Deep Positivity Hypothesis (DPH) : Abductive Theory on the Relation between Emotional Valence and Cognition Depth

Yu KANAZAWA*

ディープ・ポジティビティ仮説（DPH）：情動価と認知の深さについてのアブダクティブな理論

金澤　　佑

Abstract :

It is known that both positively valenced emotions and negatively valenced emotions provide cognitive advantages in contrast to non-emotional neutrality. There are, however, fewer theories and studies on how different kinds of emotion affect different cognitive processes. This paper first inductively formulates how different emotional valences have different impacts on various types of cognition as reported by findings along diverse academic disciplines including neuroscience, neuropsychiatry, paleopsychology, positive psychology, gerontology, and cognitive linguistics. Secondly, the inductive formulation is supplemented with further insights from neoteric cognitive theories such as the Modular On-Line Growth and Use of Language (Sharwood Smith & Truscott, 2014) and the Emotion-Involved Processing Hypothesis (Kanazawa, 2020), leading to the abductive formulation of the Deep Positivity Hypothesis (DPH) on valence-dependent differences and levels of processing, which hypothesizes that positive emotions facilitate higher/deeper/semantic cognition whereas negative emotions facilitate lower/shallower/perceptual cognition. Finally, an inquiry about whether the DPH is supported by empirical findings from relevant previous studies is conducted.

要旨：ポジティブ情動、ネガティブ情動のいずれも、認知を促進する作用を有していることが知られている。しかし、どのような認知作用にどのような情動が促進的に働くのかについての系統だった理論や統一的見解が広く共有されているとは言えない。本論ではまず、神経科学・神経精神医学・古生物心理学・ポジティブ心理学・老年学・認知言語学などの分野の、通常は関連付けされることの無い諸知見を参照しながら、情動価によって異なる認知への働きについて帰納的に定式化する。その上で、モジュール式オンライン言語成長使用フレームワーク（Sharwood Smith & Truscott, 2014）や情動関与処理仮説（Kanazawa, 2020）といった近年の認知的理論の知見を組み込むことで、異なる情動価の促進作用が顕著なのは異なった深度の認知に対してであるという仮説（ディープ・ポジティビティ仮説；DPH）を、アブダクティブな推論により提起する。最後に、ポジティブ情動が促進するのは深い認知であり、ネガティブ情動が促進するのは浅い認知であるとする DPH の予測は実証的観点から支持されるのかについて、関連先行研究を踏まえながら議論する。

Key words : Emotional Valence, Cognition Depth, Deep Positivity Hypothesis

*Assistant Professor, School of International Studies, Kwansai Gakuin University

1. Valence-dependent difference : An inductive formulation

It is known that both positively valenced emotions and negatively valenced emotions have cognitive advantages in contrast to non-emotional neutrality (cf. Kanazawa, 2016, pp.30-31). However, it would be too impetuous to conclude that their cognitive benefits are symmetrical. As Foolen (2015) argues, it is natural to assume that different valences are treated differently by the processing systems including the language system because positive and negative objects of perception (e.g., valenced words) have different meanings for the organism (p.247). Beyeler and colleagues (2016) revealed that rodents' memories with different valence were encoded and formed differently at the level of neural activity ; positive cues (viz., sucrose) exciting the neurons connecting the basolateral amygdala and the nucleus accumbens whereas negative cues (viz., quinine) exciting the neurons connecting the basolateral amygdala and the central amygdala. Also as for humans, Osaka and colleagues (2013) discovered that positive and negative emotions modulated working memory through distinctive neural circuits. After all, it would also be against common sense to assume that negative emotion enhances cognition exactly in the same manner that positive emotion does ; it should not *feel* right for most people. In this section, cases and evidences of the difference between two polarities of emotional valence are reviewed through multidisciplinary literatures. Then, based on the collected *lignes de faits* (lines of facts ; cf. Bergson, 1919/1920), an inductive formulation is attempted.

In the field of cognitive linguistics, linguistic negativity bias has been reported to apply to intensifiers such as adjectives (Jing-Schmidt, 2007) and prosody (Bąk, 2016) whereas linguistic positivity bias has been reported for nouns and verbs as well as adjectives (Augustine, Mehl, & Larsen, 2011). A developmental psychological finding suggests that emotion vocabulary is larger in discourse about negative emotions (Lagattuta & Wellman, 2002). Rozin and colleagues (2010) summarize that positive events are more common (there are more tokens), but negative events are more differentiated (there are more types ; p.536). Referring to Peeters (1991), they provide a rationale that "because of the higher frequency of positive events, people expect the positive, but compensate for this expectation by extreme sensitivity to negative outcomes" (Rozin et al., 2010, p.537). In accordance with the rationale, it has been reported that adult social interactions have a positivity bias and thus positive emotions are enhanced and more accessible in a later-learned language than in a native language (Sheikh & Titone, 2015). It is also a gerontologically established fact that the more cognitive-social-emotional development advances in one's lifetime (i.e., as one gets older healthily), the more likely that s/he becomes optimistic, attends to and remembers positive rather than negative information (Reed & Carstensen, 2012 ; Chowdhury et al., 2013). It is even reported that facilitatory negativity effect on cognition is seen only for younger people whereas negative emotion predominantly had impairing effect for older adults (Berger, 2017).[1)]

Taken together, negativity effect is not so much what makes human human as a coping mecha-

1） As for the age-related positivity effect, there has even been neural evidence of the developmental shift. For example, Cassidy and colleagues (2013) reported that the increased activity of ventral medial prefrontal cortex during socio-cognitive task was elicited by negative emotional images for younger adults while it was by positive emotional materials for older adults. Accordingly, negativity bias in children and young adults dissipate with age. It has been proven that such a shift is *not* the product of neural impairment or cognitive decline (Carstensen & DeLiema, 2018).

nism in an emergency that we have inherited from the anthropoid ancestors. The default mental state of *homo sapiens* (which literally means "wise man" in Latin) is the positivity, in which the consciousness can afford to detach from the evolutionarily-preceding fight-of-flight responses to engage in the evolutionarily-advanced higher cognition.

Neuroscientific studies on hemispheric lateralization provide further insights into the valence-dependent difference. The brain functions are known to be asymmetrical ; the left hemisphere is involved in higher cognition such as categorical thought and conceptual thought whereas the right hemisphere processes images and lower perception which are situation-dependent, perpetually flowing, and constantly changing (Glezerman & Balkoski, 2002, p.241). It is even a folk psychological common sense that the left brain is more cognitive and analytic whereas the right brain is more emotional and holistic. This prevalent view, however, is not the whole story. It has been reported that emotion is processed not only in the right brain but also in the left brain, forming dynamic and complex neural networks (Everhart, Demaree, & Shipley, 2006).

In the field of neuropsychiatry, it has been postulated that the right hemisphere is specialized for negative emotion and that the left hemisphere is specialized for positive emotion (*the valence hypothesis* ; Silberman & Weingartner, 1986). Supporting the hypothesis, it has been found that positive emotion is associated with left hemisphere (Borod et al., 1997) or bilateral involvement (Ehrlichman, 1987). The valence hypothesis of hemispheric asymmetry has been validated and subsumed into later neuropsychological models such as *the approach-withdrawal model* (Davidson et al., 1990 ; approach and withdrawal correspond to positivity and negativity respectively), which is utilized as a research paradigm in word recognition studies (e.g., Citron et al., 2014). The BIS/BAS model (i.e., the behavioral activation systems and behavioral inhibition systems model ; Gray, 1981) in the field of psychopharmacology is further corroboration in favor of the valence hypothesis ; high BIS activation is associated with negativity while high BAS activation is so with positivity (Carver & White, 1994).

Paleopsychology provides an insightful perspective to compensate the valence hypothesis. In paleopsychology, it is known that the "left hemisphere functioning is more phylogenetically advanced than that of the right hemisphere" (Bailey, 1987, p.56). To dilate on the theory, the right hemisphere is presumed to be more phylogenetically continuous with lower species than the left, and thus, involved more in lower survival functions such as emotional reactivity than in abstract issues such as language (ibid., p.57). According to the neuroanthropological specialization hypothesis (Laughlin & D'Aquili, 1974), prehominid brain was bilaterally symmetrical until the invention of language.[2)] When language specialization occurred in the process of human evolution, "the right lobe remained basically the same, while the left lobe lost many of its prior functions, replacing them with higher ones" (Bailey, 1987, p.57). In support of this, neural substrates of language, a phylogenetically advanced cognitive capacity which only human beings have (i.e., Broca's area and Wer-

2) There have been different accounts of brain lateralization. Ocklenburg and Güntürkün (2012) posit that "human language lateralization might not be due to a dominance of the left hemisphere for language as such, but rather due to a left-hemispheric dominance for more basic features of species-typical communicative sounds or their production" (p.2). Hemispheric asymmetry is reported not only for *homo sapiens* but also for other vertebrates such as birds (Manns & Ströckens, 2014) and fish (Andrew, 2002), and even for echinoderms such as starfish and sea urchins (Rogers, Vallortigara, & Andrew, 2013). Despite those evidences, it still holds true that those prehominid cases of hemispheric lateralization are far less significant than that of *homo sapiens*.

nicke's area) are located in the left hemispheres. Therefore, negativity is related more to lower mental processing and can hinder higher mental operations, where positivity plays facilitatory roles. In accordance therewith, it has empirically been proven that cognitive performance is interrupted more by negative stimuli than by neutral or positive stimuli (Itkes & Mashal, 2016).

Discussed above were long-span evolutionary accounts. Similar findings can be found in short-span cognitive neuropsychological studies. For example, Comesaña and colleagues (2013) implemented an ERP experiment with masked affective priming with emoticons and found that affective priming effect were observed in early (N 2) components for positive words and later temporal windows (LPC) for positive words. The origin of LPC is located at the ventromedial prefrontal cortex (vmPFC), which is known to be "an interface between the evolutionarily old implicit processing systems within the limbic system, and the higher-order control systems within the dorsolateral prefrontal cortex" (Tapia et al., 2008, p.199). Consequently, higher cognition is more likely to be connected with positive emotion than with negative emotion not only at the macro long-span level of evolution but also at the micro short-span level of brain waves.

The *lines of facts* reviewed and explained so far are harmonious to the extended interpretation of the Broaden-and-Build theory of positive emotion (Fredrickson, 2001) and the affect-as-information hypothesis on negative emotion (Clore, Gasper, & Garvin, 2001). Those capacities which are broadened and built owing to the positive emotion include wise decision making in complex situations (Isen, 2001), precision and specificity in making mental representations (Tugade, Fredrickson, & Barrett, 2004), creative exploration (Cohler, 1987), life satisfaction (Cohn et al., 2009), eudaimonic meaning of life (Garland et al., 2015), deep spirituality and well-being (Van Cappellen et al., 2016) ; all related to the higher, deeper, and advanced cognition and beyond. On the other hand, those situations in which negative emotions function well as information are primitive evolutionarily-preceding ones such as hunting animals in which the fight-or-flight instinct becomes dominant. For ancient hominids with little, if any, capacity of higher and deeper cognition, negative emotions should have played significant roles in the survival of the individual and the avoidance of the extinction of the species. For advanced *homo sapiens,* however, situations in which negative emotions serve well are not only cognitively immature and shallow but also intellectually detrimental.

For example, recent studies have shown how important a role *mind-wandering* (i.e., a spontaneous internal cognition unrelated to the current demands of the external environment ; cf. Christoff et al., 2016 ; Schooler et al., 2011) and its neural substrates (i.e., default mode network ; DMN ; cf. Raichle et al., 2001)[3] play in higher cognition such as theory of mind (Sprend & Grady, 2009), goal-directed cognition (Spreng et al., 2014), creative idea production (Beaty et al., 2015), psychological well-being (Welz et al., 2018), and even mental time travel and the invention of language (Corballis, 2012 ; cf. Buonomano, 2017). According to Schooler and colleagues (2011), the following two core processes characterize mind-wandering : *perceptual decoupling* (i.e., to disengage attention from perception) and *meta-awareness* (i.e., to take explicit note of the current here-and-now contents of consciousness). If the perceptual load was high as in the case of negative emotion, resources for

3）The default mode network (DMN) is expected to compensate another famous cognitive network named working memory network (WMN), leading to a deeper understanding of the neural mechanism supporting higher cognition and consciousness (Osaka, 2013 ; Piccoli et al., 2015).

mind-wandering are depleted, indirectly hindering higher cognition (Forster & Lavie, 2009). No wonder concentration on schoolwork is severely deprived of when low-level perceptual distraction and negative incidents abound, as is seen in such cases as class disruption and juvenile delinquency. What is worse, negative affective processes coupled by higher cognition (e.g., self-reflection and self-image) may accrue into self-perpetuating downward spiral of psychopathology (Garland et al., 2010).

As these *lines of facts* suggest, negative emotions will only help you improve from the minus-states to the zero-point (i.e., maintenance of the homeostasis and the *status quo*). In order to improve from the zero-point to the plus-states (i.e., creative evolution, productivity, growth, *élan vital* toward the future), the support of positive emotions is required (cf. Bergson, 1907/1911 ; Whitehead, 1929). The contemplation and understanding so far can be inductively formulated as follows (Table 1) :

Table 1　Inductive Formula of Valence-Dependent Difference

	Description
Conditions	X precedes Y evolutionarily. X is lower and Y is higher. X is shallower and Y is deeper.
Implication	X is biased toward negativity whereas Y is toward positivity.

2. Deep Positivity Hypothesis : An abductive model

To provide a solid theoretical background and to make persuasive suggestions, it is inevitable to explore what the mental information-processing network is in terms of the cognitive architecture. One of the latest sophisticated cognitive architectures proposed in the field of second language acquisition and multilingualism is the Modular On-Line Growth and Use of Language (MOGUL) framework of cognitive architecture (Sharwood Smith & Truscott, 2014 ; Truscott, 2015 ; Sharwood Smith, 2017). The MOGUL framework may well be a promising progressive research program, ambitiously designed for the integrated understanding and further research of second language cognition (Figure 1).

In the MOGUL framework, emotion (Affective Structures ; AfS) has a special module distinguished from perception (Perceptual Output Structures ; POpS), cognition (Conceptual Structures ; CS), and language (Syntactic Structures & Phonological Structures ; SS & PS). Emotion is a pervasive mental faculty which plays a significant mediating role in perception (POpS), cognition (CS), and language (SS & PS ; cf. Sharwood Smith, 2017, pp.133-147). Also as for memory, it is postulated that “the involvement of value and emotion helps to strengthen and consolidate the memory” (Truscott, 2015, p.24), echoing with the Emotion-Involved Processing Hypothesis (Kanazawa, 2020).[4)]

Based on extensive evidences and theories, Truscott (2015) notes that the central principle of learning in the MOGUL is *acquisition by processing,* which is succinctly expressed as follows : “learning is the lingering effect of processing” (p.90). “The more awareness, the greater the possibilities for the successful establishment of new representations” (ibid., p.170). In other words, the

4） In the MOGUL account, input enhancement is extended to include *affective enhancement* as a variation of it (Truscott, 2015, pp.195-199). Affective input enhancement can be regarded as a pedagogy-oriented expression of the Emotion-Involved Processing.

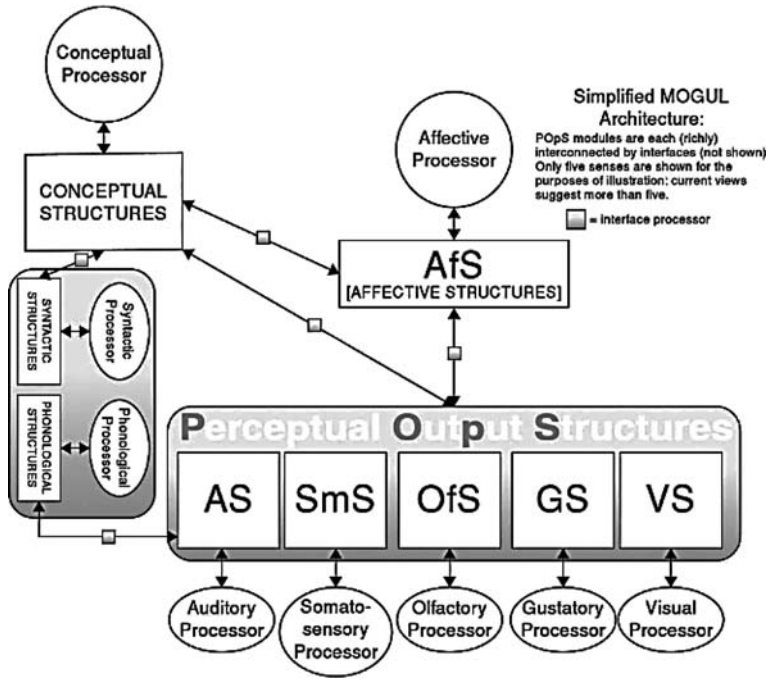

Figure 1 The Modular On-Line Growth and Use of Language (MOGUL) framework of cognitive architecture is depicted. The diagram is cited from Sharwood Smith and Truscott (2014, p.161) upon permission.

more, the better, and the deeper the input processing is, the more likely acquisition takes place. This parsimonious account of acquisition is effective, directly linking the findings of input processing to SLA. For all these benefits, the MOGUL framework is adopted as the worthy cognitive architecture in this paper. The parts relevant to the present discussion are extracted and the format is arranged in Figure 2.

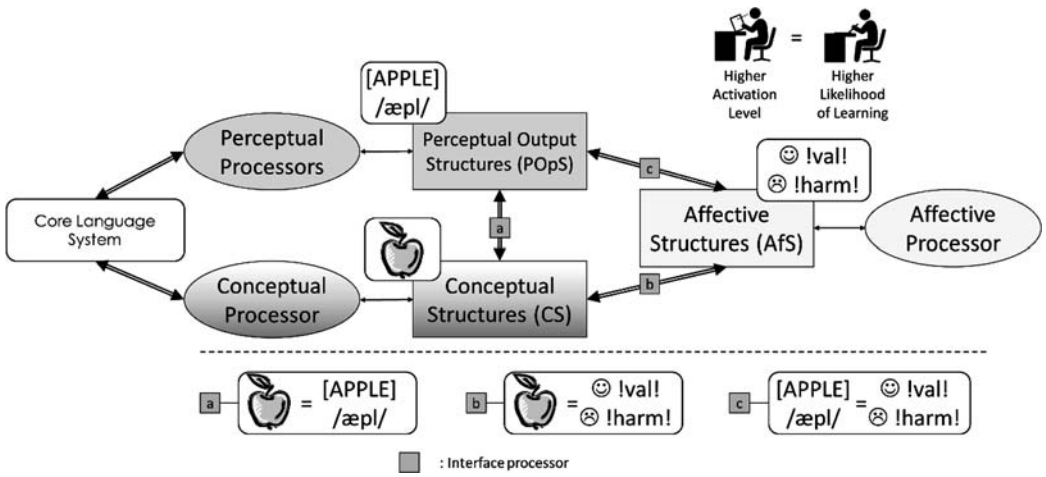

Figure 2 Relevant components of the MOGUL cognitive architecture are depicted. They were rearranged and drawn by the author based on Sharwood Smith and Truscott (2014), Truscott (2015), and Sharwood Smith (2017).

The labels with exclamation marks in Figure 2 are based on Truscott's (2015) terminology, in which *!val!* corresponds to positive valence and *!harm!* corresponds to negative valence. The function of interface processors, the small squares connecting structures in Figure 2, is "to propagate elevated activation levels to coindexed representations in adjacent stores. Extremely elevated levels [i.e., crossing the consciousness threshold] mean especially strong propagation, i.e., especially strong influences on activity in other modules" (Truscott, 2015, p.125). Activation of interface [a] is the form-meaning mapping, which is also modeled in the TOPRA model (Barcroft, 2015). However, interface [a] is not the only interface. Concurrent activation of interfaces [b] and [c] can also contribute to the raising of activation levels. Since conceptual structures (i.e., meaning) have a low activation resting level, co-activation of affective structures (i.e., emotion), which already have a high activation resting level, significantly contributes to raising the total activation levels, leading to better possibility of retention and acquisition.[5)] This may well be the mechanism of the Emotion-Involved Processing.

It is also worth noting that affective structures are interconnected not only to conceptual structures (via interface [b]) but also to perceptual structures (via interface [c]). Emotion-Involved Processing as a deeper processing than semantic processing can be regarded as activation of interfaces [a] and [b] to enhance the cognition. Therefore, Emotion-Involved Processing (EmInvProc) may more strictly be named Emotion-Involved Semantic Processing (EmInvSemProc). Another kind of emotion-involvement via interface [c], which is not included in the main scope of the theory of Emotion-Involved Processing, may tentatively be referred to as Emotion-Involved Perceptual Processing (EmInvPercProc).

Now, the right time has come for the final theoretical integration. In Section 1 of this paper, an inductive formula of asymmetrical effects of different valences was drawn based on multidisciplinary facts and evidences (Table 1). In the formulation, it was kept undetermined what X and Y stood for. Kanazawa's (2020) theoretical speculation and lines of facts shed new light towards the integration of valence-dependent difference and the Emotion-Involved Processing Hypothesis, which is attempted below.

To state the conclusion first, it is abductively hypothesized that X and Y in the inductive formula can legitimately be replaced by shallow/perceptual processing and deep/semantic processing, respectively (Table 2).

Table 2　Abductive Formula of Valence-Dependent Difference and the Levels of Processing

	Description
Conditions	*Shallow/perceptual processing* precedes *deep/semantic processing* evolutionarily. *Shallow/perceptual processing* is lower and *deep/semantic processing* is higher. *Shallow/perceptual processing* is shallower and *deep/semantic processing* is deeper.
Implication	*Shallow/perceptual processing* is biased toward negativity whereas *deep/semantic processing* is toward positivity.

Note. X and Y in the inductive formula (Table 1) were substituted with *shallow/perceptual processing* and *deep/semantic processing,* respectively.

5）The low resting activation level of conceptual structures has an exception： the concept of *self* (Truscott, 2015, p.211), which was beyond the scope of this paper.

Any organism, even an unicellular microorganism, can perceive the outer stimuli for survival. On the other hand, the construction of consciousness with organized meaningful thoughts is a higher cognition which only those organisms with highly developed neocortices are capable of. Therefore, *shallow/perceptual processing precedes deep/semantic processing evolutionarily.* In other words, *shallow/perceptual processing is lower and deep/semantic prosessing is higher.* That *shallow/perceptual processing is shallower and deep/semantic processing is deeper* is a tautology.

Since the substitution meets all the conditions, it is inductively implied that *shallow/perceptual processing is biased toward negativity whereas deep/semantic processing is toward positivity.* It has to be admitted that this is rather an abductive hypothesis because evidences are limited, the directly unobserved phenomenon of levels of processing is incorporated, and the inference was pushed a bit too far away (Peirce, 1878/1931).[6] However, as Peirce notes, abduction "is logical inference, asserting its conclusion only problematically or conjecturally, it is true, but nevertheless having a perfectly definite logical form" (1903/1934). The abductive model integrating the levels of processing and the valence-dependent difference was developed in reference to the MOGUL cognitive architecture (Deep Positivity Hypothesis ; Figure 3).

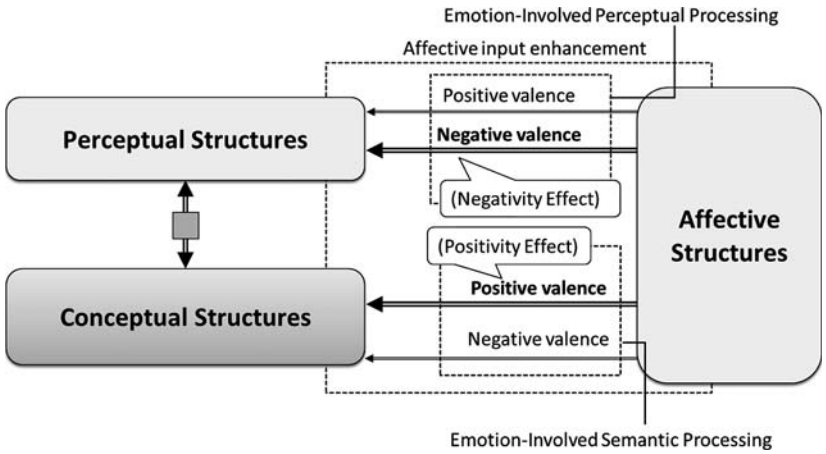

Figure 3 Deep Positivity Hypothesis (DPH) is depicted, in which the possible valence-dependent difference regarding the levels of processing is abductively incorporated in reference to the MOGUL framework.

This model also meets the important criteria for a better theoretical *aufheben* (Kanazawa, 2020) ; it is based on the synechistic view of cognitive architecture, it is thought-provoking, and it

6) The following remark by C. S. Peirce explains the difference of *abduction* and *induction* : "The great difference between induction and abduction is, that the former infers the existence of phenomena such as we have observed in cases which are similar, while abduction supposes something of a different kind from what we have directly observed, and frequently something which it would be impossible for us to observe directly. Accordingly, when we stretch an induction quite beyond the limits of our observation, the inference partakes of the nature of abduction. It would be absurd to say that we have no inductive warrant for a generalization extending a little beyond the limits of experience, and there is no line to be drawn beyond which we cannot push our inference ; only it becomes weaker the further it is pushed. Yet, if an induction be pushed very far, we cannot give it much credence unless we find that such an extension explains some fact which we can and do observe. Here, then, we have a kind of mixture of induction and abduction supporting one another ; and of this kind are most of the theories of physics" (Peirce, 1878/1931, para. 2.640 ; the term *hypothesis* in the original text was replaced with *abduction* by the author because Peirce renamed it in his later works ; cf. Yonemori, 1981).

is based on abduction (Kanazawa, 2019 ; 2020). Although the Deep Positivity Hypothesis is more complex and less cognition-friendly than the Emotion-Involved Processing Hypothesis, it still has a pragmatic value in education and pedagogy ; what is important for deeper learning is not just emotion but *positive emotion.*

However, as abduction is weaker than induction, the DPH has to be tested empirically. The following is a preliminary attempt to inquire whether previous empirical findings support the DPH. To begin with, Colbeck and Bowers (2012) found that second language (L2) users were less distracted by taboo words used as distractors of the lexical processing task compared to first language (L1) users. Furthermore, Jończyk and colleagues (2016) reported that negatively valenced semantic contents arouse less semantic brain activity (viz., N 400) in L2 context compared to in L1 context. These findings suggest that the risk of emotional disembodiment in L2 is prominent in negative valence (Sheikh & Titone, 2016), supporting the interaction between levels of processing and lexical valence. On the other hand, Jay, Caldwell-Harris, and King (2008) reported that emotional words facilitated memory only in the shallow processing condition while not in the deep processing condition. It is, however, to be noted that their stimulus grouping was regardless of emotional valence (i. e., both positive and negative words were in the same group of *emotional words*) and thus, it is likely that each valence worked differently, resulting in no effect detected as the category of *emotional words* itself. Whether and how different valences affect at the level of deep processing is a controversial issue with opposing empirical evidences (cf. Reber et al., 1994 ; Ferré, Sánchez-Casas, & Fraga, 2013). Gupta, Hur, and Lavie (2016) revealed that although the perceptual load of the cognitive task influenced the effect of negatively valenced distractors, it had no influence on the effect of positively valenced stimuli. In other words, negativity can be more related with perceptual processing than positivity. These empirical findings imply, not to say prove, that the Deep Positivity Hypothesis is not only a theoretical speculation but also an adequate working hypothesis in accordance with empirical lines of facts.

3. Concluding remarks

This paper theoretically investigated the potential mechanism behind how valence-dependent differences facilitated cognition differently. Through multidisciplinary findings and established facts, the mechanism was inductively formulated with two unknown variables (Table 1). Followed by the inductive formulation, an abductive reasoning was attempted to identify the unknown variables. Drawing insights from recent cognitive theories/models such as the Modular On-Line Growth and Use of Language (MOGUL) framework of cognitive architecture (Sharwood Smith & Truscott, 2014) and the Emotion-Involved Processing Hypothesis (Kanazawa, 2020), the Deep Positivity Hypothesis (DPH) was subsequently proposed. Its message to emphasize positive emotion in deeper learning is pedagogically implicative and a number of empirical studies appear to support the DPH. For further study, scientific approaches as well as phenomenological approaches should test the hypothesis and delve deeper into its structures and pedagogical applicability.

References

Andrew, R. J. (2002). The earlies origins and subsequent evolution of lateralization. In L. J. Rogers & R. Andrew (Eds.), *Comparative vertebrate lateralization* (pp.70-93). Cambridge, England : Cambridge University Press.

Augustine, A. A., Mehl, M. R., & Larsen, R. J. (2011). A positivity bias in written and spoken English and its moderation by personality and gender. *Social Psychological and Personality Science, 2*(5), 508-515.

Bailey, K. (1987). *Human paleopsychology.* Hillsdale, NJ : Lawrence Erlbaum.

Bąk, H. (2016). *Emotional prosody processing for non-native English speakers.* Gewerbestrasse, Switzerland : Springer.

Barcroft, J. (2015). *Lexical input processing and vocabulary learning.* Amsterdam, Netherlands : John Benjamins Publishing Company.

Beaty, R. E., Benedek, M., Kaufman, S. B., & Silvia, P. J. (2015). Default and executive network coupling supports creative idea production. *Scientific Reports, 5,* 10964.

Berger, N. (2017). *The effects of emotion on executive functions in ageing* (Doctoral dissertation). Birkbeck, University of London, London, England.

Bergson, H. (1911). *L'Évolution créatrice* [Creative evolution]. (A. Mitchell, Trans.). New York, NY : Henry Hold and Company. (Original work published 1907)

————. (1920). *L'Énergie spirituelle* [Mind-energy]. (H. W. Carr, Trans.). Westport, CT : Greenwood Press. (Original work published 1919)

Beyeler, A., Namburi, P., Glober, G. F., Simonnet, C., Calhoon, G. G., Conyers, G. F., Luck, R., Wildes, C. P. & Tye, K. M. (2016). Divergent routing of positive and negative information from the amygdala during memory retrieval. *Neuron, 90*(2), 348-361.

Borod, J. C., Haywood, C. S., & Koff, E. (1997). Neuropsychological aspects of facial asymmetry during emotional expression. *Neuropsychology Review, 7*(1), 41-60.

Buonomano, D. (2017). *Your brain is a time machine.* New York, NY : W. W. Norton & Company.

Carstensen, L., & DeLiema, M. (2018). The positivity effect. *Current Opinion in Behavioral Sciences, 19,* 7-12.

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment. *Journal of Personality and Social Psychology, 67*(2), 319-333.

Cassidy, B. S., Leshikar, E. D., Shih, J. Y., Aizenman, A., & Gutchess, A. H. (2013). Valence-based age differences in medial prefrontal activity during impression formation. *Social Neuroscience, 8*(5), 462-473.

Chowdhury, R., Sharot, T., Wolfe, T., Düzel, E., & Dolan, R. J. (2013). Optimistic update bias increases in older age. *Psychological Medicine, 44*(9), 2003-2012.

Christoff, K., Irving, Z. C., Fox, K. C., Spreng, R. N., & Andrews-Hanna, J. R. (2016). Mind-wandering as spontaneous thought. *Nature Reviews Neuroscience, 17,* 718-731.

Citron, F. M. M., Gray, M. A., Critchley, H. D., Weekes, B. S., & Ferstl, E. C. (2014). Emotional valence and arousal affect reading in an interactive way. *Neuropsychologia, 56,* 79-89.

Clore, G. L., Gasper, K., & Gavrin, E. (2001). Affect as information. In J. P. Forgas (Ed.), *Handbook of affect and social cognition* (pp.121-144). Mahwah, NJ : Lawrence Erlbaum.

Cohler, B. J. (1987). Adversity, resilience, and the study of lives. In E. J. Anthony & B. J. Cohler (Eds.), *The invulnerable child* (pp.363-424). New York, NY : The Guilford Press.

Colbeck, K. L., & Bowers, J. S. (2012). Blinded by taboo words in L1 but not L2. *Emotion, 12*(2), 217-222.

Comesaña, M., Soares, A. P., Perea, M., Piñeirod, A. P., Fraga, I., & Pinheiro, A. (2013). ERP correlates of masked affective priming with emoticons ☺. *Computers in Human Behavior, 29*(3), 588-595.

Corballis, M. C. (2012). The wandering mind : Mental time travel, theory of mind, and language. *Análise Social, 205*(4), 870-893.

Davidson, R. J., Ekman, P., Saron, C. D., Senulis, J. A., & Friesen, W. V. (1990). Approach-withdrawal and cerebral asymmetry. *Journal of Personality and Social Psychology, 58*(2), 330-341.

Ehrlichman, H. (1987). Hemispheric asymmetry and positive-negative affect. In D. Ottoson (Ed.), *Duality and unity of the brain* (pp.194-206). Hampshire, UK : Macmillan.

Everhart, D. E., Demaree, H. A., & Shipley, A. J. (2006). Perception of emotional prosody. *Behavioral and Cognitive Neuroscience Reviews, 5*(2), 92-102.

Ferré, P., Sánchez-Casas, R., & Fraga, I. (2013). Memory for emotional words in the first and the second language. *Bilingualism : Language and Cognition, 16*(3), 495-507.

Foolen, A., (2015). Word valence and its effects. In U. M. Lüdtke (Ed.), *Emotion in language* (pp.241-250). Amsterdam,

Netherlands： John Benjamins Publishing Company.

Forster, S., & Lavie, N. (2009). Harnessing the wandering mind *Cognition, 111*(3), 345-355.

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology. *American Psychologist, 56*(3), 218-226.

Garland, E. L., Farb, N. A., Goldin, P. R., & Fredrickson, B. L. (2015). Mindfulness broadens awareness and builds eudaimonic meaning. *Psychological Inquiry, 26*(4), 293-314.

Garland, E. L., Fredrickson, B., Kring, A. M., Johnson, D. P., Meyer, P. S. & Penn, D. L. (2010). Upward spirals of positive emotions counter downward spirals of negativity. *Clinical Psychology Review, 30* (7), 849-864.

Glezerman, T., & Balkoski, V. (2002). *Language, thought, and the brain.* New York, NY： Kluwer Academic Publishers.

Gray, J. A. (1981). A critique of Eysenck's theory of personality. In H. J. Eysenck (Ed.), *A model for personality* (pp.246-277). Berlin： Springer.

Gupta, R., Hur, Y. J. & Lavie, N. (2016). Distracted by pleasure. *Emotion, 16*(3), 328-337.

Isen, A. M. (2001). An influence of positive affect on decision making in complex situations. *Journal of Consumer psychology, 11*(2), 75-85.

Itkes, O., & Mashal, N. (2016). Processing negative valence of word pairs that include a positive word. *Cognition and Emotion, 30*(6), 1180-1187.

Jay, T., Caldwell-Harris, C., & King, K. (2008). Recalling taboo and nontaboo words. *American Journal of Psychology, 121* (1), 83-103.

Jing-Schmidt, Z. (2007). Negativity bias in language. *Cognitive Linguistics, 18*(3), 417-443

Jończyk, R., Boutonnet, B., Musiał, K., Hoemann, K., & Thierry, G. (2016). The bilingual brain turns a blind eye to negative statements in the second language. *Cognitive, Affective & Behavioral Neuroscience, 16,* 527-540.

Kanazawa, Y. (2016). Micro-level emotion as a factor of L2 vocabulary memory. *Language Education & Technology, 53,* 23-52.

————. (2019). From the emotion/cognition dichotomy to an organic whole： Philosophical perspectives via James, Whitehead, Peirce, Dewey, and Bergson. *Journal of International Studies, 8*(1), 85-96

————. (2020). Emotion as "deeper" than cognition. *Journal of International Studies, 9*(1), 185-206. "in press"

Lagattuta, K. H., & Wellman, H. M. (2002). Differences in early parent-child conversations about negative versus positive emotions. *Developmental Psychology, 38*(4), 564-580.

Laughlin, C. D., & D'Aquili, E. G. (1974). *Biogenetic structuralism.* New York, NY： Columbia University Press.

Manns, M., & Ströckens, F. (2014). Functional and structural comparison of visual lateralization in birds－similar but still different. *Frontiers in Psychology, 5,* 206.

Ocklenburg, S., & Güntürkün, O. (2012). Hemispheric asymmetries. *Frontiers in Psychology, 3,* 5.

Osaka, M. (2013). Understanding the brain through the default mode network (DMN). *Japanese Journal of Physiological Psychology and Psychophysiology, 31*(1), 1-3.

Osaka, M., Yaoi, K., Minamoto, T., & Osaka, N. (2013). When do negative and positive emotions modulate working memory performance? *Scientific Reports, 3,* 1375.

Peeters, G. (1991). Evaluative inference in social cognition. *European Journal of Social Psychology, 21*(2), 131-146.

Peirce, C. S. (1931). Deduction, induction, and hypothesis. In C. Hartshorne & P. Weiss (Eds.), *Collected papers of Charles Sanders Peirce* (Vols. 1-2； Paras. 2.619-644). Cambridge, MA： Harvard University Press. (Original paper published 1878)

————. (1934). Pragmatism and abduction. In C. Hartshorne & P. Weiss (Eds.), *Collected papers of Charles Sanders Peirce* (Vols. 5-6； Paras. 5.180-5.212). Cambridge, MA： Harvard University Press. (Original lecture given 1903)

Piccoli, T., Valente, G., Linden, D. E. J., Re, M., Esposito, F., Sack, A. T., & Salle, F. D. (2015). The default mode network and the working memory network are not anti-correlated during all phases of a working memory task. *PLoS One, 10*(4), e0123354.

Raichle, M. E., MacLeod, A. M., Snyder, A. Z., Powers, W. J., Gusnard, D. A., & Shulman, G. L. (2001). A default mode of brain function. *PNAS, 98*(2), 676-682

Reber, R., Perrig, W. J., Flammer, A., & Walther, D. (1994). Levels of processing and memory for emotional words. *Swiss Journal of Psychology, 53*(2), 78-85.

Reed, A. E., & Carstensen, L. L. (2012). The theory behind the age-related positivity effect. *Frontiers in Psychology, 3,* 339.

Rozin, P., Berman, L., & Royzman, E. (2010) Biases in use of positive and negative words across twenty natural languages. *Cognition and Emotion, 24*(3), 536- 548.

Schooler, J. W., Smallwood, J., Christoff, K., Handy, T. C., Reichle, E. D., & Sayette, M. A. (2011). Meta-awareness, perceptual decoupling and the wandering mind. *Trends in Cognitive Sciences, 15*(7), 319-326.

Sharwood Smith, M. (2017 a). *Introducing language and cognition.* Cambridge, England : Cambridge University Press.

Sharwood Smith, M. & Truscott, J. (2014). *Multilingual mind.* Cambridge, England : Cambridge University Press.

Sheikh, N. A., & Titone, D. (2016). The embodiment of emotional words in a second language. *Cognition and Emotion, 30* (3), 488-500.

Silberman, E. K., & Weingartner, H. (1986). Hemispheric lateralization of functions related to emotion. *Brain and Cognition, 5*(3), 322-353.

Spreng, R. N., & Grady, C. L. (2010). Patterns of brain activity supporting autobiographical memory, prospection, and theory of mind, and their relationship to the default mode network. *Journal of Cognitive Neuroscience, 22*(6), 1112-1123.

Tapia, M., Carretie, L., Sierra, B., & Mercado, F. (2008). Incidental encoding of emotional pictures. *International Journal of Psychophysiology, 68,* 193-200.

Truscott, J. (2015). *Consciousness and second language learning.* Bristol, England : Multilingual Matters.

Tugade, M. M., Fredrickson, B. L., & Barrett, L. F. (2004). Psychological resilience and positive emotional granularity. *Journal of Personality, 72*(6), 1161-1190.

Van Cappellen, P., Toth-Gauthier, M., Saroglou, V., & Fredrickson, B. L. (2016). Religion and well-being. *Journal of Happiness Studies, 17*(2), 485-505.

Welz, A., Reinhard, I., Alpers, G.W., & Kuehner, C. (2018). Happy thoughts, Mind wandering affects mood in daily life. *Mindfulness, 9*(1), 332-343.

Whitehead, A. N. (1929). *The aims of education & other essays.* London, England : Williams & Norgate, LTD.

Yonemori, Y. (1981). *Peirce no kigougaku* [Peircean semiotics]. Tokyo, Japan : Keiso Shobou.