly influential terms in a text, based on a consistent discourse coherence theory. Therefore, it provides a more precise depiction of the text message by showing the discursive connections between the most important words chosen by the speaker or writer.

Since these networks of words are constructed for the texts of interest, they can be compared for their "resonance." Resonance is an index of text similarity, calculated as a (standardized) sum of the product of the influences of each word that co-occurs in different texts.[9] So, for instance, two texts that share many influential words will have a high resonance, indicating their similarity. On the other hand, texts that do not share the occurrence of many words (or that share the occurrence of mostly non-influential words) will have a low resonance and, thus, will be considered relatively dissimilar. Therefore, CRA's resonance index compares not only lists of words but also networks of words, by considering their relative influence. As such, it is a true innovation in relation to previous content analysis comparative methods.

Using this methodological framework, we analyzed all of the 113 abstracts separately. We first preprocessed each text so that the software could correctly transform them into CRA networks. Then, we calculated word influence for each word in each text, and text resonances between every pair of texts. Based on the resonance matrix between texts, we conducted an agglomerative Hierarchical Clustering Analysis (HCA)—using the Ward method and MiniTab software—to identify the main clusters of articles in the resultant dendrogram. This well-established statistical technique automatically analyzes a similarity matrix in order to calculate a measure of relative distance between the observations. Based on these distances, it can progressively (i.e., step-by-step) cluster observations, seeking a clustering solution that will render the final clusters as internally homogeneous, and as externally heterogeneous, as possible.

Having identified these groups of abstracts, we generated a word network for each discursive cluster, congregating all the texts of the corresponding group. From interpreting these networks, we derived the label and description of the theme that seemed to characterize each cluster. A final visual analysis was conducted by depicting a bubble plot to represent the number of articles published per journal, per theme, and per semester. Based on this integrated chart, some observations were made for thematic concentration differences among the journals and theme publication trends over time.

Results

The result obtained from the HCA of the resonances between the abstracts is depicted in figure 1. This standard dendrogram format shows a vertical black line for each of the 113 observations (i.e., abstracts) and a horizontal black line for each clustering step, traced at the Euclidian resonance-based distance calculated between the respective clustered observations (i.e., the two corresponding vertical lines).

For instance, the first two abstracts (represented by the two vertical lines more to the left in fig. 1) were clustered at approximately 0.7, while this cluster was itself clustered with the four subsequent abstracts at approximately 0.9 (see dotted lines in fig. 1). Thus, the lower the horizontal line, the higher the internal homogeneity ("similarity") of the corresponding cluster; the higher the horizontal line, the more heterogeneous the clustered abstracts.

Using two distinct and statistically validated quantitative indexes for supporting the decision on which cutting-off level of the clustering procedure to use (i.e., the Cindex and Silhouette criteria[10]), we decided to stop clustering at approximately the 1.1 distance level, since both criteria recommended 20 clusters as the optimal balance between internal cluster homogeneity and total number of clusters. These clusters are represented by the 20 red boxes in figure 1. This unusually large number of clusters points to the fact that these journals publish a very broad scope of heterogeneous thematic discourses, as could be expected, since they include researchers with diverse interests in Christianity and science.

Each of these discursive clusters was thematically labeled based on its respective aggregate word network (fig. 2) and abstracts. As the legend of figure 2 implies, a word that appeared in all abstracts of the cluster was positioned in the very center of the corresponding concentric circles (e.g., "animal"). Conversely, a word that occurred in only one abstract of the cluster was positioned in the outer circle of the graph. However, as previously noted, a frequent word may not be influential in building the text's discourse coherence. Therefore, the aggregate word influence of a word in a cluster was represented by its label size. For instance, "animal" was the most influential word (i.e., biggest label) of the bottom cluster in figure 2. Nevertheless, a word may have been very influential in some abstracts, but not in others. Thus, the node area represented this influence's standard deviation in such a way that, for two equally influential words, the one with the smallest node area would be the most consistently influential among them. Moreover, some words may be highly and consistently influential, but too generic—in the sense of being influential in many different clusters (i.e., not a cluster-specific topic). Hence, the lighter

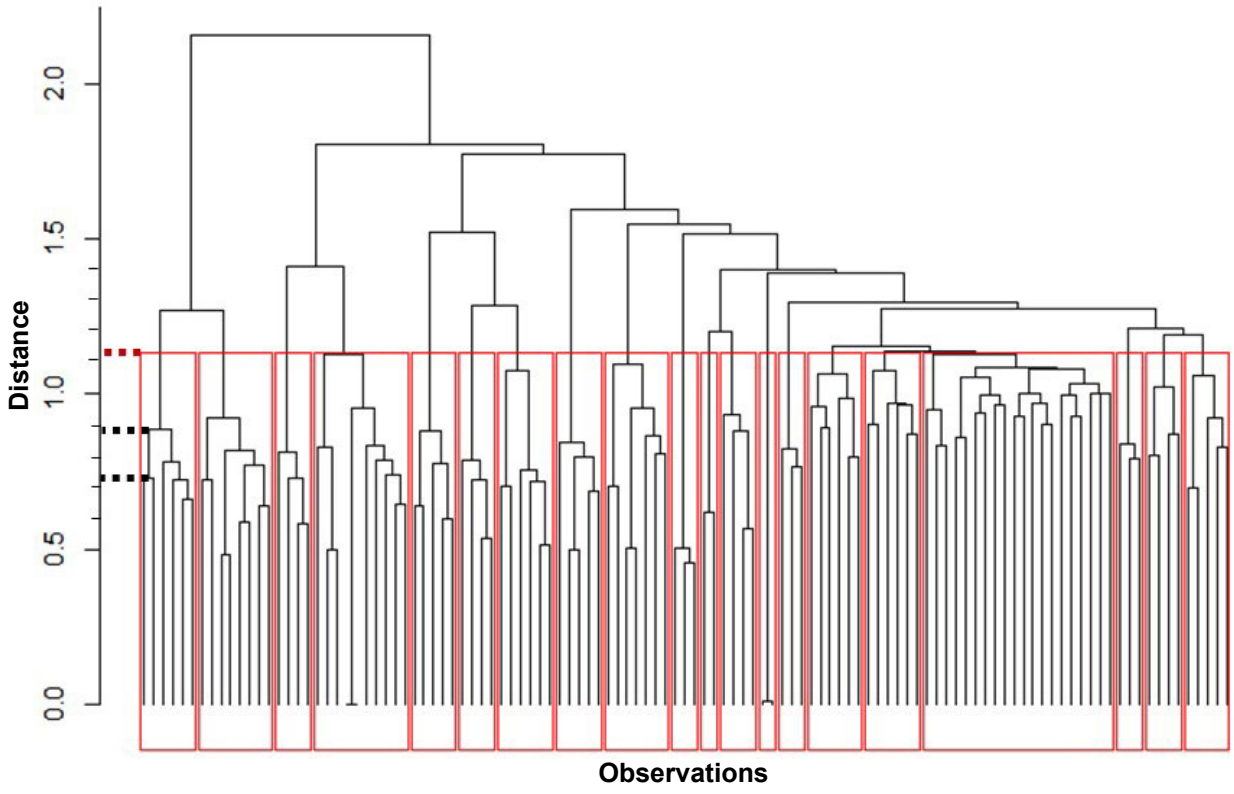
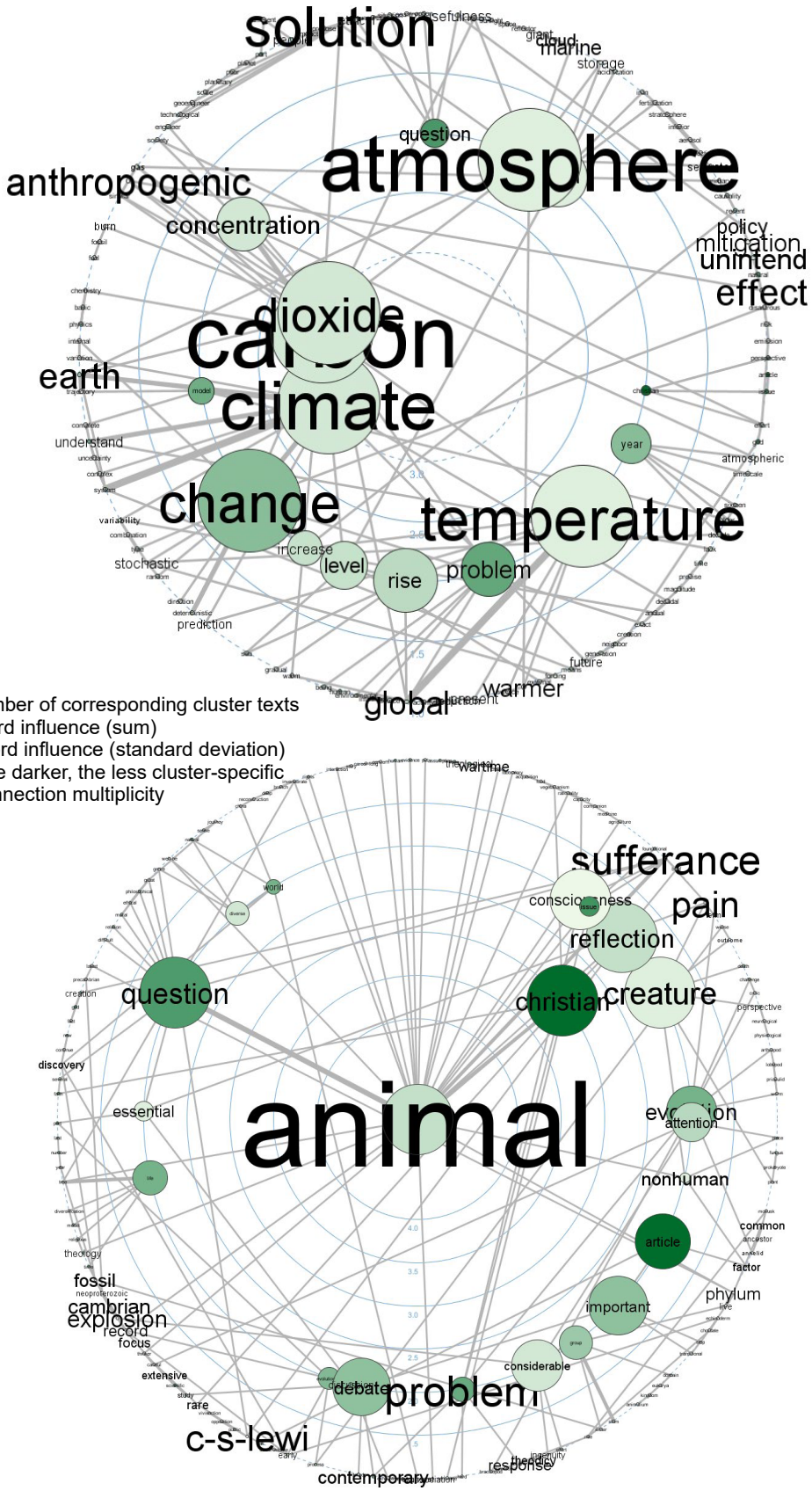


Figure 1. Dendrogram with 20 discursive clusters from the 113 abstracts.



Legend:

- Centrality: number of corresponding cluster texts
- Label size: word influence (sum)
- Node area: word influence (standard deviation)
- Node color: the darker, the less cluster-specific
- Link width: connection multiplicity

Figure 2. Word networks of the clusters labeled “climate change” (top) and “animal” (bottom).

the node color, the better the corresponding word to help distinguish the cluster's theme from other themes. Finally, the width of the connections in figure 2 helps the analyst to see which words were more directly connected in the CRA's linking procedure—that is, were closely related in the way in which the original text was written.

Considering all these criteria, we can observe, for instance, that the word network represented in the top cluster of figure 2 has some influential and cluster-specific words related to climate change. More specifically, the most important words are related to temperature effects of carbon dioxide in the atmosphere—that is, anthropogenic global warming. Thus, this cluster was labeled "climate change." On the other hand, in the bottom cluster of figure 2, there is a word network that is basically characterized by a single frequent, influential, and cluster-specific word: "animal," which was, therefore, chosen as the cluster's label. The lack of other words with similar characteristics indicates a diversity of specific animal-related topics tackled by the articles that were clustered around this core theme—which could be defined as "debates, problems, and questions concerning nonhuman animal creatures, from a Christian point of view."

One of the original 20 HCA clusters corresponded to the "exception group" of the model, because it clustered all the articles for which the method could not find another cluster to merge them into without significantly impoverishing the quality of its solution. Indeed, the 20 articles from this cluster had very little to do with one another. Based on the results of running an alternative Complete-Linkage Clustering Analysis (CLCA), we observed, in a two-step process, that it was possible to re-allocate these article abstracts into other existing HCA clusters which had clear correspondents in the CLCA solution. Checking the title and abstract of each of these articles, we proceeded with the re-allocation, which was qualitatively consistent. Only three papers remained isolated, even in CLCA, and, therefore, were not clustered with any other article. Indeed, each of them deals with a specific topic with no correspondent among the other analyzed abstracts. As a result, they were the only ones that remained labeled "exceptions."

Table 1 summarizes the final 20 discursive clusters, their themes and exemplary works.[11] As table 1 shows, themes were labeled as specifically as possible. For instance, although almost all papers dealing with animal issues took an evolutionary stance, they were not labeled "evolution," because many other clusters also took this perspective in analyzing other sci/faith topics. They were, instead, labeled "animal," because almost none of the other clusters tackled this specific theme. Moreover, the adherence of the model to the data can be seen, for example, in the "mathematics" cluster, which agglomerated all the articles published in the *PSCF* special issue dedicated to this academic discipline.

To give a full example, cluster 5 clustered seven abstracts and was labeled "universe and its natural laws" (especially, cosmology-related papers). As table 1 indicates, Bussey provides a review of the Kalam Argument of God as the first cause,[12] and Chan asks whether natural laws could create our universe or not.[13] Bussey, in another article, distinguishes between mystery and ignorance, by considering Einstein's view that contemplation of the physical universe and its laws can generate exceptionally strong feelings of mystery.[14] Gingerich uses Kepler's three laws of planetary motion to discuss the relation between the belief in deep ontological laws and a theistic understanding of the universe.[15] Larson denounces anthropic reasoning and acknowledgement of apparent design as metaphysical considerations that were undesirably brought into mainstream science by the multiverse hypothesis.[16] Saudek explores a set of eschatological options related to an overall perspective of a not completely deterministic universe.[17] Finally, Wall explores the Christian concept of resurrection in its relationship with natural laws and with the need for a transformation of the universe if life is to survive.[18]

Of course, not all clusters are as thematically homogeneous as the best groupings (such as this cluster 5), but, in general, the solution was satisfying. The relatively high heterogeneity level inside some clusters (not allowing them to be labeled in a more specific way) only reflects and reinforces the fact that, indeed, the Christian sci/faith dialogue still has been diverse in its discursive scope, hindering any attempt to systematically classify it in an exhaustive manner.

Table 1. The 20 Clusters, Ordered according to the Time Series Plot Coordinate

#	Label	Brief description	Examples
1	Broader discussions	Broader questions informed by the sci/faith dialogue	Miller relates the nature of science to the public debate over anthropogenic global warming.[1] Srokosz discusses scientific attitude using the broader ethical framework of virtues and vices.[2]
2	Historical[3]	History of science, church history, and their interplay	Knight presents historical perspectives on the relation between science and the Eastern Orthodox church.[4] Spelda highlights the importance of the church fathers for early modern astronomy.[5]
3	God	Implications of God's nature (especially as Creator)	Turl explores the assumptions held about God's nature when blaming him for disasters.[6] Bradley argues for the compatibility between the scientific concept of randomness and the historical Christian understanding of God's nature.[7]
4	Role	Role of specific ideas in the sci/faith dialogue	Contakes and Johnson point to the role played by soviet ideology in motivated anti-mainstream science efforts in chemistry.[8] Chappell presents the role of F. R. Tennant's thinking on discussions about historical fall.[9]
5	Universe and Natural laws	The universe and its natural laws (especially cosmology)	Bussey provides a review of the Kalam Argument of God as the first cause.[10] Chan asks whether natural laws could create our universe or not.[11]
6	Theologies of evolution	Divine action in the evolutionary process	Kim contrasts Peacocke's and Pannenberg's theologies of evolution.[12] Bissen compares theologies of evolution with respect to randomness in evolutionary processes.[13]
7	Theories	Implications of various specific theories and models	Murphy explores implications of Einstein's theory of relativity to the question of whether the earth really moves or not.[14] Silva tracks the evolution of Polkinghorne's theories on divine action.[15]
8	Mathematics	Mathematics from a Christian perspective (especially education issues)	Mainly, papers from the corresponding *PSCF* thematic issue—for example, Zonnefeld presents examples and techniques of various frameworks and approaches to integrate Christian faith in mathematics classroom.[16]
9	Animal	Issues related to animal creatures (nonhuman)	McFarlane explores how Christians think about and relate to animals.[17] Gilmour tackles the issue of animal experimentation in C. S. Lewis's writings.[18]
10	Human	Human nature and origin (especially genetic)	Wilcox asks if genes made us human.[19] Suarez sustains the teaching of original sin and atonement even after giving up a primal couple as the origin of humanity.[20]
11	Technology	Technology from a Christian perspective (especially environmental)	Touryan advocates a proactive engagement of Christian individuals and institutions with renewable energy resources.[21] Beaver asks whether we should or should not use hydraulic fracturing for natural gas production.[22]
12	Science and Theology	Relation between science and (Christian) theology	Woudenberg discusses the limits of science and their implications for the Christian faith.[23] Tenneson, Bundrick, and Stanford propose a new surveying instrument for relating science and theology.[24]
13	God's creation	The created order and God's work in it	Miller reflects on the issue of death and pain in creation and the goodness of God.[25] Hore-Lacy argues for viewing nuclear power as a providential resource for energy sustainability.[26]
14	Scientists and Christians	Scientists and Christians as people (especially their beliefs)	Curry asks if being a scientist leads to being an atheist.[27] Berry points out the contribution of a great scientist (David Lack) for Christians who want to make sense of evolution,[28]
15	Climate change	Climate issues (especially carbon dioxide effects)	Papers from the *PSCF* "environmental sciences" thematic issue: for example, Ackerman calls Christians to lead the efforts to reduce carbon dioxide emissions, due to their unpredictable effect on Earth climate in the long run.[29]
16	Christian research	Christian research (and development) in different areas	Mann invites a further sci/faith dialogue in five of the main themes raised by contemporary physics.[30] Crisman discusses the relation between open source software development and Christian values.[31]
17	Assumption-practice	Assumptions and their consequent practices (especially in psychology)	Mainly, papers from the *PSCF* "psychology" thematic issue: for example, Kauffmann offers a response to Heather Looy's critique of the assumptions and practices of psychology.[32]

18	Darwinian theology	Theological insights from Darwin's ideas	Two sequential papers (Part I and Part II) from Lamoureux on Darwinian theological insights.[33]
19	Information	Information, intelligence and origins	Mainly, papers from the corresponding *PSCF* thematic issue: for example, Watts explores the relation between biological information, molecular structure and the origins debate.[34]
20	Exceptions	Abstracts that did not fit into any cluster	Helble analyzes the Coconino sandstone as a test on flood geology.[35] Smith puts Nancey Murphy's physicalism into question.[36] Faries tackles the issue raised by randomness in quantum physics to the belief in a personal God.[37]

Notes

[1]Keith B. Miller, "The Nature of Science and the Public Debate over Anthropogenic Global Warming," *Perspectives on Science and Christian Faith* (hereafter *PSCF*) 64, no. 4 (2012): 220–29, http://www.asa3.org/ASA/PSCF/2012/PSCF12-12Miller.pdf.

[2]Meric Srokosz, "Humility: A Neglected Scientific Virtue?," *Science and Christian Belief* (hereafter *S&CB*) 25, no. 2 (2013): 101–12.

[3]As noted by one of the anonymous reviewers, just after our 2015 cutoff date, *PSCF* published an issue edited by James C. Peterson and Christopher M. Rios with four history-oriented articles [*PSCF* 68, no. 3 (2016)], a fact that exemplifies possible refinements of table 1 clusters in future updated analysis.

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[5]Daniel Špelda, "The Importance of the Church Fathers for Early Modern Astronomy," *S&CB* 26, no. 1 (2014): 25–51.

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[10]Peter J. Bussey, "God as First Cause—A Review of the Kalam Argument," *S&CB* 25, no. 1 (2013): 17–35.

[11]Man Ho Chan, "Can Natural Laws Create Our Universe?," *PSCF* 66, no. 1 (2014): 35–39, http://www.asa3.org/ASA/PSCF/2014/PSCF3-14Chan.pdf.

[12]Junghyung Kim, "Naturalistic versus Eschatological Theologies of Evolution," *PSCF* 63, no. 2 (2011): 95–107, http://www.asa3.org/ASA/PSCF/2011/PSCF6-11Kim.pdf.

[13]Diane Bissen, "Is Evolution Truly Random? Chance as an Ideological Weapon in the 'Evolution-Creation' Debate," *S&CB* 26, no. 2 (2014): 120–42.

[14]George L. Murphy, "Does the Earth Move?," *PSCF* 63, no. 2 (2011): 109–15, http://www.asa3.org/ASA/PSCF/2011/PSCF6-11Murphy.pdf.

[15]Ignacio Silva, "John Polkinghorne on Divine Action: A Coherent Theological Evolution," *S&CB* 24, no. 1 (2012): 19–30, https://www.researchgate.net/publication/256682662_John_Polkinghorne_on_Divine_Action_a_Coherent_Theological_Evolution.

[16]Valorie Zonnefeld, "Practical Applications of an Integrally Christian Approach to Teaching Mathematics," *PSCF* 67, no. 2 (2015): 124–34, http://www.asa3.org/ASA/PSCF/2015/PSCF6-15Zonnefeld.pdf.

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[18]Michael J. Gilmour, "C. S. Lewis and Animal Experimentation," *PSCF* 67, no. 4 (2015): 254–62, http://www.asa3.org/ASA/PSCF/2015/PSCF12-15Gilmour.pdf.

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[20]Antoine Suarez, "Can We Give Up the Origin of Humanity from a Primal Couple without Giving Up the Teaching of Original Sin and Atonement?," *S&CB* 27, no. 1 (2015): 59–83.

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[23]René van Woudenberg, "Limits of Science and the Christian Faith," *S&CB* 24, no. 2 (2012): 129–48.

[24]Michael Tenneson, David Bundrick, and Matthew Stanford, "A New Survey Instrument and Its Findings for Relating Science and Theology," *PSCF* 67, no. 3 (2015): 200–222, http://www.asa3.org/ASA/PSCF/2015/PSCF9-15Tenneson.pdf.

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[30]Robert B. Mann, "Physics at the Theological Frontiers," *PSCF* 66, no. 1 (2014): 2–12, http://www.asa3.org/ASA/PSCF/2014/PSCF3-14Mann.pdf.

[31]Karl-Dieter Crisman, "Open Source Software and Christian Thought," *PSCF* 67, no. 1 (2015): 3–13, http://www.asa3.org/ASA/PSCF/2015/PSCF3-15Crisman.pdf.

[32]Duane Kauffmann, "Biological and Environmental Constraints on Knowing the Self," *PSCF* 65, no. 3 (2013): 156–62, http://www.asa3.org/ASA/PSCF/2013/PSCF9-13Kauffmann.pdf.

[33]Denis O. Lamoureux, "Darwinian Theological Insights: Toward an Intellectually Fulfilled Christian Theism—Part I: Divine Creative Action and Intelligent Design in Nature," *PSCF* 64, no. 2 (2012): 108–19, http://www.asa3.org/ASA/PSCF/2012/PSCF6-12Lamoureux.pdf; Denis O. Lamoureux, "Darwinian Theological Insights: Toward an Intellectually Fulfilled Christian Theism—Part II: Evolutionary Theodicy and Evolutionary Psychology," *PSCF* 64, no. 3 (2012): 166–78, http://www.asa3.org/ASA/PSCF/2012/PSCF9-12Lamoureux.pdf.

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[36]Scott R. Smith, "Could We Know Reality, Given Physicalism? Nancey Murphy's Views as a Test Case," *PSCF* 64, no. 3 (2012): 179–89, http://www.asa3.org/ASA/PSCF/2012/PSCF9-12Smith.pdf.

[37]Dillard W. Faries, "A Personal God, Chance, and Randomness in Quantum Physics," *PSCF* 66, no. 1 (2014): 13–22, http://www.asa3.org/ASA/PSCF/2014/PSCF3-14Faries.pdf.

The number of published articles per cluster and journal was depicted in a time series plot (fig. 3). This chart shows that, discounting the difference in the number of publications per year between the two journals, there are observable distinctions of emphasis between the two academic outlets. *PSCF*, for instance, tended to concentrate on topics 8–20, whereas *S&CB* tended to emphasize more general themes (1–7). Finally, although we cannot speak of statistical significance with such small clusters, we can grasp initial trends—that is, whether their publication has been decreasing, increasing, or steady over time. It seems, for example, that discussions on human nature and origin are gaining force, since related publications (i.e., cluster 10) are much more concentrated on the right side of figure 3 (i.e., from semester 6 to 10) than on the left side (i.e., from semester 1 to 5). On the other hand, articles about "information," "climate change," and "mathematics" were concentrated in thematic special issues. Finally, generic themes such as "Science and Theology," "Technology," "God," and "Universe and Natural laws" remained relatively stable over time. Once again, this evidence points to the fact that, in general, sci/faith publications are still being framed and grouped in terms of broad traditional overarching themes, showing a slow pace in regard to moving toward the clear emergence of more topic-specific discussions.

Conclusion

This paper shows that the Christian sci/faith dialogue in academic journals is very heterogeneous in its discursive structure. Many diverse thematic clusters were found from the analysis of the 2011–2015 article abstracts published in *PSCF* and *S&CB*. Some of the 20 clusters were still relatively heterogeneous (i.e., internally), reinforcing this observation of an unsystematic diversity among the publications.

Nevertheless, consistent discursive clusters were circumscribed from some of the articles published in these journals in the beginning of this decade. Some groupings reflected thematic special issues, as could be expected. But others emerged from different journal issues released over time. These specializations inside the broader field could indicate the development of expert communities for topical discussions, which, in turn, could lead to even greater accumulation of specialized publications—for example,

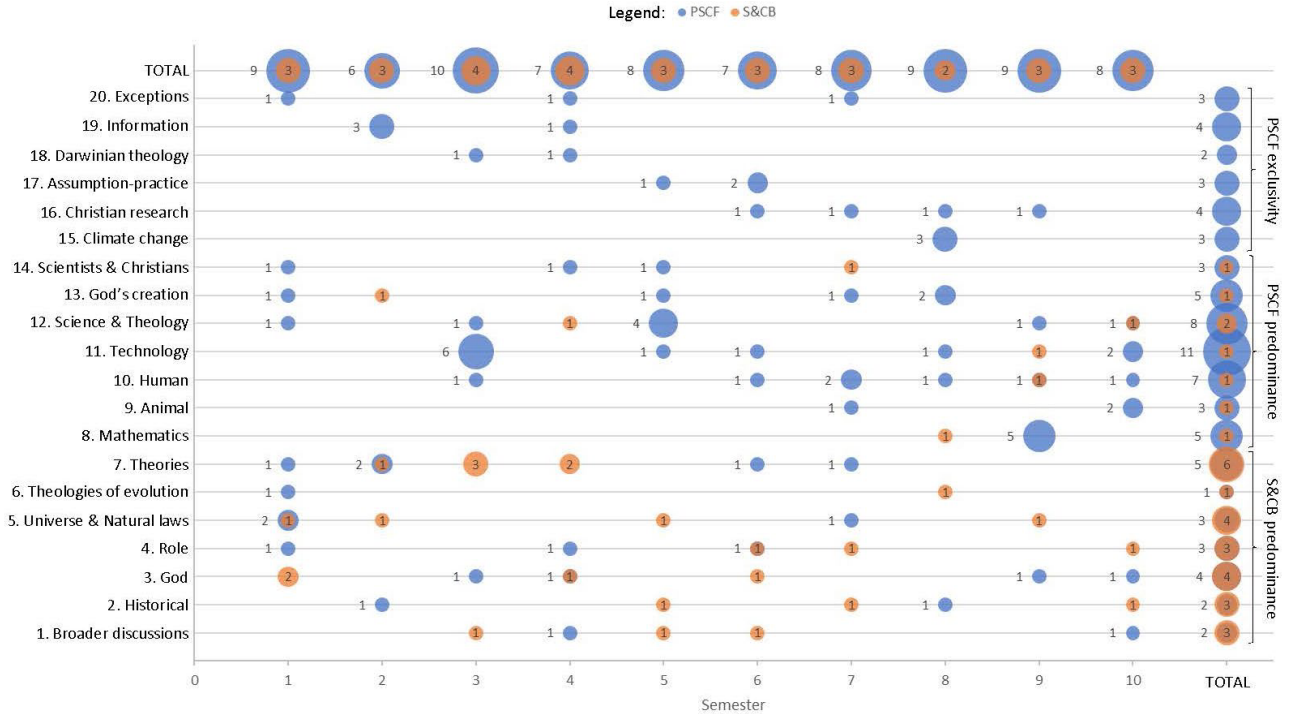

Figure 3: Articles over time, per theme and journal, ordered per journal predominance and from newer to older theme.

helping to establish cohesive subgroups inside ASA and CiS.

These specific themes also helped to distinguish both outlets, showing differing patterns of emphasis in these last years. Maybe the two journals could more clearly differentiate themselves over time, strategically representing different (though complementary) expert discursive communities for potential authors. Moreover, tracking publications over time in a time series plot may help editors to better observe the trends in the field and to note themes that should be brought in (or back) to discussion in their journals.

Undoubtedly, despite these possible benefits, the results presented in this paper should be considered introductory and exploratory. Other content analysts could replicate the study using a simpler method, a larger time span, and a broader journal selection. Future work could also analyze the complete texts (i.e., not abstracts only) of a specific theme of interest. Other statistical methods (e.g., multidimensional scaling, factor analysis) could be employed using word importance and text resonance values as input data.

Nonetheless, this paper may already illustrate the promising contribution of text analytics in sci/faith and theological studies in general. Biblical content analysis, for instance—which is usually dominated by frequency-based characterizations of book/passage thematic emphasis—could be greatly enhanced by word networks and "betweenness" as a better measure of word importance. Resonance between biblical books/passages (or even between biblical authors' literary corpus) could be calculated to explore biblical clusters. Moreover, apologetic recorded debates, for example, the Lennox-Dawkins "God Delusion Debate," could be modeled to see how the discourse is held coherent by each person over the unfolding of the discussion.

In sum, we would be glad if this article were to encourage more creative text analytical work and literature reviews in the sci/faith community. A critical mass of discourse seems to have been reached over these last decades. Let us use interesting available techniques to make the best of this rich literature, in order to better inform new entrants and to consolidate (or refine) the wisdom of experts.

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Notes

[1]See, for instance, the many interesting contributions given by the papers published in the multidisciplinary *Scientometrics* journal.

[2]Steven R. Corman, Timothy Kuhn, Robert D. McPhee, and Kevin J. Dooley, "Studying Complex Discursive Systems: Centering Resonance Analysis of Communication," *Human Communication Research* 28, no. 2 (2002): 157–206, https://doi.org/10.1111/j.1468-2958.2002.tb00802.x; Kevin J. Dooley, Steven R. Corman, and Robert D. McPhee, "A Knowledge Directory for Identifying Experts and Areas of Expertise," *Human Systems Management* 21, no. 4 (2002): 217–28, https://content.iospress.com/articles/human-systems-management/hsm515; Jonathan S. Freitas, Jéssica Ferreira, André Rennó, Júlio Melo, Lin Cheng, and Carlos Gonçalves, "Mapping Methodological Innovation: A Study of Centering Resonance Analysis," *RAUSP*, forthcoming.

[3]Barbara J. Grosz, Aravind K. Joshi, and Scott Weinstein, "Centering: A Framework for Modeling the Local Coherence of a Discourse," *Computational Linguistics* 21, no. 2 (1995): 203–25, http://nrs.harvard.edu/urn-3:HUL.InstRepos:2562369; Marilyn A. Walker, Aravind K. Joshi, and Ellen F. Prince, eds., *Centering Theory in Discourse* (New York: Oxford University Press, 1998).

[4]A more detailed step-by-step example can be found at http://visone.info/wiki/index.php/CRA.

[5]Disregarding the difference between its singular and plural variations, for the purposes of this example.

[6]The Stanford Parser: A Statistical Parser, https://nlp.stanford.edu/software/lex-parser.shtml.

[7]David D. Lewis and Karen Sparck Jones, "Natural Language Processing for Information Retrieval," *Communications of the ACM* 39, no. 1 (1996): 92–101, https://pdfs.semanticscholar.org/d51e/f575fe2317411b1395dc823a7d1625626864.pdf.

[8]See Corman, Kuhn, McPhee, and Dooley, "Studying Complex Discursive Systems," for a complete presentation and discussion of CRA's indices and their formula.

[9]Ibid.

[10]Lawrence Hubert and James Schultz, "Quadratic Assignment as a General Data Analysis Strategy," *British Journal of Mathematical and Statistical Psychology* 29,

no. 2 (1976): 190–241, https://doi.org/10.1111/j.2044-8317.1976.tb00714.x; Peter J. Rousseeuw, "Silhouettes: A Graphical Aid to the Interpretation and Validation of Cluster Analysis," *Journal of Computational and Applied Mathematics* 20 (1987): 53–65, http://www.sciencedirect.com/science/article/pii/0377042787901257?via%3Dihub.

[11]At a first glance, cluster 6 and 18 seem to be closely related. However, we did not merge them because we found no analytical support to proceed with this combination. That is, the results from the HCA applied to the CRA outputs did not indicate a sufficient relative similarity between the word networks of these two clusters. Going back to the data, the reason for this becomes clear. Cluster 18 was formed by only two sequential papers (Part I and II) written by the same author. If we check their abstracts, we note that they are virtually identical (only two slight changes). Thus, with such a distinctive internal cluster homogeneity, it would be indeed almost impossible for this cluster to be merged with any other cluster, because the slightest difference between these two identical abstracts and another text would already imply a relatively high (and undesirable) heterogeneity in the clustering solution. Thus, it would not be technically correct to merge these two groups.

[12]Peter J. Bussey, "God as First Cause—A Review of the Kalam Argument," *Science and Christian Belief* (hereafter, *S&CB*) 25, no. 1 (2013): 17–35.

[13]Man Ho Chan, "Can Natural Laws Create Our Universe?," *Perspectives on Science and Christian Faith* (hereafter, *PSCF*) 66, no. 1 (2014): 35–39, http://www.asa3.org/ASA/PSCF/2014/PSCF3-14Chan.pdf.

[14]Peter J. Bussey, "Mystery and Ignorance," *S&CB* 23, no. 1 (2011): 3–21.

[15]Owen Gingerich, "Kepler and the Laws of Nature," *PSCF* 63, no. 1 (2011): 17–23, http://www.asa3.org/ASA/PSCF/2011/PSCF3-11Gingerich.pdf.

[16]Ronald Larson, "Design or the Multiverse?," *PSCF* 63, no. 1 (2011): 42–47, http://www.asa3.org/ASA/PSCF/2011/PSCF3-11Larson.pdf.

[17]Daniel Saudek, "Science and Eschatology in the Open Universe," *S&CB* 23, no. 2 (2011): 133–57, https://www.scienceandchristianbelief.org/serve_pdf_free.php?filename=SCB+23-2+Saudek.pdf.

[18]Timothy Wall, "Resurrection and the Natural Sciences: Some Theological Insights on Sanctification and Disability," *S&CB* 27, no. 1 (2015): 41–58.

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