The Effect of Media Richness on Transactive Memory System in Virtual Teams: the Moderating Role of Team Identity

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Abstract

The model based on media richness theory, this paper explores the influence of different media richness on the development of transactive memory system in virtual teams, and examines the moderating role of team identity. The empirical research results based on 186 questionnaires indicate: in the virtual team, media richness has a significant impact on the development of transactive memory systems and team identity has a negative impact to the relationship between media richness and transactive memory system.

Keywords

Virtual team, Media richness, Transactive memory system, Team identity.

1. Introduction

In the era of knowledge economy, when the total amount of knowledge and the utilization rate of knowledge are improved, the team can make great progress. The transactive memory system (TMS) coordinates personal knowledge, enhances the total amount of knowledge, and improves the knowledge utilization rate, which is paid attention by enterprises and scholars in the process of team development. In the traditional team, a large number of scholars have done quite mature research on TMS. But in the virtual team, there are few researches in this area. Based on Internet technology, virtual teams have become the main organizational form of cooperation and communication between and within companies. Due to the cross-regional and organizational characteristics of virtual teams [1], virtual team's members cannot integrate and coordinate knowledge in a timely and effective manner through face-to-face communication (FTF) like real teams. The TMS has the characteristics of knowledge combination and coordination [2], so the research on the development of TMS in virtual team meets the actual requirements.

Communication is one of the necessary daily tasks for team members and is considered as an important factor in team development. Some literature shows that through information interaction and communication, team members are familiar with each other, understand their personality characteristics and expertise, and can form differentiated TMS [2]. Scholars such as Argote and Yuan Song aaaaaahave verified that communication can promote the development of TMS [2, 3]. With the advancement of technology, members of the virtual team use multiple communication media (email, phone, WeChat, QQ, etc.) to communicate daily. However, there are some system problems in Internet technology [3]. Communication through network media is not perfect. In addition, team members are rusty with each other, which can easily cause poor communication and distrust. At this time, the role of team identification becomes more crucial. Team identification is based on the theory of social identity, which has been proved to improve the level of trust among team members, promote mutual cooperation, and better achieve team goals [4]. In the context of high team identity, team members trust each other, have a high sense of belonging to the team, and are willing to take the responsibility and obligations of the team. Based on the characteristics of team identity, this paper will study the relationship between communication media and TMS under the influence of team identity.

Some scholars have studied the impact of different communication methods on the virtual team, but few studies have combined communication media with TMS. In the context of a virtual team, this paper studies the relationship between communication media and TMS under the moderated variable-team cognition. The purpose is to explore which kind of communication medium used, when the degree of team cognition is different, has a better impact on the TMS, so as to provide some help for the virtual team building of the enterprise. For example, in the case of low team cognition, which communication method should be adopted to promote the development of TMS and thus improve the performance of virtual teams. Therefore, for the variables of media richness, team identity and TMS, this article raises specific questions about them:

In the virtual team, communicating through different communication media, whether it has a different impact on the establishment of TMS? How do they affect TMS under the moderated variable of team identity? And whether TMS have a positive impact on team innovation in virtual teams?

2. Theoretical Model and Hypotheses

2.1 Communication media at work

The members of virtual team mainly rely on network technology for communication and cooperation, so the communication technology, namely communication media, refers to the main electronic technology that members rely on in communication, including video conference, teleconference, audio mail, timely communication, etc. Members of the virtual team rarely meet in reality, there is almost no FTF opportunities. At this time, network communication technology is particularly important. And with the development of time, the cost of network technology is getting lower and lower, and the scope of application is getting wider and wider. The classification of communication media is based on two theories: media synchronization[5] and media richness[6]. Media synchronization divides communication media into two parts: synchronous and asynchronous. Synchronous interaction means that team members communicate through telephone conferences, video conference or chat conversation at the same time. "Synchronous" communication media allows individuals to process the same tasks at the same time, with the same information [5]. Asynchronous interaction means that team members don’t communicate at the same time, for example in the case of email.

Synchronous communication is closer to face-to-face communication than asynchronous communication [7]. Media synchronization focuses on measuring communication media in terms of time. The theory of media richness explains the difference of different media's influence on task performance [6]. This paper wants to measure the different influence of different media on the TMS. Media richness theory is more applicable. Based on media richness theory, communication media can be roughly divided into [7, 8]: poor media-text, general media-audio and rich media-videoconferencing. Of course, the richest media is FTF, followed by video, and finally phone, chat, email, print communication. Rich media have the following characteristics: (1)spread multilingual and non-verbal information, (2)use natural language, (3)provide immediate feedback, (4)convey personal feelings and emotions [6].

2.2 Transactive memory system in virtual team

The concept of transactive memory system was proposed and developed by Wegner [9]. Now its definition is basically perfect. It is a system that encodes, stores, searches and communicates information from different knowledge fields in the social system, and shares team members' own professional fields, so that each other can know "who knows what" [3], which can make full use of social resources and carry out good division of labor and cooperation. It has two components: the individual's professional skills, and the interaction process of coordinating professional skills [2]. Taking the computer network of directory sharing as an example, the life cycle of TMS can be composed of three stages[10]: directory update, information distribution and retrieval coordination. In a word, the TMS is gradually formed among teams, which requires members to establish and develop through communication. Therefore, communication has a role that cannot be ignored.

Learning is a key factor in the formation of TMS. From the beginning to the end of the task, team members continue to learn and improve the "who knows what" information system, which promotes the development of TMS, so the learning process is conducive to the development of TMS [11]. Communication among members promotes members to understand professional skills, to learn in depth, and to work together to achieve goals efficiently. Therefore, communication is a factor that promotes the establishment and development of TMS[12]. Moreover, scholars such as Yuan have found that indirect communication, that is, information about members obtained from superior leaders, appointment documents and other tools, also plays a role in promoting the formation of TMS [12].

In the real team, members communicate face-to-face; in the virtual team, members are scattered and can only communicate with the help of communication technology. Now the communication media used by members of virtual team are more and more diverse, but they can be basically divided into three categories: text, audio and video. Because of the decentralized nature of virtual team members, they are more dependent on Internet communication technology. Communication enables team members to understand each other's expertise and skills and coordinate their information, which can promote the development of TMS [3, 13, 14]. So far, many researches have indicated that communication in virtual team can promote the development of TMS, or conversely, TMS in virtual team has a positive effect on communication [15], but few researches have considered media richness. Kana and other scholars have found that FTF communication can promote the development of TMS more than the communication of virtual teams [4]. The traditional team is a special virtual team, and FTF is the communication with the highest media richness. From this study, we can find that communication through rich media has a higher positive impact on the development of TMS than communication through poor media. Based on this, we believe that in the virtual team, there is a significant difference in the impact of high and low abundance media communication on the development of TMS, and the use of high abundance media can promote the establishment of TMS more than low abundance media. Therefore, the following assumptions are proposed:

H1a: in the virtual team, video conference is more conducive to the establishment of TMS than audio communication.

H1b: in the virtual team, video conferencing is more conducive to the establishment of TMS than text communication.

H1c: in the virtual team, audio communication is more conducive to the establishment of TMS than text communication.

2.3 Moderated role of team identity

Team is the smallest unit collective of human self-worth. Based on the theory of social identity, team identity is usually defined as the sense of belonging that team members experience in the team, which is the same as the identity assigned by the team, that is, they identify with the identity given by the team, and are willing to assume obligations and responsibilities for this identity. In a team, the sense of belonging will make individuals have emotional dependence on the team identity they identify, while the perceived identity will make individuals act according to the goals, norms and values contained in the team identity [16]. In this paper, team identity refers to team members' recognition of the identity given by the team, and their dependence and trust on the team, willing to assume due responsibilities and enjoy due rights according to the team identity.

Since the concept of team identity was put forward, it has been regarded as an important theoretical framework that can help teams out of the dilemma of cooperation[17] and an important adhesive. The members of virtual team are geographically and psychologically dispersed, and cannot share context and knowledge through communication technology. So it is difficult to establish trust among members, and identify each other's expertise and skills for division of labor and cooperation. Compared with traditional teams, it is difficult to build TMS[18, 19]. Team identity has been proved to improve the level of trust among team members, promote cooperation and communication, and better achieve team goals [20]. In the virtual team with high team identity, team members trust each

other, actively share knowledge and experience, and dare to take responsibility. Compared with the virtual team with low team identity, it can promote the development of TMS.

Based on the media synchronization theory, some scholars have explored the influence of communication technologies with different richness in virtual teams on team trust and communication in different time periods [21], and found that in the early stage of virtual team development, the uncertainty among team members Higher, more difficult to trust each other, and communication through rich media will lead to more Relationship conflict is not conducive to the establishment of team trust[22]. Based on the media richness theory, rich media can greatly promote the processing of fuzzy information, while poor media can promote the processing of a large amount of information [23]. Under the low team identity, virtual team members are unfamiliar with each other, and the information about tasks is vague and misunderstood. The use of rich media can improve the use efficiency of fuzzy information, which is conducive to the establishment of TMS. Under the high team identity, members understand each other and understand information clearly, but there are a lot of information to be processed at this time The use of barren media can deal with a large number of clear information, which is conducive to the development of TMS. Based on the theory of media richness, the following assumptions are put forward:

H2: team identity negatively regulates the relationship between the media richness of communication media and the TMS. That is, when the team identity is low, the use of rich media can more promote the development of TMS; on the contrary, the use of poor media can more promote the development of TMS.

In conclusion, the following conceptual models are proposed in this study, see Fig. 1.

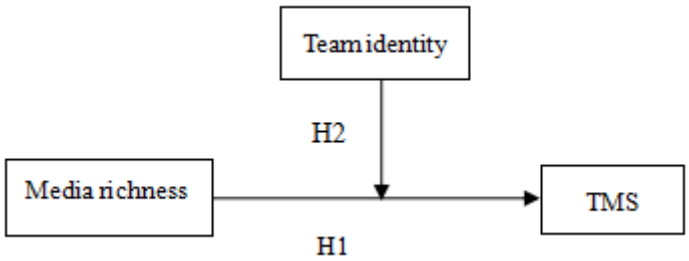

Fig. 1 Conceptual model

The virtual team is mainly researched according to the "input-process-output" (IPO) model. This theoretical model is established according to the IPO model. "Input" refers to the unique characteristics of the virtual team-communication is carried out through network media, that is, media richness; "process" refers to the transactive memory system produced by interpersonal communication and collaboration. Among them, a moderated variable of "team identity" is added to "input" and "process", and it can also be divided into social psychological factors in "process".

3. Method

3.1 Survey Sample and Data Collection

In this study, the questionnaire was distributed online in the form of electronic questionnaire to the relevant personnel who have participated or are participating in the virtual team. The questionnaire of this study is designed with reference to the previous studies at home and abroad, and after the questionnaire design was completed, the testers were selected for pre-survey. According to the questions and suggestions put forward by the participants in the pre-survey, the questionnaire was modified and improved to be used in the formal survey.

In the formal survey, 200 questionnaires were issued and 186 were recovered, with a recovery rate of 93%. After eliminating incomplete data and low quality questionnaires, 158 questionnaires were obtained, with an effective recovery rate of 79%. In terms of demography, men accounted for 43.04% and women 56.96%; in terms of age, 8.9% were under 21, 84.8% were between 22 and 35, and 6.3% were over 36. As for the education level, 1.3% of the participants are from high school / secondary

school, 8.2% have college diplomas, 81.6% are undergraduates, and 8.9% are graduate students. In general, 90.5% of the participants have university degree or above. It can be seen that the educational level of the respondents is generally high. In addition, in terms of the working years, 48.1% less than 3 months, 13.9% from 3 months to 6 months, 7.6% from half a year to 1 year, 8.2% from 1 year to 2 years, and 22.2% more than 2 years. 38% of the participants work for more than half a year, and the average working time of the participants is not high.

3.2 Survey Measures

The variables of this study mainly include media richness, team identity and TMS, which are measured by 5-level index measurement method. In order to ensure the reliability and validity of the questionnaire, except for media richness, the measurement scales are directly based on the mature scales of domestic and foreign scholars, the translation and back-translation method is used to ensure the accuracy of the measurement scale.

(1) media richness can be measured by the frequency of different communication media used by virtual team members in their daily work [21, 24]. Daily communication of team members can be divided into peer communication, upward communication and downward communication. Because participants have not worked long and communicate less downward, this study measures media richness from peer communication and upward communication. It includes 6 items, such as "Our team members communicate with colleagues by the phone", "Our team members communicate with superiors by the phone". Because different types of communication are to be measured, the following restrictions are made to the questionnaire: the answers of 123 questions and 456 questions are inconsistent, please compare the two types of questions and choose the relative value to distinguish different media richness.

(2) Team identity can be measured from three dimensions: cognition, emotion and evaluation. Most team identity studies point out that cognition based on self classification is the basis of identity formation; emotional identity has stronger and more direct explanatory power to team members' pro-social behavior[25]. Some scholars have proposed that the construction of emotional commitment reflects the emotional factors of social identity, because emotional commitment involves "collective identity, participation and emotional attachment", that is, emotional commitment can largely explain team identity. So in this paper, Allen and Meyer's Emotional Commitment Scale was used to measure the value of team identity [26], including four items such as "I have a strong sense of belonging to the team".

(3) The initial scale of TMS was developed by Lewis. It was measured from three dimensions: expertise, credibility and coordination. Each dimension corresponds to 5 items, with high reliability and validity [27]. However, due to the small amount of samples used in the development and the data of western enterprises, it is not suitable for the characteristics of Chinese enterprises. Therefore. Chinese scholars collect a large number of domestic enterprise data to modify the scale appropriately, delete the second and ninth questions on the scale, and increase the validity to 0.81[28]. This paper uses the modified scale to measure TMS, including 13 questions: "each of our team members is responsible for different aspects of expertise", "I believe that the information put forward by other team members in the discussion is reliable", "we complete the task successfully and efficiently", etc.

4. Results

This study used IBM SPSS Advanced Statistics 20.0 software to analyze the data. According to the two-stage analysis method proposed by Anderson et al. [29], the reliability and validity of the measurement model were analyzed first, and then the hypothesis was tested by hierarchical regression and regulatory regression.

4.1 Descriptive statistics

The average, standard deviation and correlation coefficient of main variables are shown in Table 1. media richness and TMS ($r = 0.339$, $P < 0.01$) were positively correlated, and team identity was positively correlated with media richness ($r = 0.495$, $P < 0.01$) and TMS ($r = 0.3658$, $P < 0.01$). It

shows that the theoretical model proposed in this study is basically correct and can be used for regression analysis of variables.

Table 1 Means, standard deviations, and correlation coefficients

	Means	SD	1	2	3
Media richness	3.133	0.911	1		
TMS	3.609	0.500	0.339***	1	
Team identity	3.653	0.837	0.495***	0.658***	1

Note: *** = p<0.001.

4.2 Reliability and validity test

Reliability and validity of variables measured with multiple indicators should be ensured when used. In this study, media richness, TMS and team identity were all measured by multiple indicators. Reliability measures the degree of consistency between indicators of a particular variable, which is statistically represented by Cronbach α. It is generally believed that Cronbach α value greater than 0.7 can meet the measurement requirements [30]. The Cronbach α values of the three scales were all greater than 0.7, indicating that the internal consistency level of the scale was high and had good reliability. As for the validity of the questionnaire, first of all, the scale used in this study is derived from the domestic and foreign mature scales or designed based on previous studies at home and abroad, and has been predicted and further modified. So the scale used in this study is consistent with the content validity. Secondly, the load value of each variable is greater than 0.6, which shows that the variables in this study have good structural validity. As to whether individual variables can be aggregated to the team level, this study uses the intra-group consistency coefficient Rwg (J), cross-level correlation coefficients ICC (1) and ICC (2), and F-statistics of ICC (1) for evaluation. The RWG (J) of the three variables are all greater than 0.6, which indicates that the variables have a good level of intra-group consistency. At the same time, the values of ICC (1) and ICC (2) were higher than James' recommended standard values of 0.05 and 0.5 respectively, and the F-statistics of ICC (1) passed the significance test. Therefore, the individual data of the three variables in this study can be effectively aggregated to the team level.

4.3 Regression

In order to obtain more robust empirical data, this study uses hierarchical regression and regulatory regression methods. First, exclude the influence of control variables on dependent variables; then, analyze the main effect, that is, the influence of media richness on TMS; finally, analyze the regulatory effect of team identity, and the results are shown in Table 2.

Model 2 examined the direct effect of media richness on TMS. The results showed that media richness had a significant positive effect on TMS ($\beta = 0.291$, $P < 0.01$). In order to test the impact of different communication media richness on TMS, this study compares the three modes of media richness in pairs, and the analysis results are shown in Table 3. There is no significant difference between the impact of audio communication and text communication on TMS (I-J = 0.063, P = 0.785 > 0.05), which does not support the H1a. There are several reasons for this result: ① the sample size used in this study is small, which may be insufficient to show the difference; ② in this study, e-mail is used to represent text communication and telephone is used to represent audio communication, which may be one-sided; ③ the use rate of telephone in daily life is relatively high, basically the same as or even higher than that of e-mail, and the telephone is not connected to the Internet, which is not a typical Internet communication medium, which is more inconsistent with that of e-mail and video conference. Compared with text communication, video conference has a greater role in promoting the development of TMS (I-J = 0.386, P = 0.000 < 0.05), which supports the H1B; compared with audio communication, video conference has a greater role in promoting the development of TMS (I-J = 0.323, P = 0.003 < 0.05), and the H1C is supported. These results show that the higher-rich communication type is more conducive to the development of TMS than lower-rich communication

type, which are consistent with the results of Model 2. Model 3 tested the moderated effect of team identity. The regression results showed that team identity had a positive moderating effect on the relationship between media richness and TMS ($\beta = 0.679$, $P < 0.1$), assuming that H2 was supported.

In order to display the regulatory effect more intuitively, the sample data is first divide into high and low groups according to the median recognized by the team, and carry out regression analysis respectively, See Fig. 2. Fig. 2 shows that under the low team identity, media communication has a positive effect on the development of TMS, Support a part of H2; under the high team identity, there is no significant difference among the three variables, but they are still positive, do not support partial H2.which partially verify h2.

Table 2 Hierarchical regression

	Model 1	Model 2	Model 3
Control variable			
Gender	0.127	0.138	0.108
Age	-0.095	-0.091	-0.052
Education	0.098	0.071	0.134
Operating hours	0.240	0.165	0.141
Main effect			
Media richness		0.289***	-1.316***
Moderated effect			
Team identity			0.420***
Team identity*Media richness			1.695***
Adj-R2	0.026	0.099	0.429
△R2	0.050	0.077	0.324
△F	2.047	13.538***	90.070***

Note：①*** =p<0.001, ** =p<0.01, * =p<0.05.

②The coefficients in the table are standard regression coefficients.

Table3 Comparison of different media richness

(I)	(J)	Mean difference (I-J)	Sig.
Text communication	audio communication	-0.063	0.785
	Video conference	-0.386***	0.000
audio communication	Text communication	0.063	0.785
	Video conference	-0.323***	0.003
Video conference	Text communication	0.386***	0.000
	audio communication	0.323***	0.003

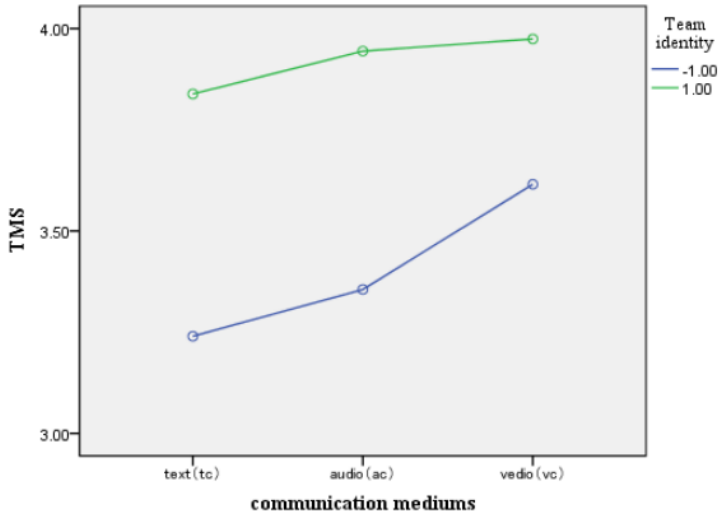

Fig. 2 Moderated effect of team identity

5. Discussion and Conclusion

Based on the theory of media richness, this study analyzes the influence of media richness on TMS, and discusses the regulatory role of team identity in virtual team through empirical research methods.

5.1 Main conclusions

The research results show that media richness is an important factor affecting virtual team development. Generally speaking, in virtual team, the richness of communication media has a positive impact on the development of TMS. Compared with the use of audio and text media, the use of video conference for communication is more conducive to the development of TMS, verifying H1B and H1C; compared with the use of text communication, the use of audio for communication has no different impact on the development of TMS, but at the same time, it does not show that text communication can promote the development of TMS more than audio communication, which does not support H1a. This is because that the richer the media is, the easier it is for team members to obtain information related to other members from text, language, form and expressions, etc. Among them, the information obtained from text and language only accounts for 7% of the total information, while the situation language accounts for 93%. Therefore, team members can get more information about other members through high-rich media to establish "who knows what" system, thereby promote the development of TMS.

At the same time, this study explored the negative moderating effect of team identity on the relationship between media richness and TMS. The results of this study partially verify H2. Video conference can promote the development of TMS better than audio communication and text communication, no matter in low team identity or high team identity. This is because: 1. In virtual team, often dealing with uncertain tasks, i.e. tasks with high ambiguity, equires comparison of information and different interpretations and discussions of existing information, which is more suitable for communication using high-rich media[31]; 2. High-rich media contains more information than other media, which is conducive to emotional integration. Virtual team cannot only rely on task to maintain, but also need emotional connection. This explains that in real life, when it is necessary to make a detailed description of uncertain events with others, such as an interview, or communicate feelings with family and friends, video conference and Wechat video chat are often used.

5.2 Implications

For knowledge management research, the theoretical contributions of this research mainly include the follows three points: First, under the model of virtual team, the development of TMS is studied, and the research scope of TMS is further expanded. Second, adding the variable of media richness to the research of TMS, not only expands the research scope of media richness theory, but also expands

the research scope of antecedent variables of TMS, which is helpful to understand the development mode of TMS in virtual team. Third, this paper tests the moderated effect of team identity on the relationship between media richness and TMS, which is helpful to understand the mechanism of media richness on TMS and open the "black box" of the development of TMS in virtual team.

For practice implication, the research results of this study have a certain guiding significance for optimizing the use of communication media in virtual team, and promoting the achievements of virtual team by using TMS. Virtual team has become an important foundation for the development of enterprises and the increase of core competitiveness. The use of various communication media has become the trend of the times. Proper use of communication media not only increases work efficiency, but also saves communication costs. In virtual team, enriching communication media is conducive to the development of TMS. Low team identity negatively regulates the relationship between media richness and TMS.

These conclusions indicate that: (1) enterprises should strengthen the education of TMS cognition and consciously promote the establishment and development of TMS. Enterprises can usually organize training on the formation, development and measurement methods of TMS, and establish communication groups for learning. Aiming at the two components of TMS: individual expertise and the sum of collective information coordination, measures are taken to strengthen the development of TMS. (2) Increase the diversity of communication media and enhance the understanding and measurement of team identity[32]. Generally speaking, the higher the richness of communication media is, the better. However, for different levels of team identity, different richness of communication media should be adopted. Therefore, we should also strengthen the understanding of the concept of team identity, understand its definition and measurement methods, and take measures (such as regular meetings, discussion of team objectives, personal objectives, etc.) to increase team members' trust and responsibility to the team, increase team identity. The higher the degree of team identity, not only represents that the team members have a sense of belonging to the team, which is conducive to the achievement of team goals, but also the proper use of low-cost communication media, can also promote the development of TMS.

5.3 Limitations and future research opportunities

This research have several limitations that offer future research opportunities. 1. In this study, the selection of text communication, audio communication and video conference is one-sided. The future research should be based on the characteristics of media richness, according to the actual situation of virtual team using communication media, combined with the relevant research at home and abroad, and make a more reasonable choice of media objects from various aspects. 2. This study is a team level study, and its data is collected by questionnaire. Due to the limitation of time and resources, as well as the characteristics of decentralized distribution of virtual team members, only personal-level research data can be collected, so virtual team is regarded as a two-person team, and personal data represents team data. Due to less sample collection and more external factors, the error of experimental results may be large. In the follow-up study, the empirical method of experimental research is proposed to collect data, which can control the overall environment, avoid the influence of other factors, and better measure the causal relationship between variables. 3. This paper only explores the influence of communication with different media richness on TMS under the regulation of team identity. There is no research on the three dimensions of TMS[27]: expertise, credibility and coordination. The future research can further explore the influence mechanism of media richness on the three components of TMS.

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