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Mental Representations of HPV in Appalachia: Gender, Semantic Network Analysis, and Knowledge Gaps

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Abstract

Media coverage has emphasized human papillomavirus (HPV) as a vaccine-preventable, sexually transmitted virus causing cervical cancer. Appalachian undergraduate students ($N = 309$, 50% female) were surveyed on their knowledge of HPV; analyses of mental representations were similar to content analyses of media coverage of HPV, suggesting media cultivation. Semantic network analysis revealed linkages between vaccine, disease causation and prevention, women's centrality in the representations, and structural differences that varied between vaccinated women, unvaccinated women, and men. The findings provided insights into gaps in the public's understanding of HPV, potential stigmatization of those testing HPV+, and future challenges in vaccinating men.

Keywords

human papillomavirus; semantic network analysis; belief systems; stigma; media coverage

HPV affects millions of people (Friedman & Sheppard, 2007). To date, research on the public's knowledge and understanding of HPV remains largely focused on awareness, not similarities between the media's coverage and the public's mental representations (i.e., cognitive frames, Scheufele, 2004, or schemas, Bartlett, 1932) of HPV. Yet, news and advertising media often fill the void left in the absence of clinical and public health communication (Donelle, Hoffman-Goetz, & Clarke, 2005), and may influence public perceptions of HPV (Habel, Liddon, & Stryker, 2009). For example, media coverage may genderize illness by focusing only on the risk to females, even though both sexes are affected.

In addition, the organized structure of concepts has implications for the emergent meaning of the mental representation, priming of concepts, and future persuasive efforts. For example, mental representation of HPV may include the concepts of women and sexually-transmitted disease. If the two concepts are structurally connected in mental representations, this genderized and sexualized representation may create social and personal barriers to informed decisions related to HPV, such as who is at risk and how to avoid transmission. For example, although male vaccinations for HPV have been approved for use in males aged 9 to 26 since 2009 (U.S. Food and Drug Administration, 2009), parents show little interest in getting their sons vaccinated (Dempsey, Butchart, Singer, Clark, & Davis, 2011). In this study, semantic network analysis (SNA) is used to reveal mental representations of HPV, that is, identifying which concepts appear in them and characterizing the concepts'

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interconnections. SNA is also used to assess if interconnections between concepts differ between groups, such as vaccinated women, unvaccinated women, and men. SNA, then, provides a quantitative description that is needed to further research into the relations between cognitive structures and their related outcomes, such as memory, attitudes, and persuasion (Fabrigar & Wegener, 2010).

This study has three aims. First, we investigated the similarity between mental representations of HPV and existing content analyses of media coverage of HPV (e.g., Habel et al., 2009). Second, we investigated whether mental representations of HPV differ across the three vaccine-related audiences: vaccinated women, unvaccinated women, and men. Third, we tested whether omitted concepts in the mental representations are less salient or, in fact, absent.

Literature Review

Media Coverage of HPV

Research on the media coverage of HPV shows a consistent and persistent emphasis on females, vaccination, and cancer (Calloway, Jorgensen, Saraiya, & Tsui, 2006; Casper & Carpenter, 2008; Habel et al., 2009). For example, a content analysis of news stories after the FDA licensed the vaccine (June 8, 2006--September 26, 2006) showed that 88% used the phrase, "cervical cancer vaccine" (Habel et al., 2009). Direct to consumer advertising (DTCA) of HPV vaccines showed similar content. For example, Gardasil ads emphasize getting vaccinated in order to be "one less" *woman* who will get cervical cancer (Polzer & Knabe, 2009). GlaxoSmithKline's name for their HPV vaccine, Cervarix™, further reinforces the links between cervical cancer and vaccination (Casper & Carpenter, 2008).

This coverage may influence public perceptions of HPV, because media provide a substantial amount of health information (e.g., Fox & Rainie, 2002). For example, a recent study showed that 57.2% of those who had heard of HPV had been exposed to HPV messaging in news or ads (Leader, Weiner, Kelly, Hornick, & Cappella, 2009). Public health officials and patient educators have expressed concerns about the confusing and stigmatizing effect of linking cervical cancer to sexual activity without addressing common knowledge gaps (Anhang, Goodman, & Goldie, 2004). For example, males are at risk for HPV and HPV-related cancers on other parts of the body (e.g., Joseph, Miller, Wu, Chen, Morris, Goodman, Villalo-Gomez, Williams, & Cress, 2008; Partridge & Koutsky, 2006). Further, HPV is transmitted through skin-to-skin contact (Ogilvie et al., 2009), which does not necessarily occur through sexual intercourse (Gillison, Chaturvedi, & Lowy, 2008).

Research on public knowledge and understanding of HPV, however, remains focused on awareness, not on similarities between media coverage and mental representations of HPV. This study aims to investigate commonalities between them.

Public Perceptions of HPV

Herein, mental representations are cognitive frames, defined as a collection of objects and their interrelations (e.g., Scheufele, 2004). This definition suggests that the ideas or beliefs are structured (Converse, 1964; Dinauer & Fink, 2005; Hunter, Levine, & Sayers, 1976), such as in a hierarchy from abstract ideas to more concrete ones. The structure has implications for interpreting a representation. For example, two groups may both include cancer, virus, women, and cause in their mental representations. If one group holds virus as the superordinate concept, with directed connections to cancer, women, and cause, this structure may evoke the meaning that the virus causes cancer in women. If another group holds women as the superordinate concept with directed connections to virus, cause, and cancer, then this structure may evoke a meaning that women cause the virus, which creates

cancer in women. The influence of superordinate concepts on their connected ideas is argued in multiple models (e.g., Dinauer & Fink, 2005; Hunter et al., 1976). Further, the models suggest that persuasive messages have different effects depending on whether they target superordinate or the subordinate (connected) ideas. Thus, the concepts and their interconnections may influence people's understanding of HPV and HPV-related actions. It is critical, then, to uncover the mental representation, the central concepts within it, and direct links between the concepts. An SNA can reveal such insights.

SNA is a method to evaluate the relations between words in a text (Carley, 1993; Doerfel, 1998) and to visually represent these relations (Ritter & Kohonen, 1989). SNA has the benefits of a content analysis (e.g., Carley, 1993), plus the unique ability to examine relationships in the content. In contrast to word-count analysis, SNA allows researchers to uncover meanings associated with a topic by examining the relations among concepts (Carley, 1993; Doerfel, 1998). SNA can represent the degree to which two concepts are connected because they appear within a certain number of words of each other in the text. This allows the researcher to visualize the associative network of a concept and its related ideas, as well as the strength of these relations (Doerfel, 1998). By investigating mental representations as a system of organized concepts, SNA allows one to estimate which concepts are interconnected, and the centrality of particular concepts within a representational system. For example, given that media content typically emphasizes vaccine, cancer, and females, we expect that when people are asked what they know about HPV, concepts such as vaccine, cancer, and females should appear, and be closely linked together. In contrast, concepts such as males and treatment, if they appear, should not be connected. Thus, we considered whether these concepts appear in reported knowledge about HPV:

RQ1: How do men and women mentally represent HPV; that is, what are its core concepts, and structural interrelationships?

Knowledge about HPV

People's mental representations may reflect what is salient about HPV or what is known about HPV. The question, then, is how to interpret what is omitted from mental representations of HPV. If males, for example, are not included this may be (a) because female-related issues are more salient, or (b) because people do not know that men are at risk for HPV-related cancers. In addition, if mental representations connect sexual transmission with HPV, then other modes of transmission may not be considered. Since mental representations of HPV prominently feature concepts such as a female, cancer, and vaccine, we considered:

RQ2: How accurate is knowledge about HPV transmission among men, vaccinated women, and unvaccinated women?

Methods

Participants

Participants were 309 undergraduate students from a variety of majors at a large eastern university (154 males, 155 females) in the Appalachian region of the US. This region is noted for elevated rates of invasive cervical cancer and cervical cancer mortality (Lengerich et al., 2005). Their mean age was 20.02 ($SD = 1.19$, $range = 9$). Participants identified themselves as Caucasian (84%), African-American (5%), Asian (5%), Hispanic (4%), multi-ethnic (1%), or did not indicate a racial or ethnic membership (1%), which is more diverse than the region (95% Caucasian reported in Lengerich et al., 2005). In the past 12 months,

participants reported seeing a physician three times ($M = 2.89$, $SD = 0.85$) and having almost 2 romantic partners ($M = 1.80$, $SD = 0.64$).

All participants were asked if they had received the HPV vaccine. Over half of the women ($n = 107$; 69%) reported that they had received the HPV vaccine; none of the men reported receiving it. This rate is similar to the CDC reported coverage (85.6%) for females aged 13-17 in the participants' state in 2010. Currently, the CDC does not provide rates for men. Most of the vaccinated women ($n = 93$, 87%) and unvaccinated women ($n = 35$, 73%) were White. They were also asked about testing: 19% of unvaccinated women ($n = 9$), 43% of vaccinated women ($n = 46$), and 7% of men ($n = 10$) had been tested for HPV. Of those tested, only eight women indicated that they were HPV+ and they were all vaccinated women.

ANOVAs showed that the vaccination groups varied in reported age, $F(2, 306) = 3.39$, $p < .05$, $R^2 = .02$, medical visits, $F(2, 306) = 9.64$, $p < .05$, $R^2 = .06$, and romantic partners, $F(2, 306) = 5.23$, $p < .05$, $R^2 = .03$. Men were older ($M = 20.19$, $SD = 1.21$) than vaccinated ($M = 19.82$, $SD = 1.10$) or unvaccinated women ($M = 19.82$, $SD = 1.25$). Men also reported fewer medical visits ($M = 2.62$, $SD = 0.86$) than did vaccinated women ($M = 3.08$, $SD = 0.81$) or unvaccinated women ($M = 2.91$, $SD = 0.92$). Vaccinated women ($M = 1.93$, $SD = 0.95$) reported more romantic partners in the past 12 months than did unvaccinated women ($M = 1.65$, $SD = 0.76$) or men ($M = 1.62$, $SD = 0.62$). Vaccination groups also varied in self-identified race, $X^2(8, 307) = 18.33$, $p < .02$, Cramer's $V = .17$. More vaccinated women (89%) and men (86%) self-identified as Caucasian, compared to unvaccinated women (73%).

Procedures

Participants were recruited to participate in the health study through a large, general education course for undergraduate students. Participants were alone when they completed an online survey on a computer in a research laboratory. Researchers were available next door if participants had questions. Participants answered the open-ended question: "What do you know about HPV?" Participants then answered questions about HPV knowledge and demographics.

Dependent Measures

HPV knowledge—After answering the open-ended question of what they knew about HPV, participants were given three statements about HPV with citations, and asked to indicate whether they were aware of the information (1 = *yes*, 0 = *no*). The three statements were (a) "Virologists have noted that HPV, in fact, can be transmitted through skin to skin contact (Ogilvie et al., 2009), which does not have to be sexually related (Gillison et al., 2008);" (b) "Cancers related to HPV appear in other areas of the body, and often in men. In fact, the number of noncervical cancers caused by HPV each year appear at roughly the same rate as cervical cancers caused by HPV, and many of the non-cervical cancers occur in men (Gillison et al., 2008, p. 3043);" and (c) "The HPV strains associated with cervical cancer (e.g., HPV-16 and HPV-18), which are addressed in the vaccine, account for a majority of the cancers found in other regions as well (e.g., Joseph et al., 2008). These other regions include the sites where men experience HPV-related cancer."

Semantic Network Analysis

In this study, SNA focused on concepts as the nodes in the semantic network, and co-occurrences in participants' open-ended responses as the basis for a relationship, also referred to as "edge" or "tie" between concepts (see Doerfel, 1998 for a review). A drop list of words to eliminate from the textual analysis was created ahead of time in order to focus

on core concepts. For this analysis, the drop list included pronouns (e.g., *I*, *he*, *she*, and *they*), to-be verbs (e.g., *am*, *is*, and *were*), and articles (e.g., “the,” “an,” and “a”). To avoid counting misspelled core concept words as separate entities, the text was corrected for spelling (i.e., *Gardasil*). Different ways to express the same concept (e.g., *girl*, *girls*, *females*, and *women*) were reduced to a common term (i.e., *women*). In addition, the expressions *do not know anything* and *know nothing* were reduced to *know nothing* and retained for comparisons and analyses.

After cleaning the text, WORDij 3.0 (Danowski, 2009) was used to generate frequency counts, directional matrices of word co-occurrences, and to compare word and word-pair proportions with *z*-tests. Words appearing fewer than three times were dropped. Relations between words are determined within a window of *N* words that moves through the text, one word at a time (Danowski, 1993), coinciding with the hierarchical association of words in people's minds (e.g., Anderson, 1993; Chang, 1986). A three-word window (Zywica & Danowski, 2008) was used to preserve the locality of the reference and possible variations in syntactic constructions. Among vaccinated women, 1,042 pairs of words were observed, with 170 unique pairs; the average pair frequency was 6.13. For men, 528 pairs of words were observed, with 117 unique pairs; average pair frequency was 4.51. For unvaccinated women, 71 pairs of words were observed, with 14 unique pairs; average pair frequency was 5.07.

The semantic networks were generated with UCINET 6.245 (Borgatti, Everett, & Freeman, 2002). Semantic networks were created for vaccinated females, unvaccinated females, and males. UCINET was also used to generate the normalized degree centrality (in and out-degree) estimates for each word in each network and for the QAP analysis. For interpretation, a binary transformation of the data matrices was used.

Additional Analysis Plan

Semantic network analysis (e.g., Danowski, 1993) is used to answer RQ1. To answer RQ2, differences in the frequencies of answers coming from the three vaccination groups are tested with chi-square analysis. Network similarities are tested with QAP (Krackhardt, 1987). Further tests into differences in group members' average level of knowledge about HPV are tested with ANCOVAs.

Results

Mental Representations of HPV

RQ1 considered how men and women mentally represent HPV. The words that appeared most frequently in HPV representations of vaccinated women in rank order were cancer, cervical, cause, vaccine, sexually-transmitted (ST), virus, women, Gardasil and prevent. Unvaccinated women's responses included cancer, cervical, women, vaccine, nothing (don't know), ST, disease, cause, and prevent. Men's answers included cancer, women, nothing (don't know), ST, cervical, disease, cause, virus, and vaccine.

Figures 1-3 show semantic network graphs of their responses. The networks were created as directional pairings, preserving word order. Direction and strength of connection have ramifications for considering the structure of mental representations. Directional relations between terms suggest that some terms may activate the salience of other ones, but not vice versa. In contrast, reciprocally tied terms may activate each other. The strength of the connection shows the likelihood that this activation will occur.

The most central concepts for vaccinated women were cancer (*in-degree* = .70, *out-degree* = .50) and cervical (*in-degree* = .70, *out-degree* = .50). For men and unvaccinated women,

the most central concepts was cancer (*in-degree* = .40, *out-degree* = .40 for men, and *in-degree* = .30, *out-degree* = .10 for unvaccinated women). Higher in-degree centrality for cancer indicates that more of the other concepts are directionally tied to cancer; higher out-degree centrality indicates that cancer is directed more often to other concepts.

The semantic networks showed that for men and vaccinated women, the concept *women* was tied to four other terms in their semantic networks; it was tied to two terms in unvaccinated women's semantic network. In all three groups, *women* was tied to *cancer* and *cervical*, but the connection type varied. Additional terms that vaccinated women tied to *women* (*vaccine* and *virus*) differed from those that men tied to *women* (*disease* and *cause*).

For vaccinated women, *women*, *cancer*, and *prevent* were reciprocally tied, suggesting that these are closely related concepts. In addition, *vaccine* and *virus* were both directionally tied to *women*, suggesting that when vaccinated women think about HPV, *vaccine* and *virus* may activate the concept *women*, but not vice versa. For unvaccinated women, only *cancer* and *cervical* were directionally tied to *women*, suggesting that cervical cancer may activate the concept of *women*, but not vice versa. For men, *women* was reciprocally related to *cervical*, *cancer*, and *cause*. In addition, *disease* was directionally tied to *women*, suggesting that when men think about HPV, *disease* may activate the concept *women*, but not vice versa.

A post-hoc search through respondents' answers showed that men appeared in only seven vaccinated female responses and seven male responses. Men were described as carriers. For example, one participant wrote that HPV is, "a virus which can cause cervical cancer. Men can carry this virus and then pass it on to women through sex."

Commonalities with media coverage—The results from the semantic network analysis showed that the most frequently used terms were markedly similar to existing content analyses of media coverage (Calloway et al., 2006; Habel et al., 2009). Further, terms in the semantic network analysis appeared with consistency across the three vaccine-related groups (see Table 1).

Post-hoc analysis—Beliefs about transmission was explored by examining the placement of *cause* in the semantic networks. As summarized in Table 1, unvaccinated women were more likely than vaccinated women to use the word *cause* ($z = 2.48, p < .05$). In the networks, *cause* was tied to *cervical* and *cancer* in all three networks. Vaccinated women and men also directionally tied it to *sexually-transmitted*. The directional tie suggests that *sexually-transmitted* may activate the concept of *cause*, but not vice versa. This finding suggests that sexual behavior is the only transmission route considered with HPV, and further, it may activate attributions of causality.

Knowledge about HPV Transmission

RQ2 considered the accuracy of understanding about HPV transmission and differences among vaccinated women, unvaccinated women, and men. All participants were asked if they knew three specific statements about HPV. A subset of participants indicated in their answer to the open-ended question that they knew nothing about HPV ($n = 52$ or 16.8% of the sample). Often, male participants included additional information, such as "I know nothing about it, except that it is a disease" or "It has something to do with cancer, but nothing else." Such participants were not coded as knowing nothing about HPV, because they did provide additional information. The participants who answered nothing without adding additional phrases or statements were more likely to be males ($n = 40$) in comparison to unvaccinated ($n = 9$) or vaccinated women ($n = 3$), $\chi^2(2, N = 309) = 24.37, p < .01$, *Cramer's V* = 0.28. Any answers provided by these participants to the specific, close-ended questions may be due to social desirability, thus they were removed from this analysis.

For the remaining participants ($n = 257$), 16% reported knowing that HPV has been documented as being transmissible through skin-to-skin contact (not necessarily sexually related), and these reports did not vary between groups, $\chi^2(2, N = 257) = 3.79$, *ns*, *Cramer's V* = 0.12. 13% reported already knowing that HPV-related cancers appear in other areas of the body and that these appear often in men, and these reports also did not vary between groups, $\chi^2(2, N = 257) = 1.15$, *ns*, *Cramer's V* = 0.07. 14% reported already knowing that the HPV strains associated with cervical cancer account for cancers found in other areas of the body. These reports varied between groups, $\chi^2(2, N = 257) = 8.57$, $p < .05$, *Cramer's V* = 0.18. More vaccinated women (21%) reported knowing that these strains are associated with non-cervical cancers than did unvaccinated women (10%) or men (8%).

Post-hoc analysis—All three knowledge items were combined to generate a single score from 3 (already knew this information) to 0 (did not already know). The average level of knowledge did not vary between groups, $F(2, 254) = 0.77$, *ns*, $R^2 = .01$. As noted in the methods section, the three groups varied in their self-reported medical visits, age, romantic partners in the past year, and self-identified ethnicity. To check whether these factors could be alternative explanations for the findings, an ANCOVA with knowledge as the dependent variable, vaccination status and race as independent variables, and medical visits, age, and romantic partners as covariates was performed. The model was not statistically significant ($F < 1$). Thus, differences in knowledge cannot be explained by these other variables either.

Network Similarity

The networks were compared using the QAP, which evaluates each cell in one sample's word-by-word matrix to another sample's matrix without making parametric assumptions about the data (Krackhardt, 1987). It has two steps: first, a simple matching coefficient is calculated between equivalent cells in the two matrices; second, the rows and columns of one matrix are randomly permuted, and the matching coefficient is recalculated (Borgatti et al., 2002). With binary relations, QAP tests for differences in the probability of a tie between two concepts in the semantic networks generated for the different samples (permutations = 500). Probabilities were similar: vaccinated women and men, *simple matching* = .78, $p < .001$, unvaccinated women and men, *simple matching* = .84, $p < .001$, and vaccinated women and unvaccinated women, *simple matching* = .76, $p < .01$. These findings suggest that the likelihood of a tie between two concepts in the semantic networks was similar, confirming that the concepts and their linkages have been adopted similarly by all three groups.

Discussion

With news reporting and DTCA emphasizing HPV as a sexually-transmitted virus causing cervical cancer for which there is a vaccine, women are likely to traverse a different course from males in understanding and taking action related to HPV. SNA provided a method to answer the research questions, by revealing and characterizing respondents' mental representations of HPV: its content and its structural interrelationships. The content in the participants' mental representations were markedly similar to the content analyses of media coverage of HPV. *Cancer* was the most frequently used word in participants' reported knowledge about HPV; *cervical*, *women*, *vaccine*, and *sexual transmitted* appeared frequently as well. The structures showed differences between groups; for example, cancer held a more superordinate, central position for vaccinated women and men, and a less prominent position for unvaccinated women. In addition, differences appeared in connections between concepts. For example, men had direct connections between *cause* and *women*, but vaccinated and unvaccinated women did not. Last, the results provided support for the idea that concepts omitted in the mental representations of HPV were not known.

Few participants reported knowing, for example, that HPV has been shown to cause non-cervical cancers and that these cancers can affect men.

Media Cultivation

The findings provide support for the claim that news reports and DTCA likely cultivated HPV representations, as six terms common to vaccinated and unvaccinated women and men in their responses—*cervical*, *women*, *vaccine*, *sexually transmitted*, *cause*, and *prevent*—coincide with content analyses of news reports and online news stories about HPV and the HPV vaccine (Casper & Carpenter, 2008; Habel et al., 2009). Thus, one may conclude that the participants' mental representations of HPV were genderized female.

The Structures in Mental Representations

The SNA results showed that *cancer*, *cervical*, and *sexual transmission* were central, superordinate concepts for vaccinated women. Superordinate concepts are important because they can strongly influence subordinate ones (Dinauer & Fink, 2005; Hunter et al., 1976). Men's representations were hierarchically organized around cancer and sexual transmission, but also included some concepts—*women*, *disease*, and *cause*—more centrally than vaccinated women did.

Differences also emerged in the pairing of words in the semantic networks, which may have implications for social distancing or stigmatization anticipated by those testing positive for HPV (Daley et al., 2010). Women, for example, never linked the frames of *women* and *cause* together, but men did. Although *women* appeared in each semantic network, linking *women* with *cause* suggests the potential to blame women for HPV. Causal attributions are seen as central components of the communication diffusing, forming, and maintaining stigmas (e.g., Smith, 2011). Indeed, HPV+ women report self-blame and stigmatization (Daley et al., 2010). After an abnormal Pap test and before giving the vaccine, HPV DNA testing has been advocated (Kahn et al., 2007), which would increase the likelihood that women would learn that they are infected with HPV (Kahn et al., 2007). The impact of a positive diagnosis has received little attention.

These findings have implications for theories built upon the presumption that beliefs, attitudes, and memory are connected to each other in a non-random fashion, and that these connections have implications for memory and social influence (see Fabrigar & Wegener, 2010 for a review). Unfortunately, a means by which to identify and quantify the organization of cognitive structures has challenged such research (e.g., Fabrigar & Wegener, 2010; Monroe & Read, 2008). For example, Judd and colleagues (1991) argued that the interconnections among attitudes, for example, are typically inferred from how much overlap there is between the evaluation of a target object and other, potentially, related objects. Although it has some utility, it is limited in that it does not actually quantify the relation among objects outside of its presumed effect. SNA can provide quantitative descriptions of structures, which allows for hypothesis testing and new insights.

For example, some concepts were bi-directionally linked to each other. The concepts of *cancer* and *women* were bi-directionally linked to each other in men's and vaccinated women's semantic networks. While much attention has been paid to the implications of belief systems with uni-directional links (e.g., Dinauer & Fink, 2005; Hunter et al., 1976), the implications for bi-directionality are unknown. Bi-directionally related concepts, for example, may be those which are more stable, more resistant to change, and/or stronger. It is possible that concepts bi-directionally linked in cognitive representations may present unique concerns for message designers. If audiences link *cancer* and *women* together, for example, then they may consider any message about HPV-related cancers in relation to

women, which also may make them more resistant to change than uni-directionally tied concepts. It is also unknown if people process messages developed from each of the three network maps differently. With a means by which to measure and quantify cognitive structures, the meaningful work in theorizing about the effects of cognitive structures may be tested, which is seen as a great challenge facing current researchers (Fabrigar & Wegener, 2010).

Knowledge Gaps

The results showed that concepts absent in the mental representations (e.g., non-cervical cancers) were evidence of existing gaps in participants' knowledge about HPV. Few participants reported knowing that HPV is related to cancers in other parts of the body, which may occur in men (Gillison et al., 2008; Petrovic, Burney, & Fletcher, 2011), or that it can potentially be transmitted through skin-to-skin contact (Gillison et al., 2008; Ogilvie et al., 2009). This knowledge may influence the perceived benefit of HPV vaccination, which has been predictive of vaccine acceptability in women (Bynum, Brandt, Annang, Friedman, Tanner, & Sharpe, 2011); Both knowledge and vaccine benefit have been predictive for men's intentions to vaccinate (Petrovic, Burney, & Fletcher, 2011; Wheldon, Daley, Buhi, Nyitray, & Giuliano, in press). In addition, the behaviors needed to avoid skin-to-skin transmission are different from those needed for sexual-transmission. Women and men may be putting themselves at risk for contracting HPV because they are unaware of this mode of transmission.

Limitations

This study focused on uncovering the belief structures surrounding HPV; it does not capture the valence or attitudes associated with them. In addition, participants were not explicitly asked about their exposure to news media or DTCA about HPV, which limits the ability to make explicit claims about the influence of news media or DTCA on public understanding of HPV. Moreover, although the sample represents those from a geographic region with elevated incidence and mortality of cervical cancer (Lengerich et al., 2005), it does not represent many women and men of color who have also been associated with elevated risk for particular HPV-related cancers (Watson, Saraiya, Ahmed, Cardinez, Reichman, Weir, & Richards, 2008). Further, the survey did not ask participants who stated that they received the vaccine to report on how many doses they received. The extent of vaccination compliance is clearly relevant for their personal protection as well as larger infectious disease dynamics. The survey also did not assess students' sexual orientations, which may also shape their mental representations (thanks to anonymous reviewer). Future research should compare the findings from this study to those generated with sample representing other at-risk groups and levels of vaccine compliance.

Conclusion

This study shows the utility of using semantic network analysis to reveal the mental representations held by men and women about HPV. Further, it is not simply the concepts but their interconnections that may help to explain misunderstandings about HPV etiology and potential stigmatization of HPV+ persons.

The marked similarities between the content of media coverage and these mental representations support for the claim that news reports and DTCA likely cultivated HPV representations. The FDA's mandate for balanced product information in DTCA (Calfee, 2002) may need to include the potential for stigmatization as a risk.

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Figure 1.

Network Graphics for Vaccinated Women, Unvaccinated Women, and Men.*

*:In these graphs, larger nodes are more central in the network, using in-degree centrality.

The links between ideas are thicker depending on how often the two words are paired together. Gray ties represent directional relationships; black ties represent bidirectional relationships (e.g., “cancer” appeared before “women” and “women” appeared before “cancer”).

Table 1
Word frequency Comparisons for Vaccinated Women, Unvaccinated Women, and Men

	Vac. women			Men			Un-vac. women			Z (vw-m)	Z (uw-m)	Z (vw-uw)
	n	%	n	%	n	%	n	%	n	%	%	%
Cancer	89	8.36%	44	6.32%	1.49	9.43%	20	9.43%	-1.39	-0.38		
Cervical	78	7.32%	31	4.45%	2.34*	8.02%	17	8.02%	-1.86	-0.21		
Vaccine	41	3.85%	14	2.87%	0.97	3.77%	17	3.77%	-0.44	0.14		
Cause	41	3.85%	20	2.01%	2.03*	8.02%	8	8.02%	-4.00*	-2.48*		
ST	40	3.76%	36	5.17%	-1.30	4.25%	9	4.25%	0.36	-0.14		
Virus	28	2.63%	11	1.58%	1.30	3.30%	7	3.30%	1.29	-0.32		
Gardasil	26	2.44%	3	0.43%	3.05*	1.89%	4	1.89%	-1.68	-0.24		
Women	26	2.44%	35	5.03%	-2.77*	6.13%	13	6.13%	0.45	-2.63*		
Prevent	21	1.97%	4	0.57%	2.22*	3.77%	8	3.77%	-3.23*	-1.35		
Disease	16	1.50%	20	2.87%	-1.81	3.77%	8	3.77%	-0.44	-1.95		
Nothing	8	0.75%	39	5.60%	-6.02*	5.19%	11	5.19%	0.57	-4.57*		

Note. Vw-m = comparison between vaccinated women and men. Uw-M = comparison between unvaccinated women and men. Vw-Uw= comparison between vaccinated women and unvaccinated women.
ST = sexually transmitted.

* $p < .05$