

Structurally embedded news consumption on mobile news applications



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ABSTRACT

This study uses a longitudinal dataset extracted from a mobile news application and adopts a multilevel design to examine the evolution of diversity of individuals' news consumption and to identify the factors that underlie such evolution. A decreasing trend in news consumption diversity is observed among users. The news consumption diversity of individuals is positively related to global information diversity. Furthermore, the news consumption diversity of males exhibits a stronger tendency to be influenced by global information diversity than that of females. The decreasing trend in news consumption diversity is less remarkable among males than among females. This study complements traditional motivation-driven perspectives of news consumption by mining the structural antecedents of news consumption diversity and further emphasizes the social implications of mobile news technology. Lastly, practical implications and limitations are discussed.

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The heterogeneity of news consumers has prompted news service providers to engage consumers with personalized information (Frasincar et al., 2009). Legacy news media platforms, including TV and print, are facing challenges in providing customized news services, primarily because of the traditional one-to-many dissemination mechanism in news delivery (Beam & Kosicki, 2014a). However, the emergence of news applications on mobile Internet has substantially revolutionized the news delivery process. These applications syndicate news content from a wide range of news providers and create personalized information repertoires for targeted consumers by using sophisticated recommendation algorithms (Hu & Zhang, 2015). Despite the technical and commercial success of personalized delivery of news information through mobile news applications (Liu et al., 2013), scant literature has addressed whether and how the continuous use of mobile news applications can influence the diversity of the news consumption of individuals.

Understanding the diversity of the news consumption of individuals has theoretical and practical implications because such diversity is closely related to social interaction and integration in modern societies. First, news with diverse genres is a major socializing agent in human society. Diverse news topics interweave with multiple spheres of inquiry ranging from intimate space (e.g., family and peer groups) to institutional entities (e.g., social organizations), thereby constructing the social identity of individuals (Swart et al., 2016). Diverse news viewing will increase the capacity in sharing information among personal groups and organizations. Such information sharing enables a person to engage in social life and to act based on collective information (Beam et al., 2016; Lemish & Alony, 2014). Moreover, news viewing diversity is also related to the degree of acceptance of civil obligations (Tewksbury, 2003). Diverse news viewing enables individuals to participate in

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various public issues (Poindexter & McCombs, 2001). The narrowed news viewing of individuals will lead to an increasingly fragmented and polarized citizenry and will result in ideological fragmentation (Flaxman et al., 2016).

Will the continuous use of mobile news applications make the news consumption of individuals more homogeneous or heterogeneous? On the one hand, the abundance of news information available on mobile news applications empowers general users to access a highly heterogeneous news environment. On the other hand, the personalized recommendation systems deployed by mobile news applications lead to speculations of the existence of “filter bubble” and “echo chamber.” Users will receive news recommendations based on their existing preferences (Pariser, 2011) and those of like-minded individuals; hence, the continuous use of mobile news applications may narrow down the diversity of news consumption. To address this concern, the present study uses a longitudinal dataset of the news viewing behavior of individuals on a mobile news application to empirically examine the evolution of the diversity of their news consumption and identify the factors that underlie such evolution.

1. Conceptual framework

News consumption has been widely examined within a motivation-driven framework, in which the news consumption of individuals is mainly determined by psychological factors, such as the need to obtain information and opinion, entertainment, and social interaction (Diddi & LaRose, 2006; Katz & Blumler, 1974). However, individuals in a society are not willful agents whose news consumption decisions are completely under their own control. Structural functionalists argue that the structure of a social system influences the behavior of individuals in different domains (Bourdieu, 1977). In news consumption on mobile news applications, individuals engage and react to two information environments (Biocca, 1988). The first is a micro information environment in which news entries are directly delivered to users by recommendation algorithms. The second is a macro or global information environment in which users are embedded into, although they are not fully aware of this situation (Goldberg et al., 2015). The current study argues that both micro and macro information environments will affect the diversity of individuals' news consumption.

1.1. Micro information environment and individual news consumption

An individualized and time-varying micro information environment will be created by recommendation algorithms for each individual user of mobile news applications. First, mobile news applications can continuously document the multiple personal traits of individual users, including their historical news viewing behavior (Liu et al., 2010), personal characteristics (Kaššák et al., 2016), and social networks (Bakshy et al., 2015). Such personal traits will be used by recommendation algorithms to evaluate and filter incoming information (Nanas et al., 2010) and create a niche information repertoire for each individual user. Second, a micro information environment is time-varying because recommendation algorithms will dynamically adjust news entries delivered to individual users based on their evolving traits, such as their past viewing behavior and the evolution of their social networks.

The creation of individualized and time-varying information repertoires by recommendation algorithms reinforces the existing news preferences of users and insulates them from interest-challenging contents (Bakshy et al., 2015). Customized news recommendation can reduce the costs of information seeking and processing for individual users and minimize uncertainty in switching to other news viewing patterns (Jun, 2016; Kuo et al., 2013; Oulasvirta et al., 2012). Thus, the continuous delivery of individualized news to users will cultivate their habitual dependence on recommendation algorithms in their news consumption. The habitual media consumption patterns of users will reinforce their existing news preferences (Rosenstein & Grant, 1997), thereby further constraining the diversity of their news information in the future.

In the long run, the micro information environment created by recommendation algorithms for individual users will iteratively become increasingly homogenous over time, thereby limiting users to repetitively select a narrowing range of news topics and decreasing the diversity of their news consumption. We develop the following hypothesis:

H1. *The diversity of an individual's news consumption on mobile news applications will decrease over time.*

1.2. Global information diversity and individual news consumption

The news consumption of individuals is also bound by what is available in the global news market (Cho & Gay, 2010). On mobile news applications, users are allowed to navigate news contents on the platform in a structured manner (Nel & Westlund, 2012). They can actively select and process news information by searching for news in news archives or clicking the hypertext embedded in news content (Tewksbury, 2005; Westlund, 2013). The diversity of the news consumption of each individual user can be enhanced by global information diversity of the platform, that is, the degree of variety of available news content that a platform can offer (Biocca, 1988; Goldberg et al., 2016). Mobile news applications with a high variety of news information provide users with a significantly expanded repertoire of choices that may, in turn, increase the diversity of their news consumption. Therefore, we developed the following hypothesis:

H2. *Global information diversity will positively influence the diversity of the news consumption of individuals.*

Micro and macro information environments interact to influence the diversity of individual news consumption through the assistance of recommendation algorithms. The global information environment features a rich set of news information

attributes (De Choudhury et al., 2011; Flaxman et al., 2016; Zhu & Gauch, 2000). Recommendation algorithms aim to match these news information attributes with the characteristics of news consumers and to create a niche information repertoire for each consumer (Liu et al., 2010; Nanas et al., 2010). When global information is heterogeneous, recommendation algorithms will match more mixed news information attributes to user features, which will result in the increasingly diverse categories of news entries, thereby increasing the heterogeneity of the micro information environment (Liu et al., 2010). By contrast, the micro information environment will become homogeneous when the global information environment is less diverse, and consequently, the declining trend of the diversity of the news consumption of individuals will be strengthened. Therefore, global information diversity helps users develop resistance to the declining trend of diversity in individual news consumption. The following hypothesis is presented:

H3. *Global information diversity will positively moderate the declining trend of diversity in news consumption. In particular, the declining trend will be less remarkable when global news information is highly diverse than when it is slightly diverse.*

1.3. Gender differences in individual news consumption

The diversity of individual news consumption is dependent on gender. First, males exhibit higher ability to adopt mobile platforms for accessing news information than females. For example, a previous study found that males focused on the functional utility of mobile data services, such as gaining news information, whereas females used mobile services mainly for communication about personal and emotional matters (Yang & Lee, 2010). In addition, the news interests of males are more diverse than those of females. Men prefer news on politics, sports, business, and finance, whereas females frequently turn to news regarding community and health issues (Knobloch Westerwick & Alter, 2007). Therefore, we hypothesized the following:

H4. *A significant difference exists between male and female users with regard to the diversity of their news consumption. In particular, the diversity of news consumption of females is lower than that of males.*

Moreover, male and female users are reported to demonstrate different decreasing rates in the diversity of news consumption. First, the micro information environment of news consumption for females is less diverse than that for males. Compared with those of males, the less diverse news interests of females indicate that they will be exposed by recommendation algorithms to an increasingly homogeneous micro information environment because of the aforementioned generation mechanism of such environment on mobile news applications (Pariser, 2011). An increasingly homogenous micro information environment will further reduce the diversity of the news interests of females. In this regard, the micro information environment created by the recommendation algorithms of mobile news application widens the gap of news consumption diversity between males and females.

In addition, we argue that females may rely more than males on the micro information environment created by recommendation systems of mobile news applications. News information overload in mobile news applications increases time-cost uncertainty in seeking news (Beam & Kosicki, 2014b). Previous psychology studies have shown that women exhibit lower uncertainty tolerance than men (Borghans et al., 2009). For example, Byrnes et al. (1999) found that males were more risk tolerant in 14 of the 16 observed types of risk behavior. Users can cope with information overload and reduce the perceived risk of wasting time by relying on the homogeneous and personalized micro information environment created by recommendation algorithms (Dabholkar & Sheng, 2012; Garbarino & Strahilevitz, 2004). Therefore, females are more likely to rely on the homogeneous micro information environment of mobile news applications compared with males (Doong & Wang, 2011; Leung & Wei, 1999). As discussed previously, the individualized information environment created by recommendation algorithms on mobile news applications strengthens the existing news preferences of users. Thus, in the long run, the news consumption diversity of females decreases more remarkably than that of males. Therefore, the following hypothesis is presented:

H5. *The diversity in news consumption of male users is less likely influenced by time than that of female users. That is, the declining trend of diversity is more prevalent among female users than among male users.*

As stated previously, users can interact with the global information environment of mobile news application in viewing news by actively navigating search engines. The diversity of the news consumption of individuals can be increased by the variety of global news information on mobile news applications. In this regard, when the degree of activeness of seeking news information is high, the effect of the diversity of global information on the diversity of individual news consumption will be strong (Biocca, 1988; Goldberg et al., 2016).

Previous studies have shown that the degree of activeness in seeking news on mobile news platforms differs between males and females (Yang & Lee, 2010). Males exhibit positive attitudes toward using search engines to seek for information and actively obtain target-specific information on mobile news platforms; by contrast, females are less likely to actively gain access to information (Ha et al., 2016). Therefore, the following hypothesis is put forward:

H6. *The diversity in news consumption of male users is more likely to be influenced by global information diversity than that of female users.*

2. Methods

2.1. Data collection

Data were extracted from the server log of the Sohu News mobile application, one of the most popular mobile news applications in China. When the data for this study were collected in May 2014, the application had reached 100 million users. Users with “55” as the last two digits of their phone number were selected.

The total number of users included in our dataset was 180,935. Tracking the news viewing behavior of these users required us to filter them and select a panel sample based on the following criteria: 1) the user was active from May 1, 2014 to October 31, 2014; 2) the minimum number of active days should not be less than 170 from May 1, 2014 to October 31, 2014; and 3) the minimum number of recorded news viewings was 50.

Finally, 29,401 users, with a total of 29,627,554 viewing records in the data, were retained for analysis. The variables incorporated into the dataset included the information of users (e.g., gender, geographical location, and operating system of their mobile phones) and their news viewing history (i.e., time and duration of news viewing, titles of news, and category of news stories).

2.2. Measurement

2.2.1. Diversity of individual news consumption

The diversity of individual news consumption is operationalized using an entropy-based measurement. Entropy quantifies the number of variations present in a sample (Shannon & Weaver, 2002). For each individual i at day j , we obtain

$$Diversity_{ij} = - \sum_{k_{ij}=1}^w p_{ij} \log(p_{ij}),$$

where k_{ij} is the number of news categories that user i has read on day j , w refers to the total number of news categories,¹ and p_{ij} refers to the percentage of news articles in a given news category to the total number of news articles that user i has viewed in day j .

2.2.2. Global information diversity

In this study, global information diversity was measured using the transitivity of the lexical co-occurrence network instead of manually coding news topics. Information retrieval scholars have stated that text documents with the same topic tend to share more words than documents with different topics (Hearst & Pedersen, 1996). That is, topics emerge as word clusters that combine documents that share many terms. Therefore, a lexical co-occurrence network was constructed in this study to measure global information diversity. Each node of the network is a unique word. Words are connected if they appeared in the same news title. The transitivity of the lexical co-occurrence network of a given text with homogeneous topics will be higher than that of a given text with heterogeneous topics. We adopt the transitivity of the lexical co-occurrence network as an inverse measurement of global information diversity. The minimum number of transitivity is 0.08 and the maximum is 0.16 ($Std = 0.01$).

In this study, *time* is treated by using incremental values from 1 to 183; 1 refers to the first day of data collection (i.e., May 1, 2014) and 183 refers to the last day of data collection (i.e., October 31, 2014).

This study uses the following control variables: time of news viewing (i.e., weekday or weekend), operating system of user smartphones (i.e., Android or iOS²), user degree of activeness on platforms, and the economic development indicator of user geographical location. The activeness of users is measured as the total number of their news viewing behavior. The mobile operating system is dichotomized as Android or iOS. The economic development indicator of user geographical location is measured as a quartile of the growth domestic product (GDP) of a province for the geographical location of individuals.

2.3. Data analysis

This study utilizes hierarchical linear modeling (HLM) by estimating the maximum likelihood across two levels (i.e., within-individual news consumption behavior and between-individual differences in news consumption). The within-individual factors (e.g., time) are theorized as nested in the between-individual factors (e.g., global news diversity and gender) in influencing the individual diversity of news consumption. HLM contributes to capturing this structure–individual

¹ The 13 news categories were generated via machine learning. In the first step, professional web editors manually tagged a training sample of the news entries into 13 categories. The naive Bayes training algorithm, a machine learning technique, was adopted to further classify the news entries. The algorithm constructed a model that assigned new data into the specified categories given a set of training examples classified as belonging to certain categories. The accuracy rate of the algorithm was over 95%.

² Sohu App is only available for smartphones with Android and iOS operating systems because the of mobile phones with Windows OS is negligible in China during the study period.

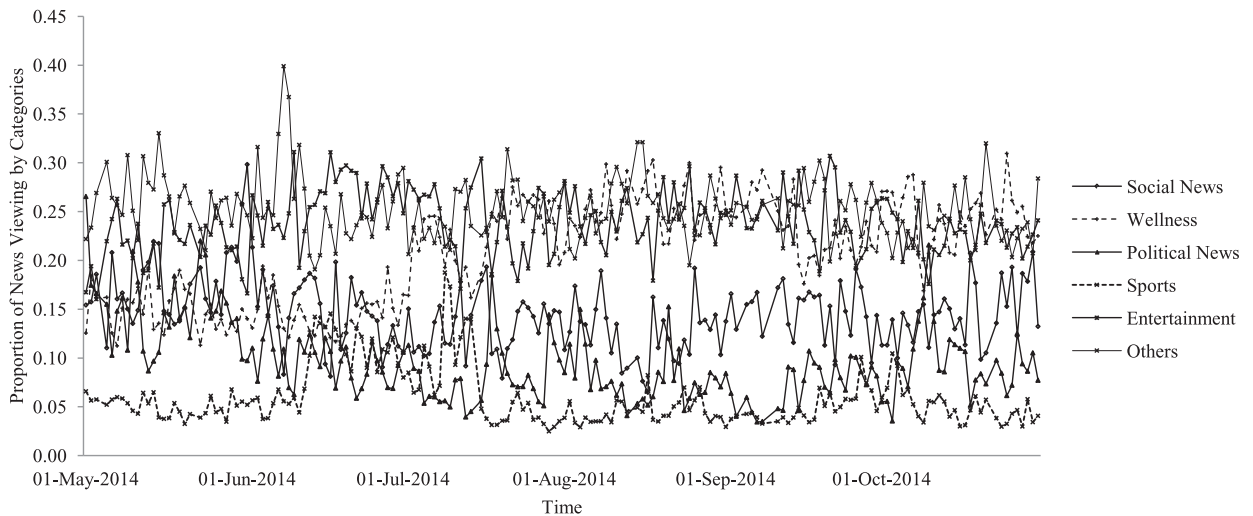


Fig. 1. Dynamics of news viewing by news categories.

Table 1
Correlation matrix of frequency of news categories.

	Wellness	Political News	Sports	Entertainment
Social News	-.37***	.13	-.13	-.36***
Wellness		-.48***	-.37***	-.08
Political News			-.19*	-.37***
Sports				.23**

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

relationship. In addition, it provides a useful method for analyzing longitudinal data, thereby enabling researchers who are studying individual change over time to fit various advanced regression models into longitudinal datasets.

The lower-level (i.e., Level 1) model depicts news consumption diversity for each individual as a linear function of factors of the characteristics of time and user activeness in news viewing. The parameters of time in news consumption and user activeness in news viewing are then considered dependent variables at the higher-level (i.e., Level 2) analysis. At Level 2, these parameters are predicted using the global information diversity between-individual differences (i.e., gender, economic development of geographical location, operating system of smartphone, and time of news viewing), the interaction effect of gender and global information diversity, the interaction effect of gender and time, and the interaction effect of time and global information diversity. To estimate the fitness of data with the model, we establish a null model, i.e., a model with no Level-1 and Level-2 predictor. We then compare the reduction of the $-2LL$ of the null model with that of the full model (Table 2).

3. Findings

3.1. Mapping the dynamics of individual news viewing behavior

All news stories are classified into 13 self-explanatory categories, namely, business, real estate, education, military, information technology, automobiles, social news, wellness, political news, sports, arts and culture, online games, and entertainment. The five most popular categories frequently read by users are social news, wellness, political news, sports, and entertainment. Entertainment and wellness news are the most popular categories, followed by social and political news. However, this news consumption pattern was interrupted during the 2014 FIFA World Cup (i.e., June 12–13, 2014), in which a sharp increase in sports news viewing but a decline in wellness news viewing occurred. This finding is consistent with that of a previous study on online news consumption conducted in the United States. Tewksbury (2003) found that over 50% of online news readers preferred obtaining online access for political affairs, sports, and entertainment news. Compared with the users described by Tewksbury (2003), Chinese users exhibit fewer tendencies to go online for business news. Fig. 1 also demonstrates that users show less interest in serious political and social news and more interest in messages about wellness in the given six months ($\beta_{\text{social}} = -0.21$, $p < 0.01$; $\beta_{\text{political}} = -0.41$, $p < 0.001$; $\beta_{\text{wellness}} = 0.71$, $p < 0.001$).

Table 1 presents the correlation matrix of news viewing frequency across the five most popular categories. The table shows that most news viewing categories from May 1 to October 31, 2014 were negatively correlated, except for the pair of entertainment and sports news. In general, the limited attention of users is suggested to lead to consumption competition

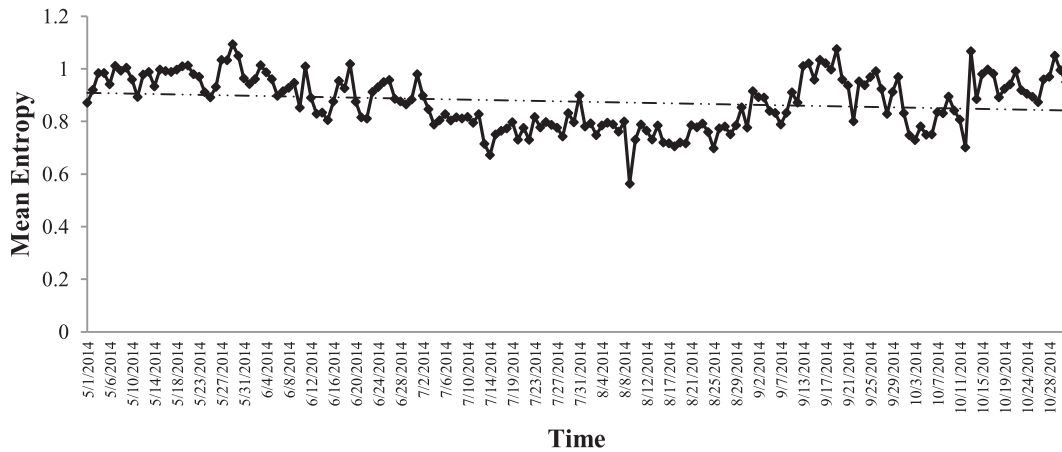


Fig. 2. Dynamics of diversity of news consumption.

Table 2
Results of HLM analysis.

	Model 1 Null model	Model 2 Unconditional linear growth model	Model 3 Conditional linear growth model
<i>Fixed Effects</i>			
Intercept	.09 (0.001)***	.82 (0.002)***	.60 (0.01)***
H1: Time		-.0004 (0.00001)***	-.0002 (0.00001)***
H2: Global Information Diversity			.79 (0.04)***
H3: Time × Global Information Diversity			.02 (0.0004)***
H4: Gender [0 = Female, 1 = Male]			.20 (0.002)***
H5: Time × Gender			.03 (0.0004)***
H6: Global Information Diversity × Gender			.88 (0.05)***
<i>Control Variables</i>			
Cell Phone Model [0 = Android; 1 = iOS]			.03 (0.002)***
Activity (n.of.views)			.07 (0.0002)***
Economic Development Indicator [Quartile = 1]			.004 (0.01)
Economic Development Indicator [Quartile = 2]			.01 (0.01)
Economic Development Indicator [Quartile = 3]			-.001 (0.01)
<i>Random Effect</i>			
Within-users Variability σ^2	.28 (0.0002)***	.27 (0.0002)***	.17 (0.0001)***
Intercept τ_{00}	.09 (0.001)***	.09 (0.001)***	.15 (0.002)***
<i>Model Fit Statistics</i>			
-2LL	5166,559	5093,905	3932,104
R ²		1.4%	23.9%

Note: Estimates and standard errors (in parentheses).

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

among different news categories. However, users who are interested in sports news also prefer entertainment news. This result is consistent with that described by Hasebrink and Paus-Hasebrink (2007), who found that the proliferation of online news content choices widens the gap between news and entertainment fans.

Fig. 2 illustrates the dynamic pattern of diversity of individual news consumption by demonstrating the trend of average entropy per day. The decreasing trend of entropy is statistically significant as evidenced by the significant slope of the regression line ($\beta = -0.18$, $t = -2.5$, $p < 0.05$, $R^2 = 0.03$). This slightly decreasing trend indicates that user news interests are narrowed down across time. In Fig. 2, the consumption of news vibrated weekly. News consumption diversity on weekends is considerably higher than that on weekdays. This result is consistent with a previous research on news viewing patterns, which found that most users have access to online newspaper websites (i.e., *Times* and *Sunday Times*) during weekdays instead of during weekends (Nicholas et al., 2000).

3.2. Factors that influence the diversity of news consumption

Table 2 presents the HLM results, with the effect of global information diversity and between-individual characteristics as aggregated variables (i.e., Level 2) as well as within-individual characteristics as individual variables (i.e., Level 1).

An unconditional mean model (i.e., Model 1) is estimated without any predictor, except for the included intercept, to evaluate whether the data fit the model well. A significant difference is found between individual variations in the influence of news consumption diversity, as evidenced by the significant intercept variance of Model 1 ($\tau_{00} = 0.09$, $p < 0.001$). The

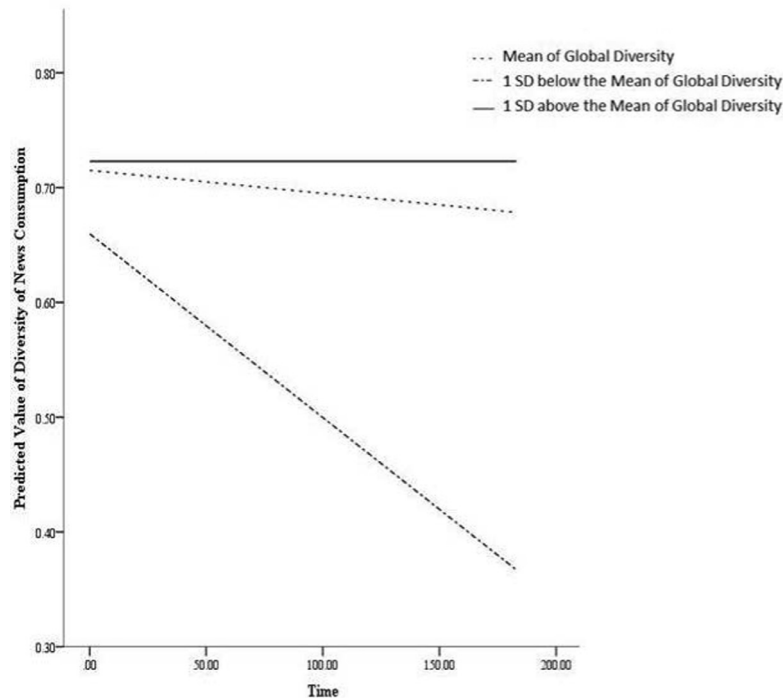


Fig. 3. Moderation effect of global information diversity on the influence of time on news consumption diversity.

intra-class correlation coefficient (ICC) for the data is 0.33, which indicates that approximately 33% of the variance in news consumption diversity can be accounted for by the effect of between-individual factors (i.e., gender, economic development of geographical location, operating system of smartphone, and news viewing time). This high ICC coefficient, which is sufficiently larger than zero, suggests that HLM is necessary compared with traditional methods (e.g., ANOVA) to estimate fixed effects (Kreft et al., 1995).

An unconditional linear growth model (i.e., Model 2) is estimated to examine whether news consumption diversity decreases over time. The linear growth rate is -0.0004 ($SE = 0.00001$, $p < 0.01$), thereby indicating that news consumption diversity decreases by 0.04 units every 100 days.

A conditional linear growth model (i.e., Model 3) is finally constructed by incorporating all within-individual and between-individual variables. As shown in Model 3 in Table 2, both within-individual and between-individual variables in the model are statistically significant to predict news consumption diversity. The pseudo R^2 of HLM is equal to 23.9%. The top portion of Model 3 in Table 2 presents the fixed effects. The coefficient of time is statistically significant ($\beta = -0.0002$, $p < 0.001$), thereby suggesting that the degree of diversity of news consumption behavior slightly decreased over time. Therefore, Hypothesis 1 is supported. Global information diversity is also determined to positively influence the diversity of individual news consumption ($\beta = 0.79$, $p < 0.001$). This finding suggests that the more diverse the global news environment is, the more diverse news an individual will consume. Therefore, Hypothesis 2 is supported. Furthermore, global information diversity positively moderates the declining trend of news consumption diversity ($\beta = 0.02$, $p < 0.001$). As shown in Fig. 3, the influence of time on news consumption diversity will be less remarkable when global news is highly diverse. Therefore, Hypothesis 3 is also supported.

This study found that news consumption diversity is dependent on gender. Significant differences exist between males and females with regard to news consumption diversity ($\beta = 0.2$, $p < 0.001$). Compared with males, females exhibit lower diversity news consumption. This result echoes the finding of a previous study (Knobloch, Westerwick, & Alter, 2007), which found that males and females have different patterns of news consumption. Therefore, Hypothesis 4 is supported. As shown in Fig. 4, the interaction effect of gender on the relationship between time and individual news consumption diversity is positive ($\beta = 0.03$, $p < 0.001$). The diversity in news consumption of male users is less likely to be influenced by time than that of female users. The decrease in news consumption diversity is less remarkable among males than among females. Therefore, Hypothesis 5 is supported. Furthermore, the effect of global information diversity on the diversity of individual news consumption is positively moderated by gender ($\beta = 0.88$, $p < 0.001$). As shown in Fig. 5, the diversity of news consumption of males is more likely to be influenced by global information diversity than that of females. Therefore, Hypothesis 6 is supported.

We also found that control variables significantly influence individual news consumption diversity. The degree of activeness of users promotes their news consumption diversity. This result suggests that access to online content is influenced

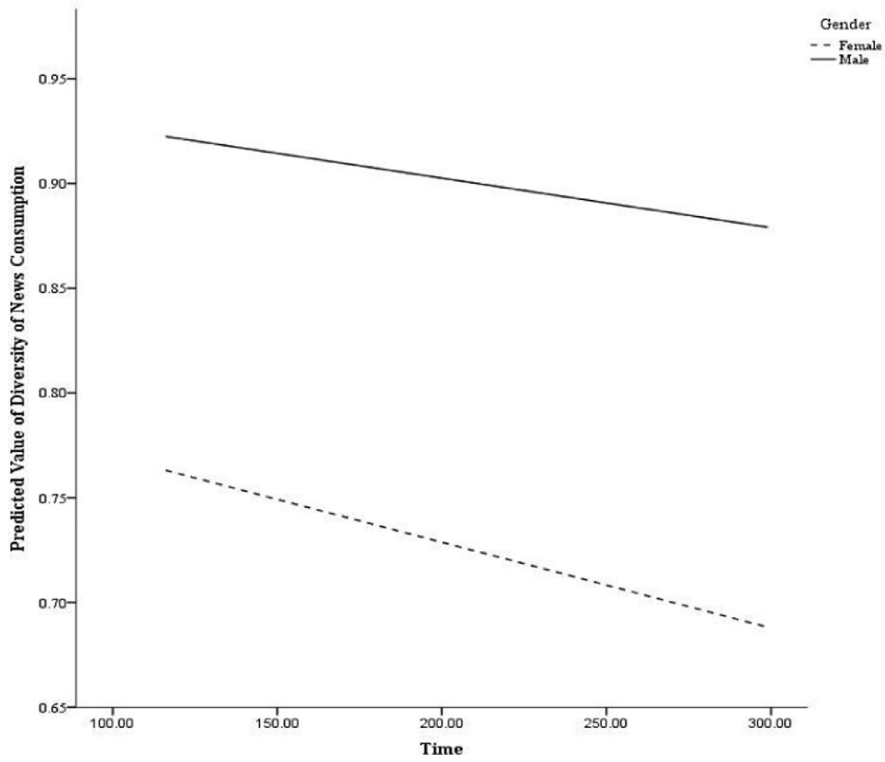


Fig. 4. Moderation effect of gender on the influence of time on news consumption diversity.

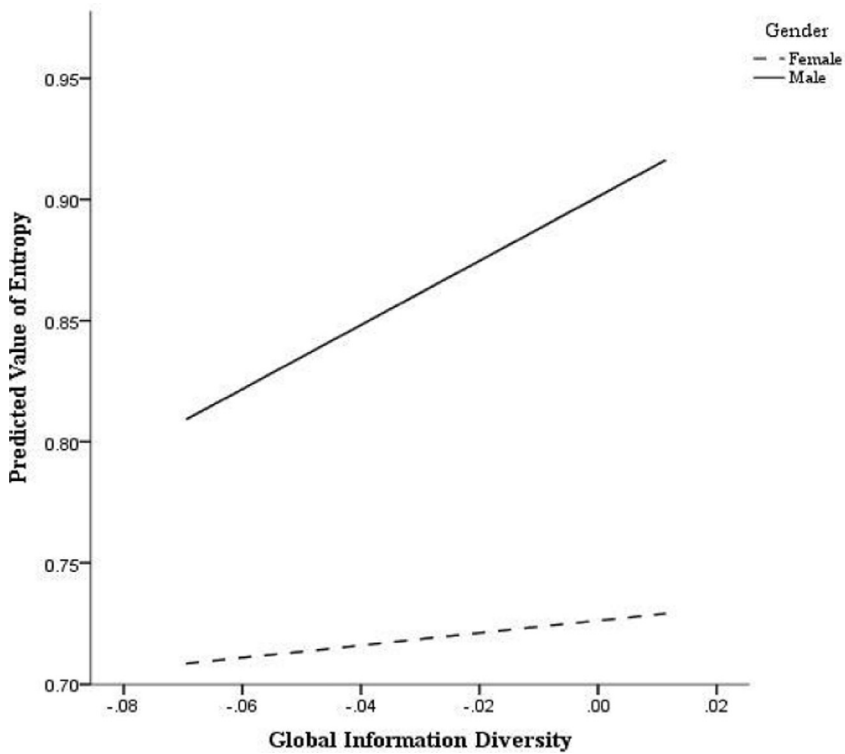


Fig. 5. Moderation effect of gender on the effect of global information diversity on news consumption diversity.

by platform adoption behavior. Active users with additional experiences in adopting the platform will consume online news with added diversity. Differences in news consumption diversity exist among users with different smartphone models. Compared with users of the Android operating system, users of iOS consume news with added diversity.

4. Discussion

This study uses a longitudinal dataset retrieved from a server log of a mobile news application in China to empirically describe the evolving diversity of user news consumption and explore the structural antecedents that drive such evolution. We first explicitly show a slightly decreasing trend of news consumption diversity and identify a positive relationship between global information diversity and individual news consumption diversity. The result indicates that the news consumption of individuals on mobile news applications have been structurally determined, such that the diversity of individual news consumption is gradually narrowed down by the creation of a homogeneous local information environment by recommendation algorithms, but strengthened by diversity of global information environment. Furthermore, significant gender differences exist with regard to the effect of micro information environment and global information diversity on the diversity of individual news consumption. Compared with that of females, the news consumption diversity of males is less likely to be influenced by a homogeneous and individualized micro information environment as represented by the diversity of news interests of males decreasing less remarkably than that of females. However, males are more likely to be influenced by global information diversity than females.

We discuss the theoretical and methodological implications of this study by focusing on the long-term consequences of the structural constraints of individual news consumption and the adoption of behavioral data. Lastly, practical implications and limitations are discussed.

4.1. Micro and macro consequences of the structural constraints of individual news consumption

The present study complements the traditional research framework that considers news consumption a motivation-driven behavior determined by psychological factors (Biocca, 1988). Selective exposure theory states that individuals have long been assumed to be goal-directed. Users select media outlets that match their beliefs and construct meanings of their news consumption behavior in accordance with their motivations (Biocca, 1988; Katz & Blumler, 1974; McQuail et al., 1972; Rosengren, 1974).

The current work contributes to the literature on news consumption by investigating its structural antecedents. We argue that individual news consumption is empowered by the diversity of the global information environment but limited by the creation of individualized and homogeneous micro information environments by recommendation algorithms on mobile news applications.

Compared with the motivation-driven approach, this structurally oriented news consumption perspective further emphasizes the social implications of mobile news technology. At the individual level, individualized and homogeneous micro information environments will create “filter bubbles” for each user. Users are gradually exposed to specific clusters of information, along with their regular adoption of mobile news application. The existing beliefs of users are reinforced because they are locked inside “filter bubbles,” in which they are exposed to a narrow set of viewpoints. Therefore, the creation of micro structural constraints for individual news consumption by the recommendation algorithms of mobile news applications facilitates news fragmentation at the individual level.

At the societal level, the long-term focus of individuals on specific news topics and the gradual decrease in news consumption diversity have created a fertile ground for exacerbating audience fragmentation, thereby leading to the disappearance of the public sphere and commonly shared topics in society (Bakshy et al., 2015; Flaxman et al., 2013; Pariser, 2011). As evidenced in the current study, the negative correlation between political news and other news categories (i.e., sports, entertainment, and wellness) indicates that a gap exists between soft news users and serious political news users. This result echoes a previous finding that argues that entertainment news viewing will lead to less political efficacy and political participation (Chan et al., 2012). The individualized choice of news content introduces difficulties to individuals in finding more heterogeneous contents. People who prefer soft news information abandon political news. Soft news audience will miss both the interest-based and information-based effects of serious news consumption.

4.2. Advantage of adopting mobile behavioral data

This study directly analyzes user news consumption behavior by extracting behavioral data from a server log instead of analyzing the self-reported news viewing intentions of users. Mobile behavioral data demonstrate its advantage in quantifying individual news consumption behavior in two ways. First, the objective individual behavioral data increases the accuracy of measuring news consumption behavior. In traditional surveys, multiple layers of cognitive filters influence a subject reporting a behavior (Eagle et al., 2009). In particular, traditional self-report survey data, through their very nature, invite respondents to rationalize their behavior and create attitudinal “causes” for their actions (Meijer & Kormelink, 2015; Salomon, 1994). In this regard, the reliance on self-report data will provide biased measurements of user news consumption behavior (Eagle et al., 2009). By contrast, the purely objective measures of news consumption used in the present study eliminate the self-reported bias and increase the accuracy of quantifying the news viewing diversity of individuals. Second,

mobile behavioral data allow researchers to investigate the temporal pattern and evolution of individual news consumption behavior. Survey-based data typically limit the number of time points of data collection. Minimal or even only a single number of snapshots of data collection is available in traditional news consumption studies (Nel & Westlund, 2012). In comparison, leveraging mobile behavioral data with real time stamps demonstrates the advantages of such data in describing and modeling the dynamics of individual news consumption behavior.

4.3. Depoliticization on Chinese mobile news platforms

Different from the argument of optimists that the higher availability of political information will lead to more people gaining access to political information, thereby facilitating their political participation (Prior, 2005; Wei, 2014), the present study finds that users of this Chinese mobile news platform have gradually shown decreasing interest in political and social news but increasing interests in wellness news.

This result indicates that mobile news applications in China fail to facilitate users to view political information. Mobile news applications strengthen their recreation function but weaken the role of distributing serious news, such as political and social issues (Leibold, 2011). One possible reason for this result is that political and social news in Chinese mobile platforms are still highly homogeneous given that serious news remains under severe censorship in China. As indicated in the *Regulation on Internet News Information Administration*, which is jointly issued by the State Council Information Office and the Ministry of Industry and Information Technology,³ commercial news websites in China are banned from publishing original political and social news stories. For current political and social news, including stories and comments on politics, economics, military, foreign affairs, public affairs, and public emergencies, commercial online news platforms can only “reprint” news stories that have already been published by state-owned media outlets. Government and party organs continue to act as the dominant sources of political and social news, thereby leading to the highly homogenized political and social news in mobile platforms. Such control over these types of news is one of the possible reasons why users on mobile platforms have gradually lost interest in political and social news.

4.4. Practical implications

This study demonstrates the implications of news recommendation application design. Mobile recommendation algorithms create an individualized but homogeneous information environment for each user and gradually narrow down their news interests, particularly on serious political news, which is highly unhealthy for the sustainability of the news platform (Chan-Olmsted et al., 2013).

Mobile news applications should be aware of this narrowing trend of users' news interests. To avoid the loss of users, mobile news services should maintain the diverse news interests of their users. For example, a recommendation system can set a minimum number of news categories to be displayed for each user. Mobile news applications can also enrich the global diversity of news topics, as suggested by the findings of this study. Furthermore, mobile news services can investigate implicit news interests and strive to develop the potential news interests of users that are beyond their demonstrated interests based on the historical news viewing behavior and personal registration information of users.

4.5. Limitations

This study fails to track the complete history of news browsing behavior for each user because of data limitation. Only active users during the data collection period (i.e., May 1–October 31, 2014) were recruited. The time trajectory of individual news consumption is likely quadratic or even cubic rather than linear. Further studies should collect data from Day 1, i.e., when users log in to the mobile application system and trace the entire process of the dynamics of news consumption behavior by using additional sophisticated time series models.

This study also limits its focus on news consumption behavior on a single mobile news application. However, news consumption on mobile platforms is not the only indicator that can measure user overall news exposure. Users have numerous alternative platforms to view news, such as encountering news information in an incidental manner, both online and offline (Tewksbury, 2003). The single data source used in this study cannot help us investigate the overall news consumption of individuals. Future studies should use cross-platform data to obtain a panoramic picture of individual news consumption and exposure behavior by investigating whether the decreasing trend of diversity of online news consumption influences the diversity of overall news consumption.

5. Conclusions

This study extends the static perspective of news consumption research to a dynamic perspective. It uses a longitudinal dataset to empirically show a slightly but significantly decreasing trend of news consumption diversity. Furthermore, this study complements the motivation-driven convention of news consumption research. Individual news consumption behavior is embedded into the structural determinants of the mobile news platform in the sense that the diversity of news

³ http://news.xinhuanet.com/politics/2005-09/25/content_3538899.htm.

consumption is narrowed down by the creation of homogeneous micro news information environments by recommendation algorithms but strengthened by the diversity of the global information environment. In addition, these structural effects on the diversity of news consumption are contingent on gender. The effect of global information structural features on the diversity of individual news consumption is stronger on males than on females. The effect of the local information diversity of mobile news platform on individual news consumption diversity is stronger among females than among males, as represented by the diversity of the news interests of males decreasing less remarkably than that of females.

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