Vertical Spatial Representation of the Ordinal Number under Different Contexts: Evidence from the SNARC Effect

Dan Luo

(Sichuan Electronic Machinery Vocational and Technical College)

Abstract: To explore the SNARC effect of vertical spatial representation of the ordinal number under different contexts (abstract, specific, between abstract and specific), the study used the timed odd—even judgment task. The participants were required to judge and respond to the stimuli presented according to the parity. The positive sequence and the reciprocal numerals were used as experiment materials. A total of 69 undergraduates and postgraduates from the same college were chosen to be experimental subjects. The results indicated that: Size effect all showed up in those vertical spatial representation of the ordinal numbers, but the SNARC effect did not appear significantly. All results demonstrated that the spatial representation of ordinal number in vertical dimension affected by the contexts to a certain extent, providing support for its instability and lack of automatism.

Keywords: SNARC effect; mental number line; ordinal; situational difference; vertical spatial representation

Author's brief introduction: The name rodin; Year of birth: 1995.12; Birthplace: Mianyang, Sichuan; Ethnic han Chinese; The title without; Degree University Bachelor's Degree; Research direction: basic psychology; Sichuan Electronic and Mechanical Vocational and Technical College.

DOI: 10.36012/fhe.v2i4.2779

1. the introduction

The concept of "mental number line" was first discovered by Restle (1970), who proposed the idea that "mental number line is the simulated mental representation of the approximate value of number number" (Kang Wu, Yang Min, Wang Liping, 2013). It is the mental representation of quantity and number size in the human brain, but it does not necessarily correspond to the number line in the mathematical sense. With the advent of spatial and numerical joint response coding, the horizontal mental numeral line from left to right is highlighted: the left side of the mental numeral line is the decimal representation, and the right side is the large number representation. This shows that the decimal number on the left and the large number on the right are the representation of numbers in the human brain, which also exactly confirms the existence of mental number lines in the human brain. Moreover, in the subsequent related studies, it has been gradually confirmed that the mental number line can also appear in the vertical direction: the upper part of the mental number line is the representation of the decimal number, and the lower part is the representation of the large

number (Schwarz, & Keus, 2004; Ito, & Hatta, 2004). The discovery of mental number lines provides us with direct evidence of the relationship between number and space, and also provides an important impetus for our understanding of the theory of "the processing mechanism of representation in digital space".

Later, Dehaene, Mehler and Dupoux(1990) found in the "size judgment task" and Dehaene, Giraux and Bossini(1993) in the "odd—even judgment task" : in the key—press response, the left hand is faster than the right hand in the human brain. For larger numbers, the right hand is faster than the left, meaning that "spatial properties are possessed by numerical representations". This discovery was named as the "Spatial Numerical Association of Response Codes" effect, or SNARC effect for short (Kang Wu, Yang Min, Wang Liping, 2013). The results of this study provide strong direct evidence for the spatial representation of numbers in the human brain, and provide theoretical support for further research.

In addition, the relevant research on SNARC effect has not been interrupted since it was discovered. More recently, as research has become more detailed, researchers have not only conducted research in the horizontal direction, but later in the vertical direction as well. As for the existing direction of SNARC effect, several recent studies have shown that the horizontal direction is no longer the only existing direction of SNARC effect, and it also exists in the vertical direction: that is, numbers are represented vertically, large numbers are represented at the top, and small numbers are represented at the bottom (Quan Xin, Si Jiwei, 2013). Therefore, in the eyes of researchers, it is not exact that a one—dimensional Mental Number line is used to represent the spatial representation of numbers. It is more accurate to say that it is similar to a "Mental Number Map" (Yang Jinqiao, Zhang Qi, 2010). Similarly, the SNARC effect was no longer confined to the study of positive numbers, but was later explored in the field of negative numbers. The part about positive numbers in the study indicates that a certain degree of stability is one of the characteristics of digital space representation, that is, reading direction from left to right is relatively common among the public based on reading habits formed over a long period of time. In this cultural context, numbers from left to right are mentally represented in the order of decimal on the left and large on the right. (Dehaene et al. ,1993; Nuerk, Bauer, Krunnenacher, Heller, & Willmes, 2005; Nuerk Willmes, & Fias, 2005) in the study of negative Numbers, however, due to the situation of the negative space representation of dependability and flexibility, digital space representation mode will also show different space with situational differences such as features, that is to say, the number of spatial representation can be flexibly adjusted changed with different conditions (zhangyu, YouXu group, 2012).

To widen the daily life, the situation of the difference from the abstract perspective, can be divided into specific situation (such as the first floor, the second floor, third floor), abstract situations (such as first, second, third) and between the specific situation and abstract situation (such as the first, second, third). An abstract situation contains the content of any other situation, such as the content expressed by literal symbols. In the abstract situation, the pure ordinal number is taken as the number existing under an abstract condition, and the abstract situation is taken as its baseline condition, and can also be used as the context reference of the concrete situation and the situation between the two. The specific situation introduces social, cultural, educational and other factors to make the situation understandable and

more realistic. In a specific situation, floor, as a concrete thing in daily life, has vertical spatial representation. People will be exposed to such events as taking elevators and climbing stairs in daily life. Therefore, this study uses floor situation to guide people to generate a psychological number line in vertical direction in their mind. As for the situation between the abstract and the concrete situation, due to the differences in direct experience or way of thinking, it will be understood in the human brain can be abstract or concrete, that is, it varies from person to person. In the in-between scenario, rankings, etc., contain something relatively concrete and abstract, both abstractionable and concrete. In the study of Qiao Fuqiang et al. (2016), three situational conditions, namely ordinal number only situation, floor situation and genealogy situation, were used to divide situational differences. Combined with the related research, so this study will be under the specific situation of floor situation, under the situation of ranking situation between concrete and abstract introduces experimental situations, on the one hand, help to meet the flexibility of ordinal vertical space mapping, dynamic and situational, on the other hand also from empirical Angle discusses the ordinal number space representation under the situation of the influence.

The spatial representation of quantity and number has been a hot topic in the field of cognitive psychology for a long time. At the same time, the proposal of psychological number line and the discovery of SNARC effect also help enrich and improve its theoretical model and cognitive neural mechanism. In many digital space representation of related study, such as Qiao Fuqiang have found about the discussion of pure digital is rich, for characterizing the ordinal number is less, when especially realistic situation is involved, for the pure digital (1, 2, 3, or one, two, three), ordinal relatively more popular and normalized, combined with the actual situation to express numerical relationship (such as the first day, the next day, the third day; First floor, second floor, third floor, etc.) is also relatively easy. Different from the experimental materials of positive ordinal words, which are only included in most previous studies, the reciprocal ordinal words of the first and second penultimate are introduced in this study as the experimental materials. As a kind of ordinal words different from positive ordinal words (such as penultimate first place, penultimate first question, penultimate first day, etc.), although the frequency of use is less than positive ordinal words in actual situations, it is also an important number existing on the mental number line. Therefore, the study of reciprocal ordinal words also has a certain theoretical significance. Similarly, the ordinal number representation and in daily life situations associated numerical representation (such as the first, second, last, the penultimate), and different from (such as first, second, eighth, ninth) on the shaft of this kind of psychological digital experiment material, to explore the effects of different Ordinal Numbers to the SNARC effect, enriching the content of predecessors' research also has certain guiding significance. Qiao Fuqiang et al. (2016) set up non-introduction situations (first, second, eighth and ninth) in their study of positive ordinal words in different contexts. Floor situation (the first floor, the second floor, the eighth floor and the ninth floor), family situation (the first generation and second generation, eighth and ninth) of the three scenarios to explore the situation of ordinal space characterization indicates that the influence of the present situation in only pure digital, SNARC effect in the vertical space representation was not there; However, the inverse SNARC effect and SNARC effect appeared in the family tree and floor situation, respectively.

Based on existing studies on the development of relevant SNARC effects, it is found that children at the age of 9 begin to show obvious SNARC effects, and then gradually stabilize (Pan Yun, Bai Xuejun, Shen Deli, 2012). Therefore, on the premise of ensuring the stable occurrence of SNARC effect and insignificant individual differences, this experiment randomly selected college students and graduate students as experimental subjects to conduct the experiment. In view of situational differences and the choice of ordinal words, and based on the above related studies, the following hypotheses are proposed in this experiment :(1) The vertical spatial representation of Ordinal Numbers in abstract situations does not have the typical SNARC effect; (2) The vertical spatial representation of ordinal number in specific situation has typical SNARC effect. (3) The vertical spatial representation of ordinal number in the context between abstract and concrete situation has inverse SNARC effect.

2. Experiment

2.1 Experimental objectives and hypotheses

In experiment 1, the SNARC effect of vertical spatial representation of ordinal number in abstract context was investigated. Abstract situation of positive Ordinal Numbers and Ordinal Numbers from bottom set respectively for the first, second, last, the penultimate, odd－even judgement task as subjects response of key tasks, used in the process of experiment the vertical button (small keyboard key figures), the participants to choose according to the present stimulation on key or the key reactions, in order to further verify whether expectations hypothesis number SNARC effect will occur. In addition, in order to discuss the spatial representation of ordinal number in the context of Experiment 2 and Experiment 3, Experiment 1 is also added here as a control under the baseline condition.

2.2 Experimental subjects

A total of 24 undergraduate and graduate students (except psychology majors) were randomly selected from a certain university to conduct the experiment under the condition of complete secrecy for the purpose of the experiment. The subjects ranged in age from 17 to 25 years old ($M=20.1$, $SD=2.4$), including 3 males and 21 females. The subjects had no abnormal visual acuity or corrected visual acuity, no abnormal visual acuity problems such as strabismus or amblyopia, and all of them were right－handed. At the end of the experiment, a small gift will be given to the participants as a reward for conducting the experiment.

2.3 Experimental equipment

The experiment was carried out in the computer room without external interference. E－Prime 2.0 was used to program the experiment, and it was run on 10 computers in the lab room (model: Lenovo T2364PA, display resolution: 1920 × 1080, refresh rate: 85Hz). In front of each computer is a vertical numeric keypad with 10 keys for numbers "0～9" as a response keyboard. The key "2" in the top position and the key "8" in the bottom position are set as the reaction key. At the same time, the 5 key in the middle of the two reaction keys (2 and 8) was set as the start key to balance the reaction time of the subjects.

2.4 Experimental Materials

Two positive Ordinal Numbers: first, second; Two reciprocal Ordinal Numbers: first to last, second to last. The four Ordinal Numbers were presented individually and randomly in the center of the computer screen as experimental stimuli.

2.5 Experimental design and procedure

The experimental type was the in－subject design of ordinal number type 2(positive order, reverse order)× key position 2(top, bottom). The ordinal number type and key position are the internal variables of the subjects, and the response time and

accuracy of the subjects are the dependent variables.

The experimental task adopted the classic task paradigm of SNARC —— "odd and even judgment task", which required the subjects to judge and press buttons quickly, well and accurately according to the odd and even properties of the present stimuli on the screen. The experiment flow chart and reaction key Settings are shown in Figure 1 below. The process of the experiment was as follows: a guide was first presented on the screen, and the subject was intentionally asked to construct mental number lines in his brain before the experiment began. After the subject correctly understood the guide, he could press the button to practice the experiment part. Is then tried in practice experiment screens are may see a "red" fixation point cross (0.5 x 0.5 degrees) perspective, and then according to the instructions of the tip after press the start key (5), followed by fixation point cross changed from red to green (keep time for 1000 ms), were then try making button to render target stimulus. After the exercise, press the button to enter the formal experiment part (the experiment process is the same as the exercise part). The formal experiment consisted of two intervals of rest (each of which was one minute) to eliminate the fatigue effects of the participants. The formal experiment was divided into two groups: in the first group, the subjects were asked to press up (8 keys) when they saw "the first or the last first" (the Angle of view was 1 degree and the font was Song), and press down (2 keys) when they saw "the second or the last second". The second block was pressed in the opposite way to the first, and the order in which the two blocks were presented was balanced between the subjects. If the subjects did not respond within 2000ms or after the key — pressing response, the computer screen would automatically jump to the empty screen interface (holding time was 500ms). After the end of the practice (a total of 8 trials) and the purpose of getting familiar with and mastering the basic experiment, the formal experiment (a total of 160 trials) can be started. Both the practice and the formal experiment were randomly presented, and the whole experiment took about 15 minutes to complete.

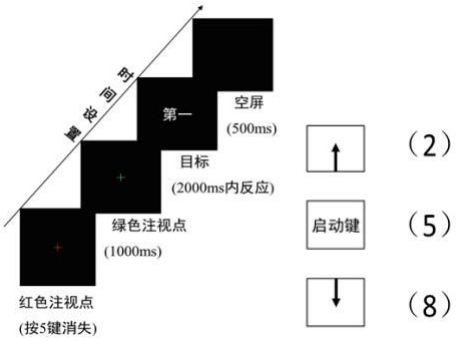

Fig. 1 Experimental flow chart and reaction key Settings

2.6 Experimental results and analysis

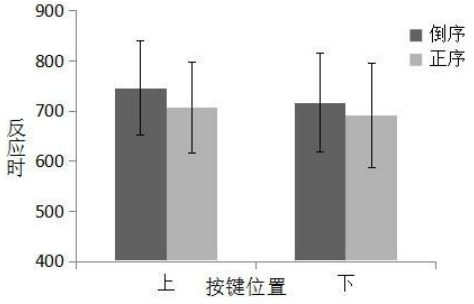

Fig. 2 The reaction time of Ordinal Numbers in abstract situations

The response time and keystroke accuracy collected from Experiment 1 were analyzed. Due to the simple experimental task, 3 invalid data (3 females) were deleted according to the invalid data whose accuracy was lower than 0.8 or below and whose response time was more than plus or minus 3 standard deviations, and a total of valid data (3 males and 18 females) of 21 subjects were obtained. The results showed that the main effect edge of the key position was significant, $F(1, 20) = 4.00$, $P = 0.059$, $\eta P2 = 0.17$. The main effect of ordinal number type was significant, $F(1, 20)$

= 47.08, P <0.000, η P2 =0.70. The pairwise comparison results showed that the response of the subjects to the upper key was slower than that to the lower key, reaching the marginal significant level, P =0.059; The reaction time of the subjects to the reciprocal ordinal words was longer than that to the positive ordinal words, and the difference reached a significant level, F(1, 20) = 47.07, P <0.000, ηp2 = 0.70. The interaction between ordinal number type and key position is not significant, F(1, 20) =0.93, P =0.346, η P2 = 0.05.

2.7 Discuss

The results of Experiment 1 show that the significant SNARC effect does not show in the vertical direction in the abstract situation. In terms of ordinal number type, different from the typical SNARC effect existing in the horizontal direction, the size effect with significant difference is shown in the response to ordinal number type, that is, the average response time to positive ordinal number words is smaller than the average response time to reciprocal ordinal number words, which is speculated to be related to the direct experience of the subjects. Under the mapping of daily life and social culture, the sensitivity and familiarity of positive Ordinal Numbers such as "first" and "second" are higher in the human brain than that of reverse Ordinal Numbers such as "penultimate" and "second to last", and are relatively easier to be activated in the brain. In terms of keystroking position, the subjects' keystroking response for positive ordinal number words was faster than that for reciprocal ordinal number words. In the vertical direction of the psychological number line, "first and second" is at the top of the mental number line in the brain, and reciprocal Ordinal Numbers like "first to last, second to last" are at the bottom, so positive Ordinal Numbers have a shorter up－key response time.

3. Experiment 2

3.1 Experimental Purpose and Hypothesis

In experiment 2, the SNARC effect of vertical spatial representation of ordinal number in specific situations was investigated. The first floor, the second floor, from the first floor, the second floor respectively from bottom is set to the specific situation is the bottom of the calender, experiment 2 experimental conditions and process (except the experimental materials) are the same with the experiment, the experimental results and comparing with experimental one, to explore the ordinal number of vertical space representation is affected by the specific situation.

3.2 Experimental subjects

A total of 24 undergraduate and graduate students (except psychology majors) were randomly selected from a certain university. The experiment was carried out under the condition that the purpose of the experiment was kept completely secret to the subjects. The subjects in experiment 2 did not participate in experiment 1. The subjects ranged in age from 17 to 23 years old (M=19.8, SD=1.5). There were 9 males and 15 females, and the others were the same as in Experiment 1.

3.3 Experimental equipment

Same as experiment one.

3.4 Experimental materials

Two positive Ordinal Numbers: the first floor, the second floor; Two reciprocal Ordinal Numbers: the last floor, the last floor. The stimulus was presented in the same way as in Experiment 1.

3.5 Experimental design and program

All the stimulus materials presented were the same as experiment 1, except that the stimulus materials presented were different from experiment 1.

3.6 Experimental results and analysis

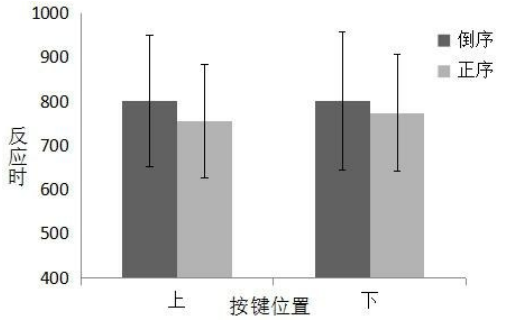

Fig. 3 Response times of Ordinal Numbers in specific situations

The response time and keystroke accuracy collected from Experiment 2 were analyzed. After screening data according to the set criteria, 2 invalid data (1 male and 1 female) were removed, and valid data of 22 subjects (8 male and 14 female) were obtained. The results of the experiment used 2(ordinal type: positive order and reverse order)×2(key position: up and down) repeated measures of variance analysis. The results showed that the main effect of ordinal type was significant, $F(1, 21) = 16.35$, $P < 0.001$, $\eta P2 = 0.44$; The main effect of key position is not significant, $F(1, 21) = 0.58$, $P = 0.456$, $\eta P2 = 0.03$. Pair comparison results showed that the reaction time of the subjects to the reciprocal ordinal number words was longer than that of the positive ordinal number words, and the difference reached a significant level ($P < 0.001$). In addition, the interaction between ordinal number type and key position is not significant, $F(1,21) = 1.12$, $P = 0.302$, $\eta P2 = 0.05$.

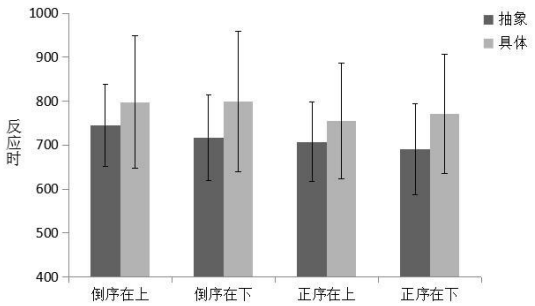

Fig. 4 Response time of abstract and concrete situations

Then, in order to compare the situational differences between concrete and abstract situations, repeated measures ANOVA of 2(situation: abstract, concrete)×2(ordinal type: positive order and reverse order)×2(key position: top, bottom) showed that the main effect edge of the situation was significant, $F(1, 41) = 3.55$, $P = 0.074$, $\eta P2 = 0.15$; The main effect of ordinal number type was significant, $F(1, 41) = 37.47$, $P < 0.000$, $\eta P2 = 0.65$; The main effect of key position is not significant, $F(1, 41) = 0.62$, $P = 0.442$, $\eta P2 = 0.03$. Pair comparison results showed that the response of the subjects in the abstract situation was slower than that in the concrete situation, reaching the significant level at the margin of difference ($P = 0.074$). The reaction time of the subjects to the reciprocal ordinal number words was longer than that of the positive ordinal number words, and the difference reached a significant level, $F(1, 41) = 37.47$, $P < 0.000$, $\eta P2 = 0.65$. The main effect margins of situation and location were significant, $F(1, 41) = 3.63$, $P = 0.071$, $\eta P2 = 0.15$; The interaction between situation and ordinal type was not significant, $F(1, 41) = 0.11$, $P = 0.742$, $\eta P2 = 0.01$; The interaction between ordinal number type and key position is not significant, $F(1, 41) = 1.50$, $P = 0.234$, $\eta P2 = 0.07$; The interaction of situation, ordinal number type and key position was not significant, $F(1, 41) = 0.01$, $P = 0.920$, $\eta P2 = 0.001$. The simple effect analysis showed that in the abstract situation, the response of the subjects to the upper bond was slower than that to the lower bond, and the difference reached a significant level, $P = 0.059$.

3.7 discuss

The results of Experiment 2 showed that the significant SNARC effect did not appear in the vertical direction in the specific situation. In terms of ordinal number type, similar to the result of Ex-

periment 1, the obvious size response was only shown in the ordinal number type response, which may be related to the individual experience of the subjects. In daily life and social and cultural mapping, "on the first floor" and "the second floor" such positive the sensitivity of the Ordinal Numbers and familiarity in the brain than "from the first floor" and "the second from bottom floor" this kind of inverse Ordinal Numbers, and on the floor "bottom" is relatively uncommon (compared with the negative a layer), and thus more is not easy to be activated in your mind. Compared with Experiment 1, the results showed that the mental representation of ordinal number words in specific situations was also affected by specific situations to some extent. It is not difficult to find that the average response time in the specific situation is greater than that in the abstract situation. This may be because when the subjects process the pure ordinal number words, they also process the appearance of the word "floor" after the introduction of the specific situation, which is reflected in the increase in response time.

4. the experiment three

4.1 Experimental Purpose and Hypothesis

In the third experiment, the SNARC effect of vertical spatial representation of ordinal number was investigated in the context between abstract and concrete situations. Among them for the first, second, last name, the second name set for this kind of situation positive Ordinal Numbers and inverse Ordinal Numbers, experiment 3 used are the same as the experiment 1 and experiment 2 buttons responses, and compared with the results of experiment 1 and experiment 2 were analyzed, to explore whether the ordinal number of vertical space representation by between abstract and concrete situation of the influence of the situation.

4.2 Experimental subjects

A total of 21 undergraduate and graduate students (except those majoring in psychology) from a certain university were randomly selected to conduct the experiment under the condition that the purpose of the experiment was kept completely confidential to the subjects. The subjects in Experiment 3 also did not participate in Experiment 1 and Experiment 2. The subjects ranged in age from 17 to 22 years old ($M=18.8$, $SD=1.2$), including 1 male and 20 female. The other subjects were the same as Experiment 1 and Experiment 2.

4.3 Experimental equipment

Same as experiment one and experiment two.

4.4 Experimental materials

Two positive Ordinal Numbers: first, second; Two reciprocal Ordinal Numbers: first from last, second from last. The stimulus was presented in the same way as in Experiment 1 and Experiment 2.

4.5 Experimental design and program

Except that the stimulus materials presented were different from Experiment 1 and Experiment 2, they were the same as Experiment 1 and Experiment 2.

4.6 Experimental results and analysis

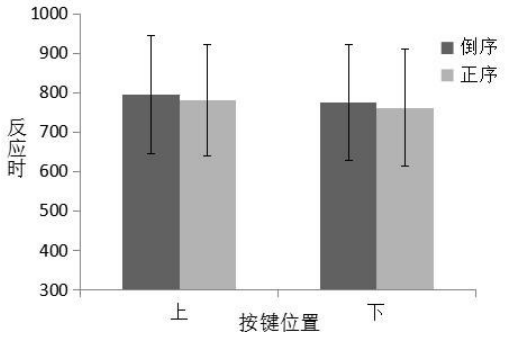

Figure 5 is between the reaction time of Ordinal Numbers in abstract and concrete situations

The response time and keystroke accuracy collected from Experiment 3 were analyzed. After screening data according to the set criteria, no invalid data were removed, and the valid data of 21

subjects (1 male and 20 female) were obtained. The results showed that the main effect edge of the key position was significant, F(1, 20) = 3.07, P =0.095, η P2 =0.13. The results showed that the key position had a significant effect edge, F(1, 20) = 3.07. The main effect edge of ordinal number type is significant, F(1, 20)= 3.26, P =0.086, η P2 =0.14. The pairwise comparison results showed that the response of the subjects to the upper key was slower than that to the lower key, reaching the significant level at the margin of difference, P =0.095; The subjects should be more significant for the reciprocal ordinal words than the positive ordinal words to the margin of difference, P =0.086. In addition, the interaction effect between ordinal number type and key position is not significant, F(1,20) =0.03, P =0.863, ηp2=0.002.

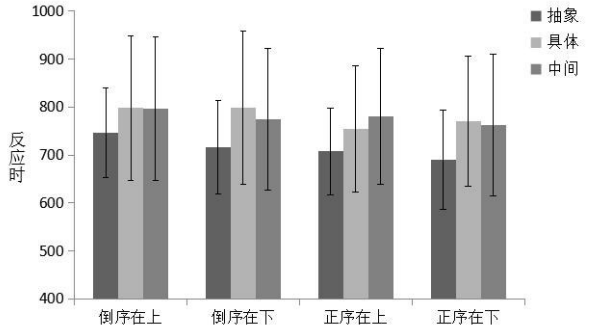

Fig. 6 Reaction times in three situations

In order to compare the situational differences of the three situations, repeated measures ANOVA of 3(situation: abstract, concrete, between abstract and concrete)×2(ordinal type: positive order and reverse order)×2(key position: top, bottom) showed that the main effect of the type with large ordinal number was significant, F(1, 61)= 33.87, P <0.000, ηp2=.629; The main effect of condition was not significant, F(2, 61)= 1.93, P =0.160, η P2 =0.09; The main effect of key position was not significant, F(1, 61)= 2.58, P =0.124, η P2 =0.11. The results of paired comparative analysis showed that the difference between the reciprocal ordinal words was slower than that between the positive ordinal words (P < 0.000). The interaction between ordinal number type and context is not significant, F(2, 61)= 2.35, P =0.116, η P2 =0.11; The interaction between key position and context is not significant, F(2, 61)= 2.22, P =0.122, η P2 =0.10; The interaction between ordinal number type and key position is not significant, F(1, 61)= 1.03, P =0.322, η P2 =0.05; The interaction of ordinal number type, situation and key position is not significant, F(2, 61)=0.17, P =0.842, η P2 =0.01.

4.7 discuss

The results of Experiment 3 showed that the significant SNARC effect did not appear in the vertical direction in the context between the concrete and abstract situations. In terms of ordinal number type, the corresponding size response is only shown in the ordinal number type response, but the significant difference between the two is not obvious. In terms of key position, the response of the subjects to the reciprocal ordinal number words was slower than that to the positive ordinal number words, but the difference between the two was not obvious. In the real life and cultural background, the phenomenon of ranking (college entrance examination score ranking, competition ranking, performance ranking, etc.) is common, and under the existing educational and cultural system of Chinese society, the selection of the best is particularly common. According to the results can be found, "first prize" and "second" and "last name" and "second from bottom in the sensitivity of the human brain were similar, are high degree of activation in the brain, this could be due to the positive effects of" first name "and" last name "to bring the negative influence on the importance of the people. Compared with Experiment 1 and Ex-

periment 2, the results show that when the ordinal number words are introduced in the context between concrete and abstract, their mental representation is not significantly affected by the context. This may be due to the differences in direct experience of the "countdown" between the subjects (this is explained in detail in the general discussion section).

5. the total discussion

In the three experiments of this study, the situations of positive reciprocal ordinal words used as experimental materials are "abstract", "concrete" and three situations in between. The "odd－even judgment task" was used to verify the influence of SNARC effect based ordinal vertical spatial representation in different situations. This can help us better understand the three characteristics of the representation of ordinal space on the vertical dimension, namely, dynamics, situational dependence and flexibility.

There are some inconsistencies between the research results and the experimental hypothesis: the SNARC effect of the vertical spatial representation of ordinal number does not appear significantly in different situations, only the corresponding response of ordinal size appears. The reasons are discussed and conjectures are made as follows: Will the introduction of reciprocal ordinal words itself interfere with the occurrence of SNARC effect? Does individual direct experience difference for reciprocal ordinal words cause the disappearance of SNARC effect? In the selection of experimental materials, are the first and second, penultimate and penultimate only the difference between positive order and reverse order, and there is no difference in size and number? Can the experimental material truly fully reflect and conform to the characteristics of vertical space representation? In the follow－up communication with the subjects, it is not difficult to find that the subjects obviously have their own cognitive processing strategies for the reciprocal ordinal words. For example, some subjects only process the number itself while ignoring the whole process of the reciprocal ordinal words. In addition, it is associated with the direct experience of different individuals, such as in the "from the first floor" and "on the first floor, under the stimulus presentation of some subjects can compare with the" first floor ", and "from the first floor" understanding for higher level, and some participants can understand for the life of the common negative layer, or the first layer is below a layer of floor. According to the descriptive statistical results of the three experiments, the average response time standard deviation of the subjects generally fluctuated too much, which also indicated to some extent that the impact of individual direct experience difference on the understanding of reciprocal ordinal words could not be excluded.

Based on the comparative analysis of existing studies, it can be concluded that the mental number line has certain stability in the horizontal dimension. However, it seems that this characteristic is not stable in the vertical spatial dimension in this study. Most studies have confirmed that the positive SNARC effect is universal and stable (Fischer et al., 2016). Based on this experiment, it can be found that the mental number line can be extended to the ordinal words, but compared with the positive ordinal words, the spatial representation of the reciprocal ordinal words may lack automaticness in a sense. At the same time, positive order and reverse order are relative concepts. If positive order is represented as up, then reverse order is represented as down. Therefore, positive ordinal words and spatial representation can extend above the mental number line, which may be caused by the subject's processing of positive and

reverse order only. Space vertically mental number line under the action of the condition of the situation, perhaps itself is not stable, may also cause the SNARC effect situation dependence was not significant, which showed no significant SNARC effect, one of the reasons may be the effect of likely depends on the intended use of instructions or tasks set by spatial reference frame, and did not generate a fixed space reference standard. The above discussion also needs to be further supplemented and improved in the follow－up research.

6. the conclusion

This study by Dehaene et al. (1993, 2003) put forward "odd－even judgement task", the introduction of positive Ordinal Numbers and inverse Ordinal Numbers as experiment material, to explore the differences between different situation under the ordinal number SNARC effect of vertical space representation, get the following conclusion: ordinal vertical space characterization under different situation are shown on the size of the corresponding effect, but did not see the SNARC effect significantly. This indicates that the vertical spatial representation of ordinal number is unstable and lacks automaticity, and is to some extent regulated by the situation.

Reference

[1] Dehaene, S., Bossini, S., & Giraux, P. (1993). The mental representation of parity and number magnitude. Journal of Experimental Psychology: General, 122(3),371－396.

[2] Fischer, M. H., & Brugger, P. (2011). When digits help digits: Spatial－numerical associations point to finger counting as prime example of embodied cognition. Frontiers in Psychology, 2, 260.

[3] Fischer, M. H., & Shaki,S. (2016). Measuring spatial－numerical associations: Evid ence for a purely conceptual link Pchological Research. 80,109－112.

[4] Gevers, W., &Lammerty, J. (2005). The hunt for SNARC. Psychology Science,47(1),10－21

[5] Gobel, S. M., Shaki, S., & Fischer, M. H. (2011). The cultural number line: Areview of cultural and linguistic influences on the development of number processing. Journal of Cross－Cultural Psychology, 42(4), 543－565.

[6] Hung, Y. H., Hung, D. L., Tzeng, O. J. L., & Wu, D. H. (2008). Flexible spatial mapping of different notations of numbers in Chinese readers. Cognition,106(3), 1441－1450.

[7] Ito, Y., & Hatta, T. (2004). Spatial structure of quantitative representation of numbers: Evidence from the SNARC effect. Memory and Cognition, 32 (4),662－673.

[8] Lakoff, G., & Johnson, M. (1980). Metaphors we live by. America: University of Chicago Press.

[9] Lakoff, G., & Johnson, M. (1999). Philosophy in the flesh: The embodied mind and its challenge to western thought. New York, America: Basic Books.

[10] Lakoff, G., & Núnez, R. E. (2000). Where mathematics comes from: How the embodied mind brings mathematics into being. New York, America: Basic Books.

[11] Nuerk, H. C., Iversen, W., & Willmes, K. (2004). Notational modulation of the SNARC and the MARC (Linguistic markedness of response codes) effect. The Quarterly Journal of Experimental Psychology, Section A, 57(5), 835－863.

[12] Nuerk, H. C., Bauer, F., Krummenacher, J., Heller, D., & Willmes, K. (2005). The power of the mental number line: How the magnitude of unattended numbers affects performance in an Eriksen task. Psychology Science, 47(1), 34－50.

[13] Nuerk, H. C., Willmes, K., & Fias, W. (2005). Perspectives on number processing. Psychology Science, 47(1), 4－9.

[14] Schwarz, W., & Keus, I. M. (2004). Moving the eyes along the mental number line: Comparing SNARC effects with saccadic and manual responses. Perception and Psychophysics, 66(4), 651－664.