

# **The Expandability and Extendability of Root Concept: An Analysis of Two Founders of Rap/Hip-Hop Music**

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**Abstract:** This study investigates evolutionary trajectories of influential ideas and assesses the quality of influences on next-generation innovators by using the data of two founders of rap music: Run-D.M.C. and N.W.A. We propose expandable and extendable root concepts, which differ in their degree of heterogeneity of recombined ideas.

**Keywords:** *Innovation, Influence, Root concepts, Cultural evolution, Rap music*

## **Introduction**

There is no doubt that Elvis Presley, Pablo Picasso, and Akira Kurosawa have played significant roles in shaping the evolutionary trajectories of their fields. These cultural innovators are not only suppliers of great works to which audiences have been persistently attracted but also providers of influential ideas that next-generation innovators have been using to create their own cultural works. Such exceptionally influential ideas are what we call root concepts, defined as path-breaking ideas with which next-generation innovators synthesize other ideas in generating their own innovations. We use the word “root” to capture evolutionary processes in which root concepts act as ancestors to develop the “sire lines” of ideas in the next generation, and open up new opportunities by creating new genres and fields, or invoking paradigm shifts.

Understanding root concepts requires theories and analyses of (1) the emergence of innovative ideas by root concept suppliers, and (2) patterns of influence that next-generation innovators receive from them. Previous research has presented some insights into the former by showing the effects of non-local searches, network brokerage, and network centrality<sup>1,2</sup>. By contrast, with some exceptions, less is known about the latter for two reasons, the first of which is methodological. While research has long relied upon backward citations of academic papers and patents to observe influence<sup>3</sup>, the available research has not fully explored alternative methods for fields and contexts wherein such citation records are unavailable. To expand the applicability of root ideas, methodological advancement is imperative. The second reason is theoretical. Research has focused on the extent of different influences by counting the number of citations but rarely studies how followers actually use root concepts in generating their own innovations<sup>4</sup>.

The objectives of this study are to propose a non-citation method for assessing root concepts' influences on next-generation innovators and to study the quality of root concepts' influence by analyzing patterns of next-generation innovators' re-combinatory activities. In particular, we are going to study how next-generation innovators use sets of ideas presented by root concept suppliers, how root concept suppliers influence next-generation innovators, and how research assesses root concept suppliers' influence with non-citation data. To achieve these objectives, we used the data of two root concept suppliers who established a new genre of rap music in the 1980s: Run-D.M.C. and N.W.A. It is typical of some specific musicians to exert considerable influence on the next generation, despite no systematic citation record being available for them. The presence of two prominent root concept suppliers offers us an opportunity to observe any variations between them. In addition, this study focuses on the

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describes sound and feeling of the song as the recombinant elements because music creation involves re-combination of emotional moods<sup>5</sup>. We propose a method of assessing influence by using the data of moods that the two suppliers presented: running topic-modeling, and measuring divergence between these moods and ones that followers presented.

Using this new method, we find that (1) both Run-D.M.C. and N.W.A had substantial and long-lasting influence on the next generation, (2) Run-D.M.C.'s root ideas attract more diversified elements (i.e., moods) than do N.W.A, (3) Run-D.M.C.'s musicality has higher interpretative flexibility than that of the latter, and (4) social networks present partial accounts for their differences in the quality of influence exerted. Using this evidence, we propose two types of root concepts: (1) expandable root concepts and (2) extendable root concepts. While both concepts are extensively used in next-generation innovation, a major distinction between them resides in the degree of heterogeneity or homogeneity of elements or pre-existing ideas that next-generation innovators synthesize with root concepts: expandable root concepts attract more diverse elements and are jointly used with more heterogeneous ideas than extendable root concepts.

### **Re-combinatory Innovation**

The Shumpeterian view of innovation considers innovation as creation of new ideas through synthesis and recombination of pre-existing ideas<sup>6</sup>. Sandwiches are products that combine breads and hams. Smartphones synthesize several core technologies such as touch displays and GPS and then present revolutionary values to markets. No new idea emerges without influences of pre-existing ideas.

Research has shown that (1) new ideas' impacts on evolutionary trajectories of knowledge increase when new ideas result from atypical or never-used combinations<sup>7,8</sup>, (2) connecting "dots" from non-neighboring knowledge fields (i.e., non-local search) promotes the emergence of such new combinations<sup>9</sup>, and (3) because individuals carry tacit knowledge to which others can gain access only via network ties, social networks and network positions matter in innovation processes<sup>2</sup>. Research also suggests several potential costs of atypical combinations: (1) audiences well accustomed to typical and prevalent combinations are less capable of appreciating the value of new and atypical combinations or become confused when facing such combinations<sup>10</sup>, (2) because atypical combinations require collaborations of innovators with different disciplines and backgrounds, they need to incur high coordination and communication costs<sup>1,10</sup>, and (3) innovators experience information overload when searching and working on atypical combinations<sup>11</sup>.

The focus on combinations enables us not only to assess the resulting new ideas' values but also to analyze how next-generation innovators jointly use pre-existing ideas. Viewing combinatory patterns as analytical tools, research can assess new ideas' influences quantitatively by, say, counting the number of citations to the new ideas and qualitatively by, say, studying patterns by which next-generation innovators jointly use pre-existing ideas. The former examination enables the assessment of size of new ideas' influences, whereas the latter examination explicates the behavior of next-generation innovators as users of pre-existing ideas and quality of influences that pre-existing ideas have on next-generation innovators.

### **Root Concepts**

We define root concepts as path-breaking ideas with which next-generation innovators synthesize other ideas in generating their own innovations. We term innovators who present root concepts as root concept suppliers. By using the word "root", we attempt to implicate two characteristics of root concepts: (1) new ideas are path-breaking and invoke paradigm shifts, and (2) there are the substantial number of followers in next generations who use new ideas.

Root concept suppliers are ancestors, and next-generation innovators who use their root concepts are the offspring.

Root concepts have three characteristics. First, root concepts are influential in the sense that there are a large number of next-generation innovators who use them in their own re-combinatory processes. Second, there are relatively a small number of root concept suppliers<sup>12</sup>. Third, root concept suppliers might be founders of new fields, categories, and genres because their root concepts are path-breaking and influential. Like other typical pre-existing ideas, root concepts are recombined by next-generation innovators, but what makes root concept distinguishable is that they are recombined much more frequently. That is, root concepts are influential because they attract other ideas to be recombined.

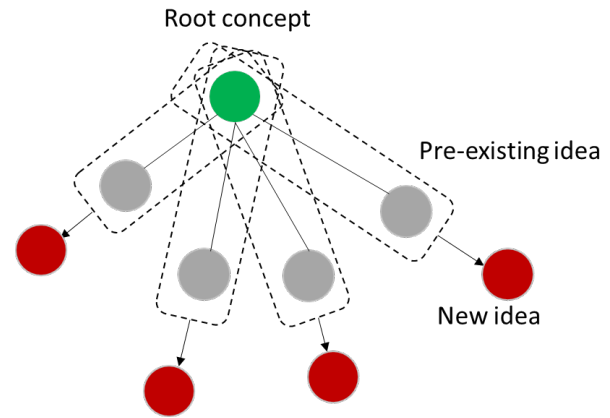


Figure 1: Root Concept and Re-combinatory Process

### A Form of Influences

If one uses citation data, s/he can easily assess root concepts' influences by examining the patterns of citations with a premise that those using and referring to root concepts are influenced by root concepts. In contrast, with non-citation data, one can assess root concepts' influences by looking at similarities between root concepts and next-generation innovators' ideas<sup>13,14</sup>. Suppose that we can decompose root concepts and followers' ideas into several elements and present them in vector forms.

$$\text{Root concept} = (er_1, er_2, er_3, \dots er_n)$$

$$\text{The follower's idea} = (ef_1, ef_2, ef_3, \dots ef_n)$$

$er_n$  represents the  $n$ th element of a root concept's vector, whereas  $ef_n$  indicates the  $n$ th element of the follower's idea. If these two vectors have high similarities, we view root concepts to have influences on the follower's idea. This similarity-based assessment of influence rests on the principle of imitation and social learning: when A proposed idea X, and B subsequently use idea X, B is viewed as being influenced by A's idea X. It is important to note that the A-B influence requires both the A-B similarity and the A-B sequences: A proposes idea X first, and then B uses it. There is also a caveat of taking this approach in assessing influences. There might be an alternative case of the A-B influence that when A proposes idea X, and B subsequently and intentionally avoids using idea X for the differentiation reason<sup>15</sup>. In this case, the A-B similarity is low, but there should be the A-B influences as A certainly limits B's choices. The following analysis does not take such case of influences into consideration.

### Methods

The objectives of our analyses are two folds: (1) to propose a non-citation method for assessing root concepts' influences on next-generation innovators and (2) to examine the quality of root concepts' influences by analyzing patterns of followers' re-combinatory activities.

To achieve these objectives, our empirical setting needs to meet following conditions. First, the focus on a domain wherein no citation data is systematically available is needed (e.g., influences of cultural products). Second, to observe variabilities in the quality of root concepts' influences, the analyses require contexts wherein there are multiple root concept suppliers in same time periods. The data of rap/hip-hop music meet these two conditions. It is well known that the rap/hip-hop music domain has two root concept suppliers who established the new genre of rap music in the 1980s: Run-D.M.C. and N.W.A. Run-D.M.C. is a New York City

based rap/hip-hop group. Run-D.M.C. released their first studio album in 1984 and established new musical style called *New school*. Experts pointed out that Run-D.M.C. not only attained great commercial success but also has significant influences on a variety of well-known artists including Public Enemy, LL Cool J, and Beasty Boys. On the other hand, N.W.A was a Los Angeles based rap/hip-hop group and released their first studio album in 1988. As with Run-D.M.C., N.W.A also achieved great commercial success and established a new style called *Gangsta rap*. In addition, several big rap stars such as Snoop Dogg, 2pac, and Eminem have received substantial influences from N.W.A. This presence of two prominent root concept suppliers offers us an opportunity to observe any variations between them.

In assessing the quality of root concept influences on next generations in terms of follower's recombination activities, what types of elements to be considered is significantly crucial. Research on foods, for instance, considers ingredients as recombinant elements<sup>16,17</sup> and research on videogames focuses on game-specific stylistic elements such as genres or perspectives<sup>18</sup>. Prior research on music considers musical instruments or musical features<sup>15,19</sup>. Here, this study focuses on *moods*, which exerts audience-perceived emotions, as recombinant elements. Hevner (1936) views music as collections of emotions and creations of music as activities involving the re-combination of emotions<sup>5</sup>. Prior research also focuses on music-generating moods<sup>20,21</sup>. Thus, this study views song-generating moods as elements to be used for analyzing re-combinatory patterns.

We collected our data mainly from AllMusic.com, which presented the data of 289 moods that describe the sound and feeling of songs or albums as adjectives, such as aggressive or fun, thus we can assess types of emotions and influences. As with the other crowdsourcing based music database, such as Discogs or MusicBrainz, AllMusic.com also provides basic information on albums and artists, such as release data, genres, music styles, song titles, and credits. We collected the data of 6,272 rap/hip-hop albums released from 1984 to 2013 by 3,140 unique artists or groups. On average, an album has 11.8 moods.

We employed the following empirical strategies to achieve our goals. First, we measure root concept suppliers' influences by focusing on "similarity" distances between moods that root concept suppliers provided and those that the next-generation musicians provided<sup>13,22</sup>. The AllMusic.com presents a set of moods for an album, and in some cases, these moods in the set are highly similar with each other. For example, when an album presents moods of anger, violence, rage, and fury, we should group them as one mood of anger, instead of viewing them as four independent moods. To do so, we used a method of topic modelling<sup>23</sup> and assessed similarities of moods between root concept suppliers and the next-generation musicians. For all of the albums in our sample, we calculated their topic vector distances with Run-D.M.C. and N.W.A. We used the K-L divergence for measuring vector distances<sup>22</sup>. In addition, we also collected the data of lyrics of all of the first three Run-D.M.C.'s and N.W.A.'s albums and assessed the next-generation musicians' use of these words in their own song titles by using TF-IDF. We traced how the next-generation musicians changed their use of lyric words used by Run-D.M.C. and N.W.A over time.

By using the topic-modelling results, we found core moods that the two root concept suppliers presented and assessed how the next-generation musicians recombined these core moods with other moods for their creations. Of the 289 moods in the AllMusic.com data, rap/hip-hop musicians used 274 moods. We constructed a mood-year panel data with the 3,946 observations. We used the generalized estimating equations (i.e., GEE) to account for the intra-correlations in repeated observations for the same moods over time<sup>24</sup>. We analyzed (1) how frequently core moods presented by the two root concept suppliers are used in the next-generation musicians' creation of their music (i.e., combined elements), (2) how different other moods are with which the next-generation musicians recombined the core moods (i.e., element diversity), and (3) how closely other moods with which the next-generation musicians

recombined the core moods are related to each other (i.e., combinatory strength). In the following analyses, for these three, we developed the corresponding dependent variables. It is notable that GEE requires specifications of auto-correlation structures in our dataset<sup>25</sup>. The results of the quasi-likelihood under the independence model criterion (QIC) suggest that correlation structures of the models predicting combined elements and combinatory strength are independent, suggesting no correlation between repeated measures. In contrast, we found that correlation structures of the model predicting combinatory strength is exchangeable, meaning that the levels of correlations neither decrease nor increase over time<sup>25,26</sup>.

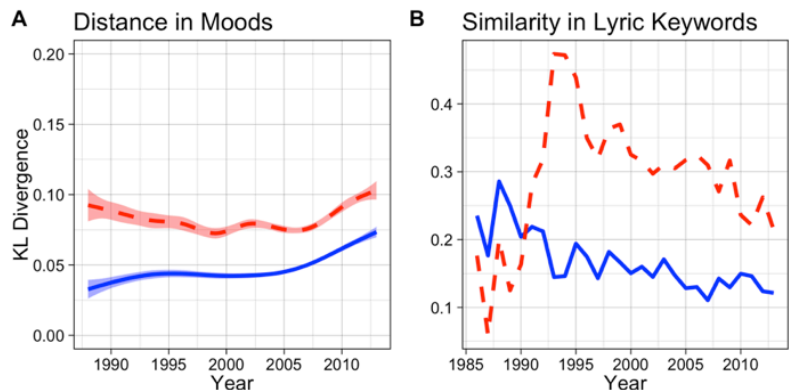
## Results

In our topic modeling for the rap/hip-hop album moods data, we extracted four estimated topics of moods, which we interpreted as moods of *introspective*, *violent*, *energetic*, and *tough*. Table 1 summarized the topic vectors of Run-D.M.C. and N.W.A, and top 5 moods most strongly associated with the topic. The second and third columns of Table 1 indicate topics that Run-D.M.C. and N.W.A used in their first albums and show sharp differences between them: Run-D.M.C.’s core mood is energetic, while N.W.A.’s core mood is violent.

**Table 1: Root Concept Suppliers’ Topic Vectors and the Top 5 Associated Moods**

	Topic 1 Introspective	Topic 2 Violent	Topic 3 Energetic	Topic 4 Tough
Run-D.M.C. ( <i>Run-D.M.C.</i> )	0.18	0.26	0.32	0.24
N.W.A ( <i>Straight Outta Compton</i> )	0.16	0.37	0.20	0.28
	1. stylish	confrontational	energetic	street smart
	2. literate	aggressive	celebratory	brash
	3. reflective	menacing	rousing	tough
	4. laid back mellow	rebellious	boisterous	confident
	5. nocturnal	intense	confident	bravado

Using the estimated topic vectors of Run-D.M.C. and N.W.A, we assessed the root concept suppliers’ influences on all of the next-generation musicians. Panel A in Figure 2 shows over-time changes in mood topic distances, measured with topic vectors of the KL-Divergence between the two root concept suppliers and all of other musicians’ albums (n = 6272). The lower scores indicate that an album presents moods more similar with those that either Run-D.M.C. or N.W.A. presented. The solid and dashed lines represent an album’s KL-Divergence scores with Run-D.M.C. and N.W.A., respectively. The figure presents the three insights. First, we found that both of the root concept suppliers have long-term influences on the next-generation musicians. Our visual inspection suggests that their influence persisted until the early 2000s. Second, we found that throughout our observation periods, their KL-Divergence scores with Run-D.M.C. are consistently lower than those with N.W.A., suggesting Run-D.M.C.’s greater influences than N.W.A. Third, we found that Run-D.M.C. has S-curve effects, while N.W.A. has the inverted-U shape effects. This finding



**Figure 2: Founders’ Influences on Moods and Lyrics**

suggests that Run-D.M.C.’s influences became dominant first, followed by the surge of N.W.A.’s influences.

Panel B in Figure 2 shows the rate of the next-generation musicians’ use of key words embedded in root concept suppliers’ lyrics in their song titles. We first identified key words that the two root concept suppliers used in lyrics of all of the songs in their first three albums and then counted how many times all other albums used these key words in their song titles. We then divided this number by the total number of albums in a given year. The higher scores represent the next-generation musicians’ higher similarity to the root concept suppliers in terms of their use of keywords in the song titles. The solid and dashed lines represent the similarity scores with Run-D.M.C. and N.W.A. It appears that the next-generation musicians used more Run-D.M.C.’s words in their song titles than N.W.A.’s words. In contrast to the results of Panel A, our lyric keywords analysis shows the stronger influences of N.W.A on the next-generation musicians.

Above all, our methods using topic models with KL-Divergence or using associated keywords can graphically show the pattern of influences over time. Both Run-D.M.C and N.W.A, two root concept suppliers, have long-lasting influences on all other rap/hip-hop artists.

Next, we addressed our second objective: assessing the quality of influences of root concepts by focusing on the next-generation musicians’ recombinant activities. Figure 3 shows that the estimated coefficients of the energetic mood dummies proposed by Run-D.M.C. and violent mood dummies proposed by N.W.A. Panel A shows effects for the combined elements, Panel B for the element diversity, Panel C for the combinatory strength, respectively. All of our models controlled for mood age, mood popularity, total moods, total albums, and year dummies. Our results show that the energetic mood proposed by Run-D.M.C. is more likely to be recombined with various moods (panels A and B), and that these recombined moods are less likely to be used together than the violent moods proposed by N.W.A (panel C).

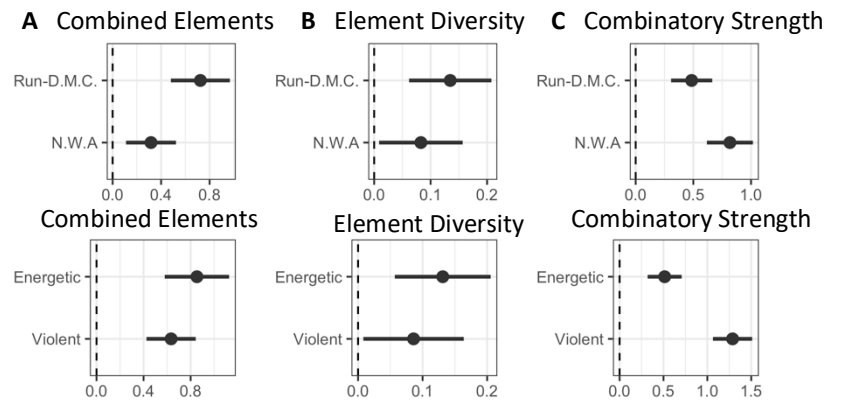


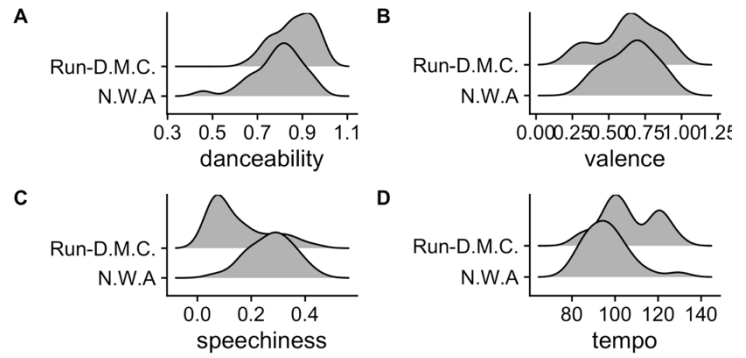
Figure 3: Regression Coefficients

### Further Analysis

Given the strong influences of Run-D.M.C. and N.W.A on the next-generation musicians, we found that these two root concepts are systematically different in ways by which they are recombined: Run-D.M.C.’s energetic moods were recombined with various kinds of moods, whereas N.W.A.’s violent moods were recombined with similar kinds of moods. These observations lead to another question: what caused these paternal differences? Prior research on idea/information adoption suggests two potential factors: intrinsic factors such as values or adoption cost<sup>27,28</sup>, and extrinsic factors such as social networks or competition among ideas<sup>29,30</sup>. In our additional analysis, we focused on root concept suppliers’ audio features to explore the possibilities of the intrinsic factors and their collaborative networks to assess the possibilities of the extrinsic factors.

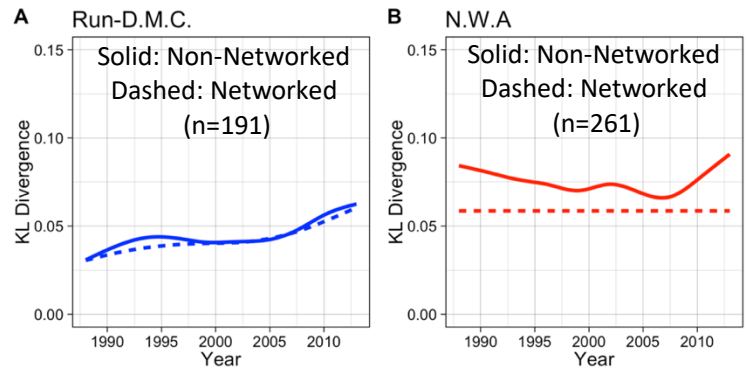
By using the data of Spotify, we analyzed audio features of Run-D.M.C.’s 29 and N.W.A.’s 26 tracks with four dimensions: danceability, valence, speechiness, and tempo, we found that compared to N.W.A, Run-D.M.C.’s tracks have features with higher danceability (panel A), greater mixed emotions (e.g., happy and sad) (panel B), fewer raps (panel C), and greater variety of song speed (panel D). The findings implicate that Run-D.M.C.’s root concepts

have higher interpretative flexibility for the next-generation musicians than N.W.A.'s ones. This interpretative flexibility might reduce costs for the musicians to use Run-D.M.C.'s root concepts, and create opportunities for them to experimentally recombine them with other various elements. On the other hand, N.W.A might provide the concept characterized by the lower interpretative flexibility (i.e., a specific tempo is required), reflecting our aforementioned findings about the higher combinatory strength in panel C in Figure 3.



**Figure 4: Audio Analyses of Root Concept Suppliers' Music**

Figure 5 reproduces Panel A in Figure 2, but here two panels show the role of social networks as root concept suppliers' carriers of influences. While the solid and dashed lines in both panels indicate the KL-Divergence scores based on the albums by non-networked musicians and the albums by the networked musicians, respectively. The networked musicians refer to those having experiences of collaboration with the root concept suppliers in a given album. We found 191 albums with 56 collaborators including the group front members for Run-D.M.C., and 261 albums with 29 collaborators for N.W.A. The figure shows that the next-generation musicians receive greater influences from N.W.A if working with N.W.A's ex-collaborators (e.g., Dr. Dre from N.W.A joins Snoop Dogg's Album). Together with the above findings about the audio features and those in Figure 5, we can speculate the results as the consequences of interplays between the roles of interpretative flexibility for the root concepts and the root concept suppliers' social networks: while Run-D.M.C.'s root concepts can be easily recombined without any help of social networks due to the interpretative flexibility, N.W.A.'s ones need to be carefully used with the help of social networks.



**Figure 5: Influences via Networks**

## Discussion and Conclusion

We propose a method of assessing influence by using the data of moods that the two root concept suppliers presented: running topic-modeling, and focusing on divergence between these moods and ones that the followers presented. Using this method, we found that (1) both Run-D.M.C. and N.W.A had substantial and long-lasting influences on the next-generation musicians (Figures 2), (2) Run-D.M.C.'s root concepts attracted more diversified elements (i.e., moods) than did N.W.A (Figure 3), (3) Run-D.M.C.'s musicality had higher interpretative flexibility than that of the N.W.A (Figure 4), and (4) social networks might be another reasons for their differences in the quality of influence exerted (Figure 5).

Using this evidence, we propose two types of root concepts: (1) *expandable* root concepts and (2) *extendable* root concepts. While both concepts are extensively used in next-generation innovation, a major distinction between them resides in the degree of heterogeneity (or homogeneity) of elements. In other words, we found differences in ways by which next-generation innovators use root concepts in their own work: they synthesize heterogeneous

elements with expandable root concepts and homogeneous elements with extendable root concepts. Expandable root concepts attract more diversified elements than do extendable root concepts.

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