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Research Article

Representation of Hearing Loss and Hearing Aids in the U.S. Newspaper Media: Cross-Sectional Analysis of Secondary Data

Vinaya Manchaiah,^{a,b,c} Pierre Ratinaud,^d and Eldré W. Beukes^a

Purpose: News media plays an important role in formulating people's knowledge and opinions about various aspects of life, including health. The current study explored how hearing loss and hearing aids are represented in the U.S. newspaper media.

Method: A cross-sectional study design was selected to analyze publicly available newspaper media data. The data sets were generated from the database, the U.S. Major Dailies by ProQuest, by searching key words for newspapers published during 1990–2017. Cluster analysis (i.e., text pattern analysis) and chi-square tests were performed using Iramuteq software.

Results: The hearing loss data set had 1,527 texts (i.e., articles). The cluster analysis resulted in 7 clusters, which were named as (1) *causes and consequences* (26.1%), (2) *early identification and diagnosis* (9%), (3) *health promotion and prevention* (22.1%), (4) *recreational noise exposure* (10.4%), (5) *prevalence* (14.3%), (6) *research and development* (12.4%), and (7) *cognitive hearing science* (5.6%). The hearing aids

data set had 2,667 texts. The cluster analysis resulted in 8 clusters, which were named as (1) *signal processing* (20.2%), (2) *insurance* (8.9%), (3) *prevalence* (12.4%), (4) *research and development* (5.4%), (5) *activities and relation* (16.2%), (6) *features to address background noise* (13.8%), (7) *innovation* (12%), and (8) *wireless and connectivity* (11.1%). Time series analysis of clusters in both “hearing loss” and “hearing aids” data sets indicated changes in the pattern of information presented in the newspaper media during 1990–2016 (e.g., Cluster 7 focuses on cognitive hearing science in a hearing loss data set emerging only since the year 2012 and growing rapidly).

Conclusions: The text pattern analysis showed that the U.S. newspaper media focuses on a range of issues when considering hearing loss and hearing aids and that patterns or trends change over time. The study results can be helpful for hearing health care professionals to understand what presuppositions society in general may have as the media has the ability to influence societal perception and opinions.

Hearing loss is one of the most frequent occurring chronic conditions in older adults. It is estimated that over 360 million people across the globe suffer from disabling hearing loss (World Health Organization, 2017). The consequences of hearing loss may reach physical, mental, social, and emotional domains (Chia et al., 2007). Although various types of management and

rehabilitation strategies can help people with hearing loss, there is a low help-seeking and uptake of hearing rehabilitation (Knudsen, Öberg, Nielsen, Naylor, & Kramer, 2010). The use of hearing aids is the single most commonly used management strategy used by people with hearing loss (Laplante-Lévesque, Hickson, & Worrall, 2010). Despite this, only about 20%–25% of people with hearing loss in North America are estimated to own hearing aids (Bainbridge & Ramachandran, 2014).

Various factors contribute to low rates of help-seeking and hearing aid uptake (Knudsen et al., 2010). These include acceptance of hearing loss, perceived benefit from hearing aids, and the associated costs and access to appropriate hearing care. Social and environmental attitudes toward hearing loss and hearing aids may also be an important contributing factor for help-seeking, uptake of rehabilitation, and self-management of hearing loss. During the process of taking action regarding health conditions, people may consume information from various sources (e.g., news media,

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social media, health professionals, friends, and family). Hence, the opinion and perception of various stakeholders, including the public perception of hearing loss and hearing aids, could impact hearing aid uptake (Manchaiah, Danermark, Ahmadi, et al., 2015; Manchaiah, Danermark, Vinay, et al., 2015). Therefore, from the public health viewpoint, health communication plays an important role in shaping health behavior (Rimal & Lapinski, 2009). However, Granberg, Möller, Skagerstrand, Möller, and Danermark (2014) suggest that there is limited research on environmental factors (including physical, social, and attitudinal environment) related to hearing loss.

The media is an important external factor that may have influence on hearing help-seeking, hearing rehabilitation uptake, its use, and its outcome. Theories of social representation suggest that the media plays a key role in shaping public perception, which informs societal attitudes and/or beliefs (Happer & Philo, 2013). These include the theory of social representation (Sibley, Liu, & Kirkwood, 2006), the dependency theory (Ball-Rokeach, 1998), and the critical framing theory (Edelman, 1993). The ubiquitous nature of mass media, in particular news media, makes it one of the most influential environmental factors to shape people's views on specific issues, including health care (Schwitzer et al., 2005). People are more likely to talk and consider topics that the media features. Themes not presented in the news media may not receive much public consideration, despite their significance. More importantly, the media plays a key role in gaining the attention of specific opinion leaders, such as politicians, governmental regulators, community leaders, and corporate executives. However, incongruities are found between issues covered in the media and their actual impact on society. The media's focus is to feature themes that gain public attention and to raise their readership or viewership, although these themes may have limited social and economic importance. Furthermore, scientists and health professionals may disagree on the emphasis and approach taken by media professions on certain health issues (Hartz & Chappell, 1997). Despite these disagreements, the general public—including those with health conditions such as hearing loss—may use the media in developing knowledge and making voluntary and informed decisions. Hence, understanding the influence of the media on hearing health care behavior could be informative for health care professionals.

Medical management alone is not sufficient to address the distress caused by various health conditions (Østbye et al., 2005), including hearing loss. The health care community has identified these limitations and has started to promote self-management initiatives in which individuals with a health condition take responsibility and ownership in managing their health conditions and symptoms (Grady & Gough, 2014). However, a significant factor that determines effective self-management is the quality of information people with health conditions obtain through various sources (e.g., news media, social media, health professionals, friends, and family). For example, according to the self-regulatory model of illness, an individual

may be confronted with the problem of a potential illness through two channels, which include (a) symptom perception and (b) social messages (Leventhal, Meyer, & Nerenz, 1980). Individual experiences and symptom perception can be influenced by the social messages individuals receive (i.e., input from friends, family, and the media). For this reason, health communication, especially through the use of media, is an important element of facilitating self-management in chronic disease management from the public health viewpoint (Rimal & Lapinski, 2009).

Only a few studies explore the media's coverage of hearing-related aspects. The literature in this area can be presented in two distinct themes, which include (a) use of media by people with hearing loss and (b) portrayal of hearing-related aspects in the media.

Choudhury, Dinger, and Fichera (2017) studied the use of social media on the hearing aid community (i.e., hearing aid users, other individuals including hearing aid user's family members, and organizations interested in hearing aids). The study results demonstrated that the hearing aid-related community used social media sources for advice and support, information sharing, and service-related information. This study belongs to the first theme and examines the use of media by the hearing aid community.

The second group of studies focuses on how media portrays hearing-related aspects. For example, Foss (2014) conducted textual analysis of 276 television episodes that involved people with acquired and congenital hearing loss (i.e., Deaf) characters and/or storylines about those individuals from 1987 through 2013. The study results suggest that only a fraction of the programs addressed the experience of hearing loss. Hearing loss was generally characterized in younger persons and was depicted as comical, embarrassing, lonely, and threatening to one's work. The authors conclude that these negative representations in the media could explain why hearing loss is stigmatized and/or overlooked. A study by Crowson, Tucci, and Kaylie (2018) explored the patterns of Twitter usage using common references to hearing loss. The study showed that Twitter accounts owned by organizations outnumbered individual accounts; also, the accounts from commercial organizations were most frequently active (Crowson et al., 2018). More recently, Basch et al. (2018) examined the information about tinnitus contained in the top 100 most viewed video sources on YouTube. The study provided interesting observations demonstrating that most of the commonly viewed videos were uploaded by consumers sharing their experiences. Moreover, some studies have examined the portrayal of hearing-related aspects in newspaper media. Kensicki (2001) conducted an earlier study examining newspaper coverage in relation to deafness. In this study, the author examined newspaper coverage of the political movement, Deaf President Now, for positive or negative framing in photographic or written content. The study results show that the Deaf President Now movement received positive media framing. Koerber, Jennings, Shaw, and Cheesman (2017) explored the representation of workers

with hearing loss in Canadian newspapers. The results suggest that the dominant framing describes individual workers with hearing loss as ingenious, determined, and successful. Negative framings also exist, which predominantly generalized these workers as a group. Further studies are required to extract the information regarding the news media's presentation regarding hearing loss and hearing aids. This may differ for different media sources and the media representation in different countries. In addition, we have recently explored how the newspaper media and Facebook pages represent information about tinnitus (Manchaiah, Ratinaud, & Andersson, 2018). In that study, we highlighted specific aspects about tinnitus that the U.S. newspaper media and Facebook pages focus on and how these aspects change over time. Although these are of importance, we were unable to find any studies focusing specifically on analyzing the large text corpus about hearing loss and hearing aids in the news media. Overall, these studies have examined the media and its content regarding hearing loss, hearing aids, and tinnitus.

Even though the general public, including people with disabilities, have access to and are exposed to information from various media outlets (e.g., television, social media, Internet), the newspaper media is still considered the most important medium through which to understand the world (Pettegree, 2014). This is because anyone can develop and share news and information about a specific topic on the Internet and in social media, whereas the information in the newspaper media is generally verified through a source. Hence, information in the newspaper media can be considered as the primary source of reliable information, even in the overload of digital information from various news sources. These observations may highlight the importance of studying the content and trends of newspaper media in relation to various disabilities, including hearing loss.

The objective of the current study was to explore how "hearing loss" and "hearing aids" are represented in the U.S. newspaper media. Based on our recent study on tinnitus (Manchaiah et al., 2018), we hypothesize that the media provides information about various aspects of hearing loss and hearing aids, including symptoms, treatment options, research and development aspects, and so on, with a fairly equal distribution of its content across these themes. In addition, we also hypothesize about the trends involving information change over time to better reflect the practice trends.

Method

Study Design

This study used a cross-sectional design based on analyses of publicly available secondary data (i.e., data collected by the database agency) from newspaper media. The study did not require ethical approval as the data were gathered from publicly available sources and do not contain any human subject information.

Data Extraction

To develop the text corpuses, we first explored databases with the newspaper collection available at Lamar University. The U.S. Major Dailies by ProQuest was selected as the database, as it had the largest and most important newspaper collection with the top five newspapers in full-text format with significant back files. U.S. Major Dailies provides access to the five most widely circulated U.S. national and regional newspapers: *The New York Times*, *The Washington Post*, *Los Angeles Times*, *Chicago Tribune*, and the *Wall Street Journal*. The titles offer researchers thorough and timely coverage of local, regional, and global events with journalistic balance and perspective. The database provides archives from as far back as 1980, and all titles are cross-searchable on the ProQuest platform. Also, the database search will result in an output of all available newspaper articles indexed in the database. Hence, we believe that this database provides indexing of newspapers with an adequate representation of U.S. newspapers.

The database included indexing of newspapers in the electronic form beginning in 1990. Hence, the database was searched from 1990 to 2017. The search terms were *hearing loss* and *hearing aids*, and results were downloaded as two different corpuses. Initially, we considered searching multiple key words (e.g., hearing loss, hearing impairment, hearing disability, deafness) about each topic to ensure we covered all the articles related to this topic while building the data corpus. However, we had to search each key word separately in the database and then search multiple text corpuses to build one corpus. In consequence, there was no way to automatically check and remove duplications. Hence, we decided to search only one key word (i.e., hearing loss) in building the data corpus. A python script was written to convert the text corpus to a format that was needed for data analysis and to preserve the metadata (i.e., newspaper name, year of publication).

Data Analysis

Data analysis included a text pattern analysis using cluster analysis. The text corpus consisted of multiple newspaper articles. The text corpuses were analyzed using the Iramuteq software (Ratinaud, 2014), which is an open-source software used to analyze text data. The software treats each of these articles as text (i.e., it's the first unit). Initially, each article (i.e., text) was segmented into smaller units referred to as text segments (i.e., each text is split into multiple text segments based on criteria of size and punctuation). The split of the text into segments decreases the granularity of the units and thus makes it possible to increase the precision of certain analysis, in particular the search of themes within the text corpus. Following this, the text corpus was lemmatized. This process involves sorting words into groups or variant forms of the same word, known as lemmas (i.e., group of words in a single form). Distinction is made between "full words" (e.g., verbs, noun,

adjectives, adverbs) and “tool words” (e.g., pronoun, determiner, and useful verbs such as *to be* and *to have*). This distinction is made so that only full words are included in the main analysis. These steps are necessary in order to convert the whole corpus to easily manageable data sets for further analysis. A more detailed description about this process has been presented in our recent publication (Manchaiah et al., 2018).

In order to specifically analyze the text that is closely related to *hearing loss* and *hearing aids*, the text segments related to these two terms were extracted, and new corpora were formed. The software has a feature to automatically choose the text segments (typically one or two sentences) related to the key words chosen (e.g., hearing loss) and build a text corpus. This method avoids the researcher bias in selecting the text segments. It is important to note that the expressions “hearing loss” or “hearing aids” were inside each of the text segments extracted. These sub-corpora with more directed text segments were used for all further analysis.

In the next stage, cluster analysis was performed on data sets with the Reinert’s method (i.e., divisive hierarchical clustering) used for textual data analysis (Ratinaud & Marchand, 2012; Reinert, 1983, 1990). This method has been frequently used in French media studies. A recent comparison between the Reinert method and the latent Dirichlet allocation showed that topics from the Iramuteq software that use the Reinert method are more accurate (Sbalchiero & Tuzzi, 2017). Although the traditional qualitative methods (e.g., content analysis) can provide in-depth understanding of the data, the automated text pattern analysis using cluster analysis can provide a broader understanding of the data (Ratinaud & Marchand, 2012). Automated analysis has the advantage of analyzing large amounts of data (i.e., big data), whereas this is not feasible using traditional qualitative methods.

The maximum number of possible clusters was set to 20, although the software would automatically create appropriate numbers of clusters based on the data. Initially, the program builds a binary matrix with text segments in rows and full words in columns. Hierarchical divisive clustering is then performed based on a series of bipartitions made with a correspondent analysis. This cluster analysis groups the text segments based on co-occurrence of lemmas. Each of the clusters aims to be homogeneous (regrouping text segments with a common pattern of lemmas). Also, clusters have to be as heterogeneous as possible between them (pattern of lemmas between groups should be as different as possible). The results are presented in a dendrogram that characterizes the clustering. For each cluster, the program computes profiles of lemmas, which are overrepresented (i.e., a significantly higher proportion in the cluster when compared with the rest of the text corpora based on chi-square analysis). In the next step, the same text corpus was subjected to a time series analysis using the metadata (i.e., chronological bar). For example, in this corpus, we analyzed how the patterns of clusters change over time. In the chronological bar, the width of the bar is

proportional to the number of text segments each year (i.e., the higher the width, the higher the number of text segments), and the height of the clusters (indicated in different colors) represents the frequency of text segments within the clusters. Finally, the chronological bar based on chi square are presented, which highlights the clusters that are significantly overrepresented during the years from 1990 to 2016–2017. In these, the width of the bar is proportional to the number of text segments of each year, and the height of the bar represents the size of the clusters. The chi-square analysis examined if one or more of the clusters was significantly overrepresented in each year.

Results

Hearing Loss Text Corpus

Context Analysis

During context analysis, the original text corpus had 3,809 articles, 104,761 text segments, and 3,634,358 words. After extracting the text segments related to hearing loss, the subcorpus had 1,527 articles, 4,908 text segments, and 183,321 words. The number of articles was reduced to half in the subcorpus. This is because many articles in the main corpus had text segments involving “hearing” and “loss” separately, but not about “hearing loss” specifically. For this reason, the creation of a subcorpus was necessary to ensure that further data analysis will focus on the text segments related to hearing loss. Each article may have one or more text segments with *hearing loss* (i.e., the subcorpus had 4,908 text segments related to hearing loss from 1,527 articles).

Table 1 provides information about the newspaper source and the frequency of texts from each source in the hearing loss corpus. The majority of texts came from *The Washington Post* (26.13%), followed by the *U.S. Federal News Services* (15.19%), *Chicago Tribune* (13.82%), and *Targeted News Service* (13.23%). These four sources accounted for 68% of all the articles in the hearing loss corpus. Table 2 provides information regarding the frequency of texts related to hearing loss over time. The frequency of texts published about hearing loss increased over time. The percentage of articles in Tables 1 and 2 refers to articles containing at least one text segment related to hearing loss in subcorpus. However, it was not possible to examine what percentage of each newspaper article addressed the topic of interest (i.e., hearing loss) based on our automated text pattern analysis.

Content Analysis

Cluster analysis identified seven clusters, namely based on their characteristics, as seen in Figure 1. Cluster 1 was the largest among all and included 26.1% of the texts. This cluster focused on reasons for hearing loss and its symptoms and was named *causes and consequences*. Cluster 2 included 9% of the texts and was related to identification and diagnosis of hearing loss, hence was named as the *early identification and diagnosis* cluster. Cluster 3 included

Table 1. Frequency and percentage of articles containing at least one text segment related to “hearing loss” in the subcorpus among different newspapers.

Newspaper	Frequency of articles	
	<i>n</i>	%
Chicago Tribune	211	13.82
Farm Weekly	13	0.85
Federal Times	2	0.13
Forward	3	0.2
Investor's Business Daily	15	0.98
Journal of Commerce	1	0.07
Journal of Record	29	1.9
Los Angeles Times	132	8.64
Marine Corps Times	14	0.92
Milwaukee Journal	7	0.46
Milwaukee Sentinel	11	0.72
Missouri Lawyers Media	3	0.2
NASDAQ OMXs News Release Distribution Channel	18	1.18
The New York Times	150	9.82
Not known	1	0.07
Roll Call	1	0.07
Sunday Mail	2	0.13
Targeted News Service	202	13.23
The Dailey Beast	2	0.13
The Washington Post	399	26.13
The Weekly Times	2	0.13
Times Record News	1	0.07
U.S. Federal News Services	232	15.19
Wall Street Journal	71	4.65
York Weekly Record	5	0.33
	1,527	100

22.1% of texts and was named *health promotion and prevention* cluster. Cluster 4 was related to *recreational noise exposure* and included 10.4% of the texts. Cluster 5 included 14.3% of the clusters and was named as *prevalence*, as it mainly contained information about how frequent hearing loss occurred. Cluster 6 had 12.4% of texts and focused on scientific studies and new developments and was named as *research and development*. The smallest among all was Cluster 7, which included only 5.6% of the texts and focused on cognitive aspects and was named *cognitive hearing science*. Table 3 provides examples of text segments that typically represent each of these seven clusters in the hearing loss text corpus.

Time Series Analysis

Time series analysis of clusters indicated the change in the pattern of information presented in the newspaper media about hearing loss during the years 1990–2016. Figures 2 (i.e., chronological bar) and Figure 3 (i.e., chronological bar with chi square) presents the time series analysis results of the hearing loss text corpus demonstrating how the information presented in the newspaper media changes over time (i.e., trends). For example, in Figure 2, it is evident that Cluster 7 (cognitive hearing science) was not appearing in newspapers prior to 2012, but the number of texts increased substantially from 2012 to 2016. The chi-square analysis (see Figure 3 and Table 4) illustrates

Table 2. Frequency and percentage of articles containing at least one text segment related to “hearing loss” in the subcorpus based on time scale.

Year	Frequency of articles	
	<i>n</i>	%
1990	35	2.29
1991	31	2.03
1992	26	1.7
1993	38	2.49
1994	51	3.34
1995	21	1.38
1996	20	1.31
1997	27	1.77
1998	38	2.49
1999	32	2.1
2000	41	2.69
2001	50	3.27
2002	77	5.04
2003	61	3.99
2004	55	3.6
2005	75	4.91
2006	69	4.52
2007	73	4.78
2008	65	4.26
2009	43	2.82
2010	73	4.78
2011	86	5.63
2012	75	4.78
2013	91	5.96
2014	95	6.22
2015	96	6.29
2016	82	5.37
Not known	1	0.07
	1,527	100

that some clusters are more likely to occur within certain time scales. For example, Cluster 1 (causes and consequences) was statistically and significantly more frequent during the years 1990–2004 than the other clusters, whereas Cluster 2 (early identification and diagnosis) was statistically and significantly more frequent during the years 2005–2009 than the other clusters, and Cluster 7 (cognitive hearing science) occurred more frequently during the years 2012–2016 than the other clusters.

Hearing Aids Text Corpus

Context Analysis

The initial analysis text corpus had 5,576 texts, 130,866 text segments, and 4,485,675 occurrences or tokens. After extraction of the text segment related to hearing aids, the text corpus (i.e., subcorpus) was reduced to 2,667 texts, 8,042 text segments, and 293,735 occurrences or tokens.

Table 5 provides information about the newspaper source and the frequency of texts from each source in the hearing aids corpus. The *U.S. Federal News Services* (50.19%) contributes to half of all the texts in the hearing aids corpus. The other sources such as *The Washington Post* (8.4%), *Chicago Tribune* (8.47%), *The New York Times* (7.39%), and *Targeted News Service* (7.24%) are

Figure 1. Dendrogram (i.e., classification of clusters), size of clusters as percentage of the text segments, and overrepresented words in each cluster in the “hearing loss” corpus (the words are ordered by chi-square value, with words at the bottom having lower value).

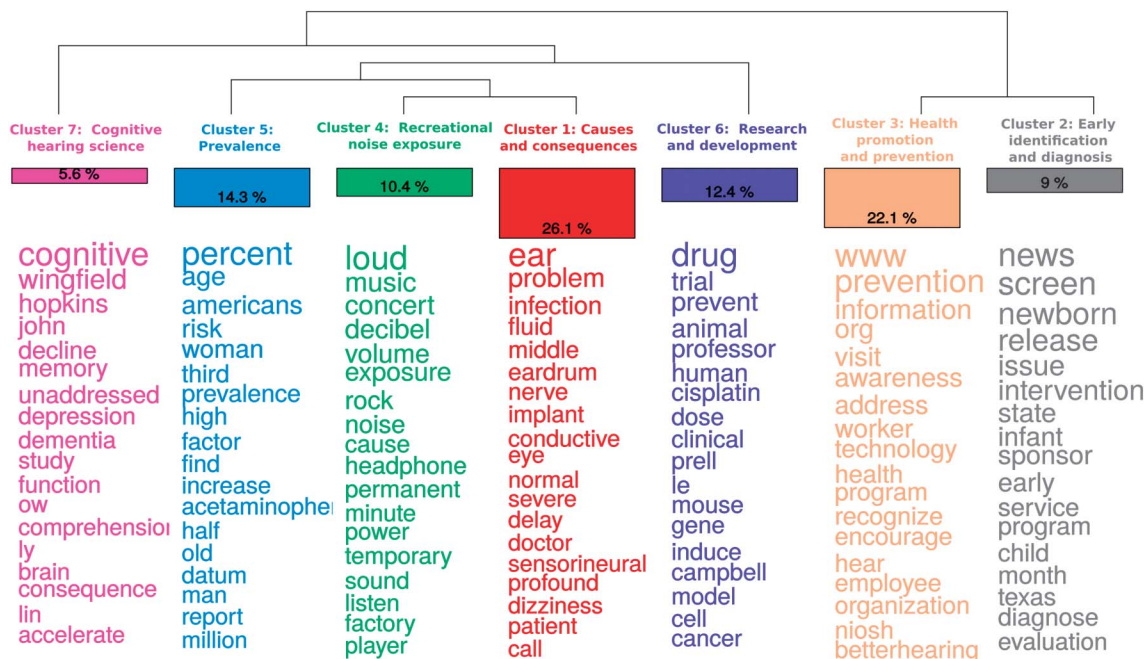


Table 3. Example of a text segment for each cluster in “hearing loss” corpus.

Cluster	Example of a text segment
Cluster 1: Causes and consequences	dr berman suggested that otherwise normal children with the middle ear disorder who did not suffer from recurrent ear infections should be considered candidates for ear tube surgery only if the problem persisted for four months or longer and was associated with a hearing loss of 40 or more decibels
Cluster 2: Early identification and diagnosis	the australian medical association issued the following news release pregnant women and newborns should be routinely screened for cytomegalovirus cmv to prevent hearing loss and intellectual disability in infants according to research in the medical journal of australia
Cluster 3: Health promotion and prevention	a copy of assisting employees with hearing loss as well as information on hearing loss prevention can be found at www betterhearing org to find information and resources for workplace wellness along with information on national employee wellness month visit www
Cluster 4: Recreational noise exposure	excessive exposure to loud noises usually more than 85 decibels that can destroy the delicate structures of the inner ear that transmit sounds to the brain attending rock concerts sporting events or listening to a loud stereo for long periods of time can cause permanent hearing loss
Cluster 5: Prevalence	the national institute on deafness and other communication disorders estimates that 26 million americans between the ages of 20 and 69 have high frequency hearing loss while 2 percent of adults aged 45 to 54 have disabling hearing loss the rate increases to 8
Cluster 6: Research and development	le prell started with a unique idea to create a reversible noise induced hearing loss and has established solid groundwork for this new model in the use of clinical drug testing said hearing expert jianxin bao an associate professor of otolaryngology and biology and biomedical sciences at washington university school of medicine in st
Cluster 7: Cognitive hearing science	a pair of studies by johns hopkins university researchers found hearing loss is associated with accelerated cognitive decline in older adults and that seniors with hearing loss are significantly more likely to develop dementia over time than those who retain their hearing http

Figure 2. Chronological bar showing the proportion of each cluster for each year in the “hearing loss” corpus (the width of the bar is proportional to the number of text segments each year, and the height of the clusters represents the frequency of text segments within the clusters).

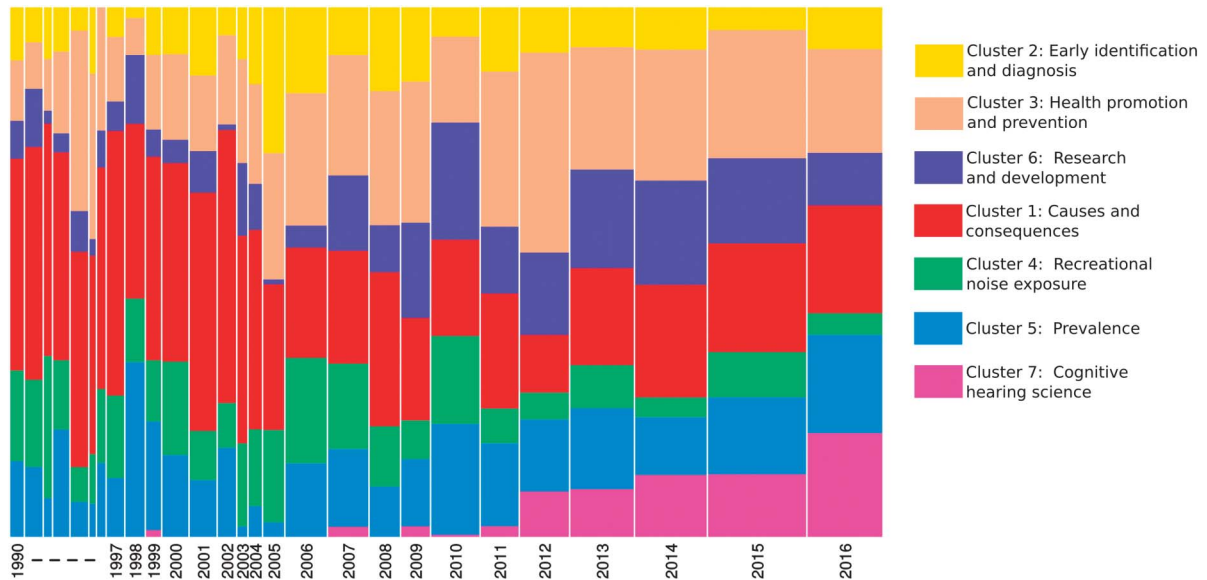


Figure 3. Chronological bar based on chi-square analysis showing the proportion of each cluster for each year in the “hearing loss” corpus (the width of the bar is proportional to the number of text segments each year, and the height of the bar represents the size of the clusters).

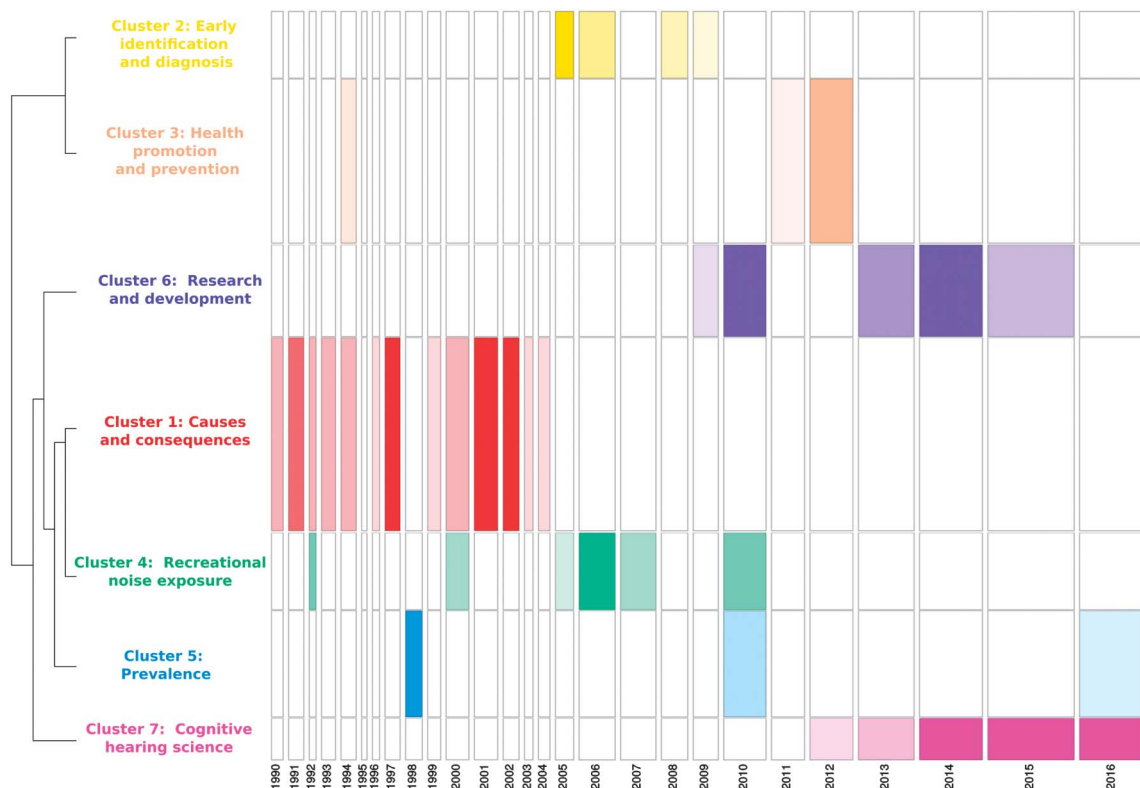


Table 4. Chi-square analysis showing cluster in each year that is significantly overrepresented in “hearing loss” corpus.

Year	Cluster 1		Cluster 2		Cluster 3		Cluster 4		Cluster 5		Cluster 6		Cluster 7	
	χ^2	<i>p</i>	χ^2	<i>p</i>	χ^2	<i>p</i>	χ^2	<i>p</i>	χ^2	<i>p</i>	χ^2	<i>p</i>	χ^2	<i>p</i>
1990	7.2	.007	—	—	—	—	—	—	—	—	—	—	—	—
1991	15.4	< .001	—	—	—	—	—	—	—	—	—	—	—	—
1992	6.8	.009	—	—	—	—	11.9	.001	—	—	—	—	—	—
1993	7.8	.005	—	—	—	—	—	—	—	—	—	—	—	—
1994	10.3	.001	—	—	7.7	.006	—	—	—	—	—	—	—	—
1995	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1996	5.6	.018	—	—	—	—	—	—	—	—	—	—	—	—
1997	27.3	< .001	—	—	—	—	—	—	—	—	—	—	—	—
1998	—	—	—	—	—	—	—	—	28.9	< .001	—	—	—	—
1999	6.3	.012	—	—	—	—	—	—	—	—	—	—	—	—
2000	9.5	.002	—	—	—	—	7.9	.005	—	—	—	—	—	—
2001	26.9	< .001	—	—	—	—	—	—	—	—	—	—	—	—
2002	32.8	< .001	—	—	—	—	—	—	—	—	—	—	—	—
2003	4.6	.031	—	—	—	—	—	—	—	—	—	—	—	—
2004	4.9	.027	—	—	—	—	—	—	—	—	—	—	—	—
2005	—	—	46.7, <i>p</i> < .001	< .001	—	—	5.9	.015	—	—	—	—	—	—
2006	—	—	14.3, <i>p</i> < .001	< .001	—	—	21.9	< .001	—	—	—	—	—	—
2007	—	—	—	—	—	—	7.7	.005	—	—	—	—	—	—
2008	—	—	9.3, <i>p</i> = .002	.002	—	—	—	—	—	—	—	—	—	—
2009	—	—	4.7, <i>p</i> = .03	.03	—	—	—	—	—	—	4.5	.034	—	—
2010	—	—	—	—	—	—	11.1	.001	9.5	.002	23.5	< .001	—	—
2011	—	—	—	—	6.2	.013	—	—	—	—	—	—	—	—
2012	—	—	—	—	38.6	< .001	—	—	—	—	—	—	4.4	.036
2013	—	—	—	—	—	—	—	—	—	—	12.9	< .001	7.7	.006
2014	—	—	—	—	—	—	—	—	—	—	20.1	< .001	28.5	< .001
2015	—	—	—	—	—	—	—	—	—	—	7.3	.007	42.1	< .001
2016	—	—	—	—	—	—	—	—	6.3	.012	—	—	158.1	< .001

Note. Em dashes indicate data not available.

the sources with the most frequent posts. These five sources accounted for 82% of all the articles in the hearing aids corpus. Table 6 provides information about the frequency of texts related to hearing aids over time. The frequency of published articles about hearing aids has increased over time.

Content Analysis

Figure 4 provides results of the cluster analysis on the hearing aids text corpus. The cluster analysis resulted in eight clusters. Cluster 1 was the largest with 20.2% of texts in the corpus that focused primarily on hearing aid processing of sound and was named as *signal processing*. Cluster 2 contains 8.9% of the texts and focuses on *insurance*. Cluster 3 includes 12.4% of the texts, containing information about hearing loss prevalence, and was named as *prevalence* cluster. Cluster 4 was the smallest cluster (5.4% of the texts), focusing on new advancements of hearing aids, and was named as *research and development*. Cluster 5 focuses on various hearing activities and relationships with 16.2% of the texts and was named as *activities and relationships*. Cluster 6 includes 13.8% of the texts and focuses on the hearing aid features that are developed to address background noise and was named as *features to address background noise*. Cluster 7 emphasizes new developments and innovations with 12% of the texts and was named as *innovation* cluster. Cluster 8 had 11.1% of the

texts and focused on *wireless and connectivity*. Table 7 provides examples of text segments that typically represent each of these eight clusters in the hearing aids text corpus.

Time Series Analysis

Figures 5 and 6 present the time series analysis results of hearing aids text corpus. The information presented in the newspaper media about hearing aids appears to change over time. Figure 5 shows that Cluster 1 (signal processing) appears mainly after the year 2006 and continues till 2017, whereas Cluster 3 (prevalence) has existed since 1990 through 2017 (27 years). The chi-square analysis (see Figure 6 and Table 8) illustrates that some clusters are more likely to occur within a certain time scale. For example, Cluster 5 (activities and relations) was statistically and significantly more frequent during the years 1990–2004 than the other clusters, whereas Cluster 8 (wireless and compatibility) was statistically and significantly more frequent in 2005 and 2007 than the other clusters and Cluster 1 (signal processing) occurred more frequently during the years 2010–2016 than the other clusters.

Discussion

The media plays an influential role in disseminating health information and also in determining public responses

Table 5. Frequency and percentage of articles containing at least one text segment related to “hearing aids” in the subcorpus among different newspapers.

Newspaper	Frequency of articles	
	<i>n</i>	%
<i>American Banker</i>	3	0.11
<i>Chicago Tribune</i>	226	8.47
<i>China Today</i>	1	0.04
<i>Commerce Business Daily</i>	16	0.6
<i>Defense News</i>	2	0.07
<i>Farm weekly</i>	13	0.49
<i>Federal Times</i>	6	0.22
<i>Forward</i>	4	0.15
<i>High Country News</i>	1	0.04
<i>Investor's Business Daily</i>	22	0.82
<i>Japan Times</i>	1	0.04
<i>Journal of Commerce</i>	3	0.11
<i>Journal Record</i>	27	1.01
<i>Los Angeles Times</i>	161	6.04
<i>Marine Corps Times</i>	7	0.26
<i>Miami Daily Business Review</i>	1	0.04
<i>Miami Review</i>	2	0.07
<i>Milwaukee Journal</i>	18	0.67
<i>Milwaukee Sentinel</i>	16	0.6
<i>NASDAO OMXs News Release Distribution Channel</i>	9	0.34
<i>The New York Times</i>	197	7.39
<i>Roll Call</i>	6	0.22
<i>San Diego Daily Transcripts</i>	2	0.07
<i>Sunday Mail</i>	2	0.07
<i>Targeted News Service</i>	193	7.24
<i>The Daily Beast</i>	2	0.07
<i>The Daily Journal</i>	1	0.04
<i>The Village Voice</i>	1	0.04
<i>The Washington Post</i>	224	8.4
<i>The Weekly Times</i>	3	0.11
<i>Times Record News</i>	1	0.04
<i>U.S. Fed News Service</i>	1,340	50.24
<i>Victoria Advocate</i>	1	0.04
<i>Wall Street Journal</i>	120	4.5
<i>York Weekly Record</i>	35	1.31
	2,667	100

to health issues (Gunther, 1998; McCombs & Shaw, 1972; Schwitzer et al., 2005). The current study examines the way hearing loss and hearing aids are represented in the newspaper media using text pattern analysis. Findings from the current study suggest that the newspaper media focuses on various elements of hearing loss, including consequences, early identification and diagnosis, health promotion, and prevention, and also focuses on different elements of hearing aids, including signal processing, insurance, features to address background noise, innovation, wireless, and connectivity. Also, there were some differences in the newspapers that covered articles about hearing loss and hearing aids (see Tables 1 and 5). According to the theory of social representation, mass media venues such as the newspaper media play an important role in shaping public perception about various aspects in society (Happer & Philo, 2013; Moscovici, 1988). Hence, the aspects identified in this study with the analysis of newspaper media clearly demonstrate how the consumption of newspaper

Table 6. Frequency and percentage of articles containing at least one text segment related to “hearing aids” in the subcorpus based on time scale.

Year	Frequency of articles	
	<i>n</i>	%
1990	39	1.46
1991	34	1.27
1992	46	1.72
1993	68	2.55
1994	70	2624
1995	35	1.31
1996	31	1.16
1997	37	1.39
1998	44	1.65
1999	32	1.2
2000	54	2.02
2001	46	1.72
2002	30	1.12
2003	37	1.39
2004	34	1.27
2005	53	1.99
2006	98	3.67
2007	143	5.36
2008	166	6.22
2009	156	5.85
2010	173	6.49
2011	189	7.09
2012	193	7.24
2013	254	9.52
2014	203	7.61
2015	172	6.45
2016	216	8.1
2017	17	0.52
	2,667	100

media contributes significantly to people’s common knowledge.

It was found that the frequency of published texts regarding hearing loss and hearing aids increases over time (see Tables 2 and 6). This may be related to the increase in attention to hearing loss and to the increase in the number of newspapers published in general. However, it is hard to distinguish between the relative contributions of these different factors. The trends on cluster representation have changed over time, consistent with changing perspectives in line with new research findings. Changes in time regarding the hearing aid cluster also indicate that the focus of different text patterns changes over time. These changes largely reflect development in the hearing aid field. Moreover, it is noteworthy that there were numerous commonalities in some clusters created automatically from the software based on the heterogeneity of the text data within each cluster. For example, Clusters 1 (signal processing), 7 (innovation), and 8 (wireless and connectivity) in the hearing aids data corpus showed frequent commonalities as they came under the same node. However, these clusters may have been combined if the same data were analyzed using the qualitative content analysis, depending on the interpretation of the researcher.

The current study results suggest that newspapers provide wider and more realistic portrayal of hearing loss

Figure 4. Dendrogram (i.e., classification of clusters), size of clusters as percentage of the text segments, and overrepresented words in each cluster in “hearing aids” corpus (the words are ordered by chi-square value, with words at the bottom having lower value).

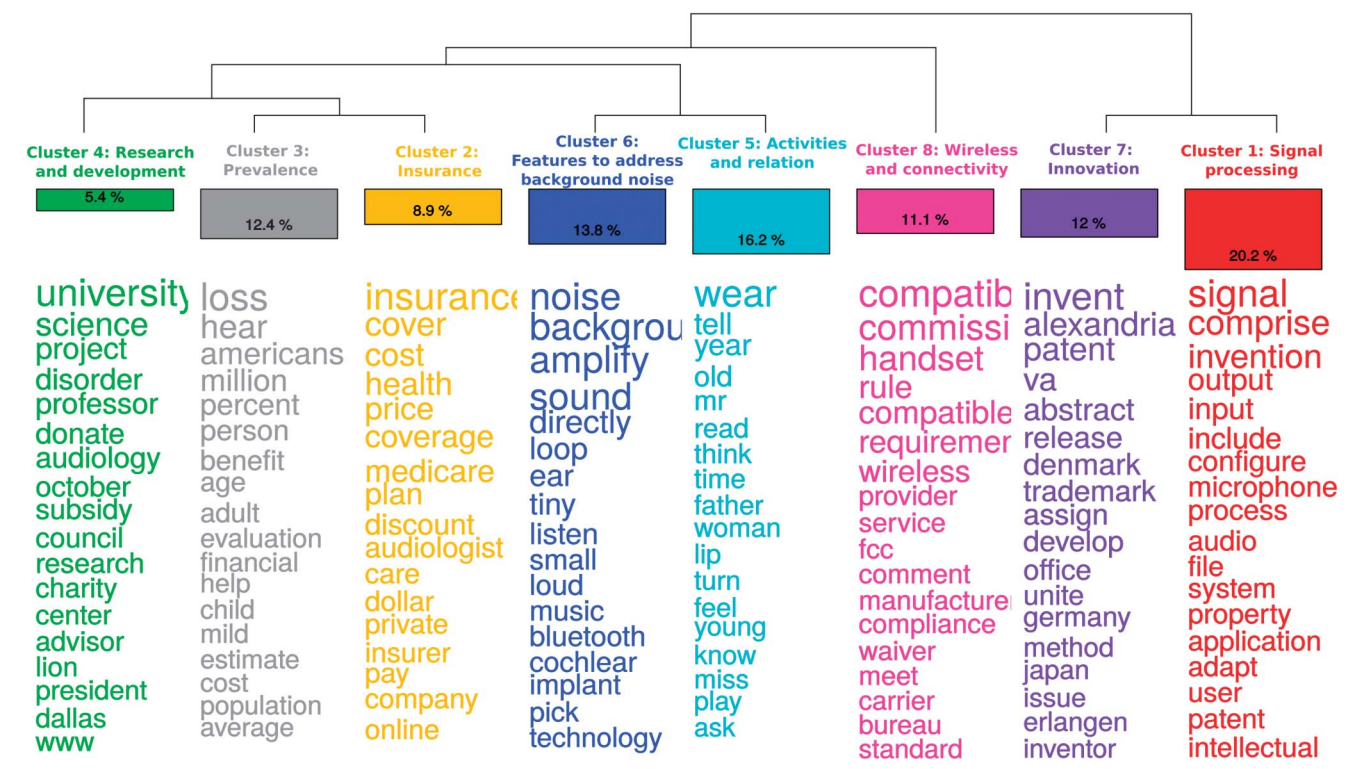


Table 7. Example of a text segment for each cluster in “hearing aids” corpus.

Cluster	Example of a text segment
Cluster 1: Signal processing	the invention relates to a hearing aid system comprising an input transducer a forward path an output transducer and an electrical feedback path the forward path comprising a signal processing unit for modifying an electrical input signal to a specific hearing profile over a predefined frequency range
Cluster 2: Insurance	the bill requires health insurance policies and plans to cover the cost of hearing aid or cochlear implants and related treatment for children under 18 coverage is limited to two hearing aid every three years and the child must be diagnosed by a physician or audiologist as being deaf or hearing impaired
Cluster 3: Prevalence	many people might profit from this research some 28 million americans have hearing loss dr luethke said only 20 percent of those people who might benefit from hearing aid currently even try them she said and only half of that 20 percent are satisfied
Cluster 4: Research and development	new jersey hearing aid project department of communication sciences and disorders montclair state university 1515 broad street bldg b bloomfield nj 07003 or new jersey hearing aid project hearing charities of america 1912 east meyer blvd
Cluster 5: Activities and relations	we think it is less embarrassing to wear a hearing aid than to ask people what they said several times or mishear them popular opinion over many years has conditioned the average patient that a hearing loss is a consequence of getting older
Cluster 6: Features to address background noise	but unlike my mother i am served by new ear opening technologies my hearing aid suppress background noise and amplify only the sounds I need i can wirelessly transmit phone calls and stereo music to them from my smartphone
Cluster 7: Innovation	alexandria va march 26 united states patent no 8 406 440 issued on march 26 was assigned to widex a lynge denmark hearing aid and method of operating a hearing aid was invented by preben kidmose maalov denmark
Cluster 8: Wireless and compatibility	the federal communications commission issued the following press release today the federal communications commission fcc released a memorandum opinion and order that addresses waiver requests filed by wireless service providers and a handset manufacturer seeking additional time to comply with a 2006 benchmark in the fcc_s hearing_aid compatibility rules

Figure 5. Chronological bar showing the proportion of each cluster for each year in the “hearing aids” corpus (the width of the bar is proportional to the number of text segments each year, and the height of the clusters represents the frequency of text segments within the clusters).

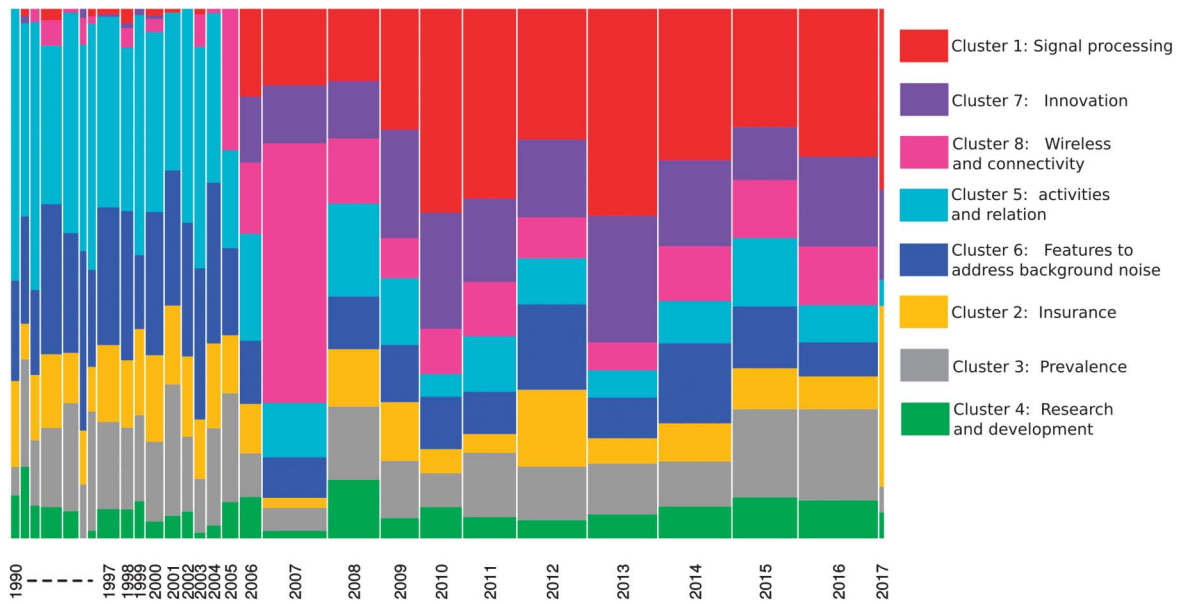


Figure 6. Chronological bar based on chi-square analysis showing the proportion of each cluster for each year in the “hearing aids” corpus (the width of the bar is proportional to the number of text segments each year, and the height of the bar represents the size of the clusters).

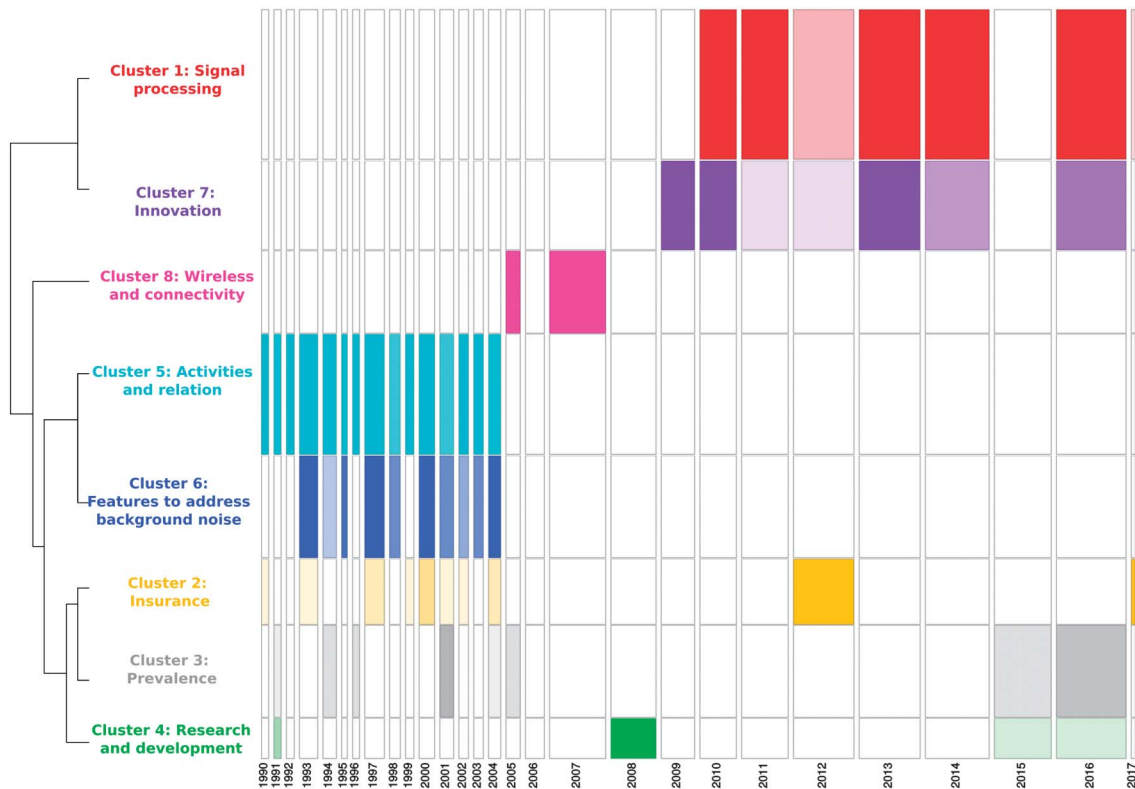


Table 8. Chi-square analysis showing cluster in each year that is significantly overrepresented in “hearing aids” corpus.

Year	Cluster 1		Cluster 2		Cluster 3		Cluster 4		Cluster 5		Cluster 6		Cluster 7		Cluster 8	
	χ^2	<i>p</i>	χ^2	<i>p</i>	χ^2	<i>p</i>	χ^2	<i>p</i>	χ^2	<i>p</i>	χ^2	<i>p</i>	χ^2	<i>p</i>	χ^2	<i>p</i>
1990	—	—	5.0	.025	—	—	—	—	67.9	< .001	—	—	—	—	—	—
1991	—	—	—	—	4.2	.04	9.5	.002	22.6	< .001	—	—	—	—	—	—
1992	—	—	—	—	—	—	—	—	71.3	< .001	—	—	—	—	—	—
1993	—	—	6.0	.014	—	—	—	—	26.6	< .001	34.2	< .001	—	—	—	—
1994	—	—	—	—	8.3	.004	—	—	66.2	< .001	9.2	.002	—	—	—	—
1995	—	—	—	—	—	—	—	—	22.7	< .001	20.2	< .001	—	—	—	—
1996	—	—	—	—	6.7	.009	—	—	48.3	< .001	—	—	—	—	—	—
1997	—	—	8.1	.004	—	—	—	—	59.2	< .001	25.9	< .001	—	—	—	—
1998	—	—	—	—	—	—	—	—	17.7	< .001	19.5	< .001	—	—	—	—
1999	—	—	5.9	.015	—	—	—	—	54.3	< .001	—	—	—	—	—	—
2000	—	—	11.3	.001	—	—	—	—	37.6	< .001	24.1	< .001	—	—	—	—
2001	—	—	6.5	.011	20.3	< .001	—	—	19.5	< .001	16.7	< .001	—	—	—	—
2002	—	—	4.9	.027	—	—	—	—	43.1	< .001	11.1	.001	—	—	—	—
2003	—	—	—	—	—	—	—	—	47.9	< .001	18.3	< .001	—	—	—	—
2004	—	—	8.0	.005	4.2	.04	—	—	23.3	< .001	29.6	< .001	—	—	—	—
2005	—	—	—	—	9.0	.003	—	—	—	—	—	—	—	—	36.7	< .001
2007	—	—	—	—	—	—	—	—	—	—	—	—	—	—	906.8	< .001
2008	—	—	—	—	—	—	30.3	< .001	—	—	—	—	—	—	—	—
2009	—	—	—	—	—	—	—	—	—	—	—	—	24.2	< .001	—	—
2010	82.2	< .001	—	—	—	—	—	—	—	—	—	—	36.5	< .001	—	—
2011	77.9	< .001	—	—	—	—	—	—	—	—	—	—	6.6	.01	—	—
2012	8.6	.003	26.752	< .001	—	—	—	—	—	—	—	—	4.5	.034	—	—
2013	151.7	< .001	—	—	—	—	—	—	—	—	—	—	90.5	< .001	—	—
2014	31.6	< .001	—	—	—	—	—	—	—	—	—	—	11.9	.001	—	—
2015	—	—	—	—	10.5	.001	6.5	.01	—	—	—	—	—	—	—	—
2016	29.4	< .001	—	—	16.9	< .001	4.6	.032	—	—	—	—	18.3	< .001	—	—
2017	5.0	.025	32.632	< .001	—	—	—	—	—	—	—	—	—	—	—	—

Note. Em dashes indicate data not available.

and hearing aids when compared with previous studies on media and hearing-related aspects. For example, a study by Foss (2014) suggests that television media depicts hearing loss negatively (e.g., hearing loss is often characterized as comical, embarrassing, lonely, and threatening to one’s work). On the other hand, previous studies on newspaper media and hearing loss show either positive or negative portrayals of hearing loss (e.g., Kensicki, 2001; Koerber et al., 2017). Nevertheless, the current study results are also similar (i.e., showing various themes of discussion, identifying change in patterns over time) to our recent study on representation of tinnitus in the U.S. newspaper media (Manchaiah et al., 2018).

Study Implications

It is noteworthy that there have been changes in the type and demographics of media consumption in the United States, especially during the last decade (Knight Foundation, 2018). Historically, television and newspaper media have been the main sources of information. Currently, consumption of news media is declining (Pew Research Center, 2017), whereas the use of social media to learn about various news is increasing (Social Media Today, 2012). In addition, there is also a decline in the use of print media, whereas there has been a substantial increase in the use of digital media consumption over recent years

(Nielsen, 2015). However, contrary to our assumption, the data suggest that people of all ages (young, middle age, and older) and also both genders (i.e., male and female) use the newspaper media for gathering information (News Media Alliance, 2017). Hence, understanding the content produced by the newspaper media is still of great importance to researchers.

The news media has a key role in determining societal perceptions, attitudes, and/or beliefs (Sibley et al., 2006). Hence, understanding the role of the media in forming health knowledge and attitudes is necessary for successful management of chronic conditions. Health professionals should be aware of issues covered by the news media in order to better understand the assumptions that patients may have and also to address some of the myths in a timely manner. For example, understanding the topics covered in the media about hearing loss (i.e., causes and consequences, cognitive hearing science, early identification and diagnosis) and hearing aids (e.g., signal processing, wireless and connectivity, features to address background noise) will put hearing health care professionals in a better position to address questions and concerns raised by patients and their family members during clinical consultations. Moreover, the news media can be a very powerful way to promote self-management of the condition and also to promote healthy behavior regarding early diagnosis and management. For promotion of healthy behavior, a clear understanding of the

causes, symptoms, and also management strategies available are required. By working with journalists in developing content for the newspaper media, hearing health care professions have the opportunity to promote healthy management of hearing.

Study Limitations and Future Directions

The current study helps develop new knowledge about hearing loss and hearing aids in the media. However, the study has a few limitations, and the results must be interpreted with caution. First, no database represents all newspapers. We selected the U.S. Major Dailies database by ProQuest to construct the text corpus as this has indexing of national, regional, and local newspapers. Hence, we believe that this database provides an accurate and credible representation of the U.S. newspaper media. However, it is important to be aware that using a different database may have possibly resulted in different findings. Also, the database identifies and returns searches of all the articles indexed in the database. Hence, some news outlets with multiple newspapers may have influenced the results by overrepresenting the articles published about a particular topic. Moreover, in recent years, there has been increased attention paid to media outlets as the public's trust in the media is at question (The Guardian, 2017). In the current study, we conducted the analysis by using a data set that included all the newspapers that were available in the database and presented information about hearing loss and hearing aids. For this reason, our data do not provide insights about whether or not the media outlets have any influence on the kinds of information they present regarding hearing loss and hearing aids.

Second, as discussed in the Method section, our search was limited to one key word (e.g., hearing loss). Using other key words with similar meanings (e.g., hearing impairment, hard of hearing) would give additional hits. We did conduct the search with different key words and combined the corpuses, which resulted in repetition of articles as some articles contained both key words (i.e., *hearing loss* and *hearing impairment*). However, there was no way to eliminate the overlap; hence, we decided to use a single key word to develop the text corpus in this study. Third, the automated text pattern analysis of big data was conducted using software. Such an analysis provides a macro view of the content. However, traditional qualitative methods can be useful to gain an in-depth understanding (i.e., microview) of the data as used by other researchers (e.g., Koerber et al., 2017).

Newspaper media is only one type of media source from which people traditionally gather information and knowledge. However, there has been tremendous development in the media, particularly in social media (e.g., Facebook, Twitter, YouTube; Basch et al., 2018; Crowson et al., 2018; Manchaiah et al., 2018), and also in terms of content found on various websites. It would be useful to study the content of those forms of media to supplement our understanding of what kinds of information the

public is regularly exposed to. In addition, understanding the media content is only the first step. It is useful to study what kinds of media people with hearing and balance disorders consume and also trust. Eventually, the future studies should focus on the influence of media on hearing help-seeking, hearing rehabilitation uptake, and also on its outcome.

Conclusions

The current study examines how hearing loss and hearing aids are represented in the media, specifically in the U.S. newspaper media. The information in the U.S. newspapers about hearing loss was mainly related to consequences, early identification and diagnosis, health promotion and prevention, recreational noise exposure, prevalence, research and development, and cognitive hearing science. The information in the U.S. newspapers about hearing aids was mainly related to signal processing, insurance, prevalence, research and development, activities and relation, features to address background noise, innovation, and wireless and connectivity. Time series analysis of clusters in both hearing loss and hearing aids data sets indicated that the change in pattern of information presented in the newspaper media during 1990–2016 (e.g., Cluster 7 focusing on cognitive hearing science in a hearing loss data set emerging only since the year 2012 and growing rapidly). The text pattern analysis showed that the U.S. newspaper media focuses on a range of issues when considering hearing loss and hearing aids and that patterns or trends change over time. The study results can be helpful for hearing health care professionals to understand what presuppositions society, in general, may have as a result of the newspaper media's influence on societal perception and opinions. Hearing health care professionals should endeavor to play an active role in providing accurate and useful information to the media regarding important trends in hearing loss and hearing aids.

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