

Reading and Cognitive Processes: A Literature Review of Cognitive Psychology

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Abstract

Several studies are showing that executive functions such as working memory, inhibition, updating, shifting, and cognitive functions such as memory, attention, and perception are related to reading acquisition. The purpose of this literature review is to explore the psychological study of reading; In first place, we will be processing reading as a phenomenon in a human's life: encompassing the historical importance of literacy in general and reading in specific, developmental aspects, with a particular focus on childhood experiences and family environments. Then on the other hand, we will analyze reading from a purely psychological view, i.e. as a cognitive process by digging into the theoretical frameworks and discovering the various models of reading acquisition, the contributions of different fields in this study (e.g. neuroscience), especially cognitive psychology's role in understanding reading processes (word identification - word comprehension). We aimed to clarify the correlation between cognitive (memory-attention) and executive functioning (working memory-inhibition) on the one hand, and the reading process on the other, drawing support from a wide range of studies. Understanding these interrelationships enables us to conclude their implications for educational practices and cognitive development strategies. The literature search was primarily executed using databases like Google Scholar, ScienceDirect, and Scopus, ensuring a diverse array of scholarly sources. Thematic analysis was employed to categorize insights across the reviewed literature, enabling a comprehensive understanding of the interplay between reading, cognitive functions, and executive functions.

Keywords: Reading - Cognitive functions - Executive functions - Literacy - Identification - Comprehension- Cognitive psychology

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Lecture et Processus Cognitifs : Revue de Littérature en Psychologie Cognitive

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Resumé

Plusieurs études ont montré que les fonctions exécutives telle la mémoire de travail, l'inhibition, la mise à jour... et les fonctions cognitives telles que la mémoire, l'attention, et la perception sont liées à l'acquisition de la lecture. Le but de cette revue de la littérature est d'explorer l'étude psychologique de la lecture ; Au premier lieu, nous traiterons la lecture comme un phénomène dans la vie humaine : enveloppant l'importance historique de la littératie en général et spécifiquement la lecture, les aspects spécifiques du développement, en mettant particulièrement l'accent sur les expériences d'enfance et les environnements familiaux. En deuxième lieu, nous analyserons la lecture d'un point de vue purement psychologique, c'est-à-dire, comme un processus cognitif en approfondissant dans les cadres théoriques et en mettant l'accent sur les différents modèles d'acquisition de la lecture, les contributions de différents domaines dans cette étude (ex., neuroscience), en particulier le rôle de la psychologie cognitive dans la compréhension des processus de lecture (l'identification et la compréhension du mot écrit). Nous visons à clarifier la corrélation entre le fonctionnement cognitive (mémoire-attention) et exécutif (mémoire de travail-inhibition) d'une part, et le processus de lecture d'autre part, en s'appuyant sur un large éventail d'études. Comprendre ces interrelations nous permet de tirer des conclusions concernant leurs implications pour les pratiques éducatives et les stratégies de développement cognitif. La recherche bibliographique a été principalement effectuée à l'aide de bases de données telles que Google Scholar, ScienceDirect et Scopus, pour garantir une diversité de sources académiques en employant une analyse thématique pour catégoriser les idées à travers la littérature examinée.

Mots clés

Lecture - Fonctions cognitives – Fonctions exécutives – Littératie – Identification – Compréhension-
Psychologie cognitive

Introduction

No one can deny the profound impact of literacy throughout history. Kofi Annan, Abraham Lincoln, and Frederick Douglass all recognize the transformative power of literacy. “Literacy is a bridge from misery to hope. It is a tool for daily life in modern society. It is a bulwark against poverty, and a building block of development, an essential complement to investments in roads, dams, clinics and factories “. Annan (the former Secretary-General of the UN) describes it as a bridge from despair to hope, a tool for daily life, and a foundation for development. Lincoln regards writing as the greatest invention, enabling the communication of thoughts. Douglass (American abolitionist and orator) views literacy as the key to freedom. Together, these quotes highlight the fact that literacy is not merely about reading and writing; a tremendous force that empowers individuals, builds societies, and drives progress. That explains the massive attention delivered from several fields to the topic of literacy generally and the reading process exactly. Psychology is one of those fields, presented exactly by the contributions of Cognitive psychologists.

In this literature review, we will discuss some topics about the reading process, first the history of literacy, because we cannot talk about reading in isolation from writing. Then moving to the theoretical framework, and finally the main problematic of this article, which is the relationship between reading and cognitive processes. It is also important to say that we will not include the pathological part of the reading process, which can assure a pure cognitive study.

Research methodology

This literature review was carried out using a systematic approach to explore the psychological study of reading. We used databases such as Google Scholar, ScienceDirect, and Scopus, to ensure a diverse range of scholarly sources. A thematic analysis was employed for a structured comparison across multiple aspects and to synthesize insights across the reviewed literature. Historical perspectives on literacy were documented through a review of articles and books published between 1900 and the late 1980s. For the development of literacy in childhood, we used key meta-analyses, (e.g., white's,1982), to synthesize findings on early reading acquisition. Recent studies were examined to address the review's central research question

regarding the correlation between reading and cognitive and executive processes shedding light to the theoretical framework

1. Reading the phenomenon:

1.1. History:

From a historical eye, the study of literacy has been done for decades, starting from the publication of Huey's The Psychology and Pedagogy of Reading in 1908, where Huey discussed many topics such as word recognition process, inner speech, reading rate, etc. However, we can define three modern generations of historical literacy studies. The first generation was known in the 20s and 30s, when psychological research was dominated by the behaviorist approach (1920-1960). This period was also marked by some publications especially with the works of Fleury and Valmary (1957), Stones (1969), Cipolla (1969), Schofield (1968) and others. This generation of scholars focused on the historical study of literacy, The importance of literacy in the context of the human lifespan hasn't gotten sufficient attention. It also emphasizes the need to be cautious when making a correlation between basic literacy levels and reading patterns. The late 50s was highlighted by the "Cognitive revolution". We refer here to three works, Broadbent (1958), Neissier (1967) and Chomsky (1971). The second generation was led by their students, for example, Schofield (1973), Egil Johansson (1977, 1981, 1985), Cressay (1980). These works examined the relationship between literacy and social and economic development, political transformations, and ideological aspects. They began to employ quantitative methods to study literacy, leading to an increase in studies on the topic in fields such as economic change, demographic behavior, cultural development, conflict, and class formation. Finally, the third generation, we are referring here to two new and original directions in the social scientific study of literacy; the socio-psychological work led by experimental, ethnographic and comparative cognitive psychologists (e. g. Sylvia Scribner and Michael Cole, especially in their The Psychology of Literacy (1981)). We should also highlight the works of Sylvia Scribner's (1984) about skills including reading and writing. The second direction is the community-based ethnographies of literacy and education brought together by anthropologist and linguist Shirley Heath. Therefore, this interdisciplinary approach reinforced the study of Literacy in terms of learning and use, nature of acquisition, culture and traditions, etc.

1.2. Literacy development in childhood: Home experience

In this part, we are going to zoom into the first environment for the young reader, which is the family. The reading readiness perspective marked this study; an approach that focuses on the idea that the child needs to gain some abilities (phonological, morphological, cognitive, linguistic, etc.) in order to be successful in reading. This concept was introduced by Arnold Gesell. Gesell was especially interested in children's physical and motor development, resulting from his work and that these aspects of development "unfold in stages." Or, to put it in another way, a young child grows and develops as a result of maturation, not learning" (Durkin, 1970, p.529).

In the early 70s, many forms of literacy were viewed and emphasized, which made the scientists discover that the young children had rich strategies and ways related to literacy. Here the concept of "Emergent literacy" took place by Teale and Sulzby in 1986. For them the emergent literacy refers to the early reading and writing knowledge and ways of learning.

After discussing the theoretical basis of this period, it is time to deal with some important findings based on White's (1982) meta-analysis, that shows a correlation between early reading and the following factors: family characteristics (such as academic guidance, attitude toward education, and aspirations of parents for children), conversations in the home, and reading materials and cultural activities. For the first factor, White highlights the effects of **the environment characteristics** on the reading and writing development, we can say the indirect effect. The quantity of literacy behaviors displayed by parents is a better predictor of children's literacy learning. (Dunn, 1981; Hess, Holloway, Price, & Dickson, 1982; Hiebert, 1980). This finding suggests that parents' own actions related to literacy, such as reading or writing, have a greater impact on children's literacy development. For example, a parent who always keeps a book or newspaper in his hand can give us a sign that his child will be more able to read and write more efficiently than a child whose parent does not. The second factor is **parent-child interactions**, we refer here to the first factor from the other side, the direct effect. Studies have shown a strong relationship between storybook reading and literacy acquisition. (Flood, 1977, cited in Yussen & Smith, 2012, Reading Across the Lifespan, p.33). The third factor is represented by **everyday interactions with written language**; when we hear written language we think only of books, but there are various forms of written language around us that makes the child exercise his reading

and writing skills (signs, advertisements...). In the same line, the observations (approximately 2000 hours of observations in the homes of Anglo-, African-, and Hispanic-American preschool children) of Anderson and Strokes (1984) showed eight forms of literacy occasion (in addition to storybook time): daily living, entertainment, school-related activity, religion, general information, work, literacy techniques, skills, and interpersonal communication. However, nowadays and due to the massive improvement and development of artificial intelligence, and its various forms of effects in the life of individuals, I think that a certain change will affect this list.

2. Theoretical framework

2.1. Cognitive psychology and reading

As we mentioned earlier, the cognitive revolution pushed the study of literacy, especially the study of reading. Starting with one of the world's most eminent linguists Chomsky as he published a book titled The Case against B. F. Skinner where he criticized the behavioristic approach to studying language, by proving the behavioral approach's limitations dealing with language and reading. Behaviorists see human behavior as a stimulus-response equation, disregarding by that, or considering the cognitive and mental process as just some by-products. On this basis, Skinner discussed the reading process and its development in his book Verbal Behavior (1957). Broadbent (1958) and Neisser (1967) were important publications in this study, even if those works were specifically about reading. However, they both start the discussion about visual stimuli processing and encoding. After a stimulus was captured (input), the organism executes several operations of coding presented schematically by boxes (take a place in the brain) and arrows (transition from sensory organ to processing system). The cognitive approach tried to align with the existing knowledge about the brain and nervous system. Nevertheless, after cognitive neuroscience brought light into the nervous system, using brain imaging techniques and analyzing electrophysiological data, the cognitive revolution is equipped with new techniques that allow a new study of reading and word identification. For example, lexical decision tasks, priming techniques, reaction time (RT), eye-movement techniques, eye tracking (picture. 1)

Reading is a result of a reaction between two processes (Reading = word recognition + comprehension) (Gough et Tunmer, 1986), word identification and word comprehension; which means if the identification was not right, the comprehension would not be right too and then the

failure of the reading process. Another reason can result from the failure of the reading process, that is the cognitive overload the words apply on the cognitive (attention, memory), executive (inhibition, planification) abilities. Thus in the next part we will discover those two fundamental processes and the theoretical framework, and we will discuss the relationships between reading and cognitive functions supported by several studies.



Picture.1- Potocki, Ros, Vibert and Rouet (2017) Experience using an eye-tracking method (Potocki, A.,et al. 2017. Children’s visual scanning of textual documents.p13)

2.2. Word Identification

The acquisition of word identification is a process that is carried out in several stages: a **logographic recognition**, based only on visual recognition of the written word without including phonological traits. **Guessing procedures**, either total (based on context) or partial (based on knowledge of a few letters). **Decoding procedure** characterized by establishing grapho-phonological correspondences. This unit will allow us to build an orthographic representation of the word.

There are two types of theoretical models that try to explain the process of reading; Stage models (or acquisition stages) (Frith, 1985; Morton, 1989, Interactive models (Goswami 1999; Gombert 2003). Concerning the stage models, this type is based on general description (each stage

involves developmental changes: qualitative and quantitative) regrouped in sequence of stages, the order of succession is strict and identical for all children. The transition from one stage to another occurs only after mastery of the current stage. For example: Frith (1985) who defined three stages, each stage corresponds to a specific procedure for recognizing written words: 1) the logographic procedure, which involves using visual cues, 2) the alphabetic procedure, which entails systematic use of phonological ability, and finally 3) the orthographic

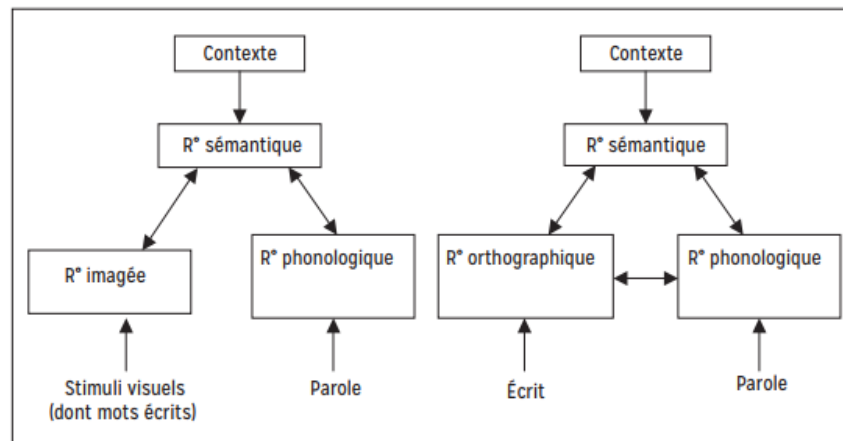


Figure.1 – Learning Model of Gombert (2003)
(Ecalte, J., & Magnan, A. (2021). *L'apprentissage de la lecture et ses difficultés*, p 92).

procedure, which involves processing orthographic patterns. (Gombert, 2003) criticized this type of model, due to the negligence of learning in its two dimensions (explicit and implicit)? We also notice the absence of individuality and singularity of the reader which have a dynamic role in this process. The second type is the Interactive model; this model emphasizes the early connections between phonological units and orthographic units. In this perspective, Goswami (1999) proposes a developmental framework based on the idea that four causal connections can explain the acquisition of reading. The first connection is established between knowledge of oral rhymes and knowledge of orthographic sequences, The second relationship occurs between phonemic competence and reading, A third connection is made through written production activities and finally the fourth connection concerning the quality of phonological representations. Another interesting model presented by Gombert in 2003. Gombert suggests a design of reading learning

that takes into account written code, grapheme-phoneme correspondence, Orthographic – morpheme configuration and implicit/explicit learning (Figure.1).

Gombert suggests that children before learning to read have an oral language processing system that allows them to develop a written language processing system. This initial system is composed of a pictorial processor; responsible for visual information processing (e. g. the picture of a cup seen in an advertisement; fronts, colors...); a phonological processor that processes linguistics information ([KUP]); a semantic processor that allows us to give a sense and meaning and finally a contextual processor (is it a cup for tea-coffee, made of plastic-glass?).

Therefore, this initial system will develop another system to process written language. The simultaneous processing of written information by pictorial, phonological, and semantic processors leads to the development of an orthographic processor (implicit learning). In addition to the orthographic processor, there is also a phonological processor and a semantic processor. We can say that the only distinction between the two systems is the orthographic processor.

As a conclusion, we can discuss another model that regroups several other types. We refer here to the general model based on word processing. This model allows us to frame the different procedures that the young beginner reader can implement during reading. The written word accepts three paths (we can find more, but these are the essentials). The first path is the direct one; when captured, a written word is known in terms of some characteristics (phonological - visual contextual); in other words, we did process this word in one time, so we retrieve the address from the lexicon through the phonological representation. The indirect path is when we face a word we do not know, we use the phonological, visual and contextual characteristics to decode the word by assembling the graphemic units and transcription into phonological units and then accessing the lexicon. The third path is when the word identification fails, which means that the young reader thinks he knows the word but in fact he doesn't, so the word with its characteristics takes the addressing path but no representations are found in the lexicon, and so the word takes the way of decoding all over again. We can notice the excessive use of decoding which has an impact cognitively on the reader. This idea makes us wonder: What are the effects of reading on the cognitive performances of readers? How are the outcomes of cognitive performance affected by reading?

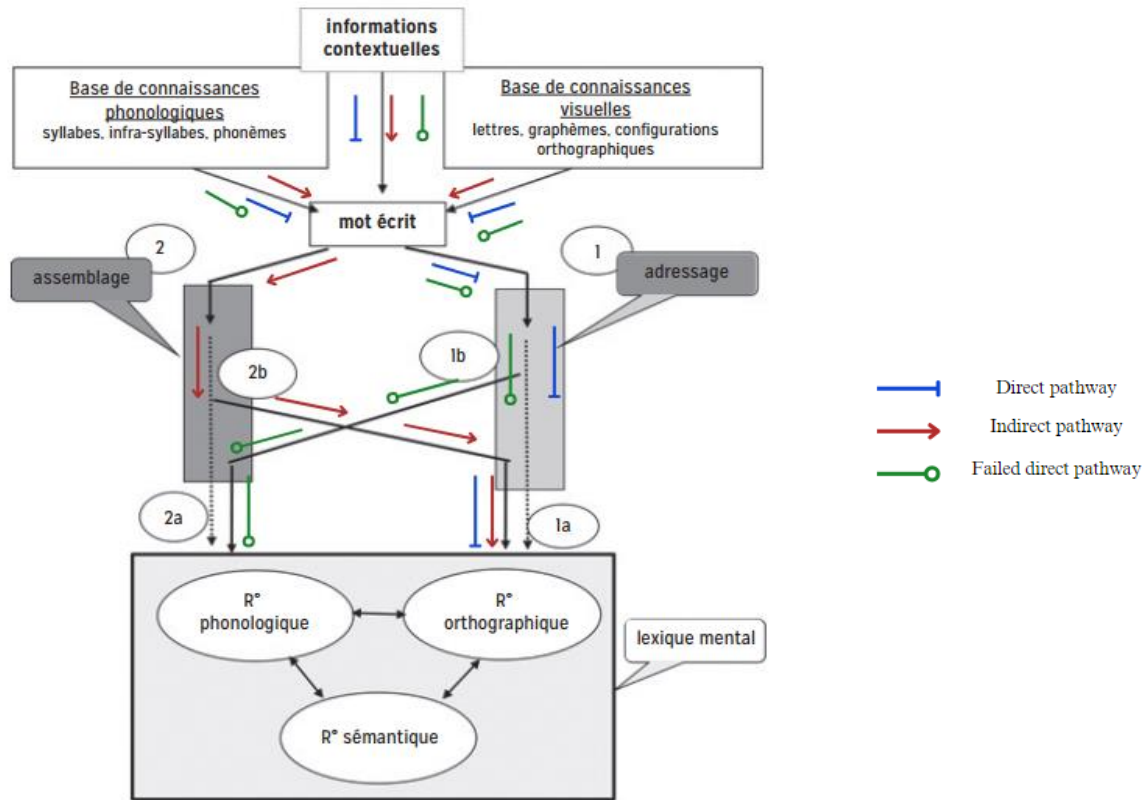


Figure.2 – the general model based on word processing (Ecalte, J., & Magnan, A. (2021). *L'apprentissage de la lecture et ses difficultés*, p 94).

2.3. Word Comprehension:

In addition to identification, comprehension is the second process that determines if the reading process will fail or not. Reading comprehension involves local processes including the processing of linguistic cues (lexical, morphological, and syntactic) during word reading. In the opposite of identification, reading comprehension arises from sequential processes. Thus, several steps must be distinguished in accessing the comprehension of a text: **Access to the mental lexicon**; it is the final step of word identification and also the first for word comprehension. The automatization of this process lightens the working memory to allocate more cognitive resources to comprehension; **Syntactic analysis, the integration of propositions with their meaning**; the syntax-semantics information identified, **combining different propositions**, and finally **the construction of a mental model of the situation** (Denhière & Baudet, 1992, cited in Ecalte, J., & Magnan, A. (2021) *L'apprentissage de la lecture et ses difficultés*, p 122)

3. Reading and the cognitive process:

In this part, we will be discussing the associations between the reading process and cognitive functioning of the human being. To be more specific, we chose attention and memory for cognitive functions, inhibition and working memory for executive functions. The reason behind this choice is not to marginalize the other functions (including permanent memory, working-memory processes, and metalinguistic processes, linguistic and visual coding processes) but just to focus the discussion on the main and crucial functions in the information processing.

3.1. Reading and cognitive functions:

Memory is often described as a collection of separate systems and subsystems that interact with one another. This function has known consecutive models trying to explain its functioning and the rest of other functions. Starting with the Atkinson & Shiffrin model in 1968 (Long-term memory – short-term memory), Baddeley & Hitch model in 1974 (working memory), Tulving (1972, 1983) with episodic and semantic memory. On the other hand, attention is of utmost importance in information processing and is essential for the proper development of complex cognitive abilities and academic progress. It plays a crucial role in integrating relevant information, memory processes, and coordinating motor and behavioral responses. Additionally, attention holds great significance in learning as it enables us to concentrate on specific targets for adequate durations, while disregarding irrelevant distractions (Hale & Lewis 1979, cited in Commodari & Guarnera, 2005, p376). Decoding text is a demanding task for a child (in his first steps of reading acquisition). We are referring here to the two processes of reading (identification and comprehension). Attention interferes here in multiple phases, for example: identifying the signs, associating it with sound. It is crucial to possess a high visual reaction time, a well-functioning immediate span of attention, and the ability to be selective. These fundamental conditions play a vital role in ensuring a favorable outcome, (La Berge & Samuels, 1974). To support this idea, the study (Wolf, M. S., et al. 2012) examined to what degree cognitive skills (Processing Speed, Working Memory, Inductive Reasoning Long-Term Memory, Prospective Memory, Crystallized Verbal Ability) explain associations between health literacy, performance on common health tasks, and functional health status. As a result, the study found a strong correlation between health literacy

and fluid/crystallized cognitive abilities. After observing the presence of executive function in this study, we were compelled to explore its impact on reading as well.

3.2. Reading and executive functions:

Working memory manages information for immediate use. This involves the processing and temporary maintenance of data necessary for the execution of cognitive tasks (Baddeley, 1986). The role of working memory resides beside temporal storage in “decoding”. Working memory is composed according to Baddeley’s model by **the phonological loop** to maintain verbal information, **visuospatial sketchpad** the processing of visual-spatial information under the supervision of **the central executive** who is responsible for the allocation of attentional resources. (Arrington et al., 2014). We can say that poor decoders explain poor reading comprehension.

In other terms, behavioral inhibition, also known as response inhibition, involves the intentional and conscious suppression of dominant, automatic, or instinctive reactions to external stimuli. (Logan & Cowan, 1984; Wilson & Kipp, 1998). Students with poor decoding skills often exhibit deficits in both response inhibition and working memory. This is especially true for children who also struggle with reading difficulties and attention deficits. These challenges can significantly affect their academic performance and overall learning experience, (Purvis & Tannock, 2000). Another study done by (Savage et al., 2006) investigated cognitive deficits in working memory, response inhibition and dual tasks. The results suggest that certain processes previously believed to be indicative of attention difficulties may actually be related to the development of reading skills. In another recent study (Johann et al., 2019), the goal was to examine the specific contributions of working memory, inhibition, cognitive flexibility, and fluid intelligence to reading ability. The results showed that working memory, inhibition, cognitive flexibility and fluid intelligence played distinct roles in determining reading speed and reading comprehension; which means higher capacity of working memory, stronger inhibitory abilities, and greater fluid intelligence were all associated with improved reading speed and reading comprehension.

4. Conclusion

In conclusion, the literature review has provided an exploration of the psychological study of reading. We have traced the history of literacy, revealing the profound evolution of reading as a phenomenon and we have examined the developmental aspects of reading. The various models of reading acquisition, which underpin the complexity of this cognitive ability, demonstrate the multi-faceted nature of reading. These models provided different perspectives and approaches. The review's central problematic, concerning the associations between reading and cognitive functions, has been discussed. The examination of empirical studies has provided substantial evidence in support of a strong correlation between reading and cognitive functions. This is not surprising, given that reading is fundamentally a cognitive process. These studies have shown that reading does not only involve the simple decoding of symbols, but also requires a wide range of cognitive skills such as attention, memory, and language processing abilities. Overall, this review has underscored the importance of reading in cognitive development and function. The strong relationship between reading and cognitive functions highlights the critical role that literacy plays in our daily life. Hence, further research in this field is essential to continue expanding our understanding using different methods (e.g., experimentation) by manipulating cognitive and executive functions in real context of reading (e.g., Class ,Reading sessions) so that we can have a close up view of these interrelationships and the complex mechanisms that interfere in this process to conclude their implications for educational practices and cognitive development strategies.

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