Diana Deutsch (Ed), The Psychology of Music, Second Edition, San Diego: Academic Press, 1999. 807 pp, ISBN 0-12-213565-2 (paperback); $69.95; ISBN: 0-12-213564-4 (cloth), $129.95.

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There are certain landmark books in any science that serve to establish a culture of ideas, define the field, and draw together intellectual principles to form a new unified topic of inquiry. For example, although modern approaches to Cognitive Psychology may have begun with Bruner, Goodnow, and Austin's (1956) "A Study of Thinking," it was not until the landmark publication of Neisser's (1967) "Cognitive Psychology" that the field gained coherent unity. *Cognitive Psychology* defined those topics that the new field would address, and the approaches to be used; after reading it, researchers both in and out of the nascent discipline knew what its boundaries were, and what is essential *mission* was.

At the time of its initial publication in 1982, Diana Deutsch's "The Psychology of Music" confronted a discipline whose essential mission was far from clear. By her selection of topics and authors, Deutsch defined a field that did not then exist with any degree of coherence. Several then-contemporary reviewers complained that the book did not resemble the young field as they saw it, but time has proven Deutsch right: The field has become what she (through her book) thought it should be. At the time, Deutsch might have well responded as Picasso did when the artist had to counter Gertrude Stein's charge that his portrait of her did not look like her: "Don't worry," Picasso is reported to have said, "it will."

The publication of the second edition of Diana Deutsch's landmark collection of articles seems an appropriate occasion to reflect about where the field has gone in the 17 years since the book first appeared. To invoke a Kuhnian perspective, is Music Psychology a field that is constantly reinventing itself, or one that has reached the relative comfort of a mature science with well-accepted paradigms and clearly defined issues? What has been the impact of the *first edition* of *The Psychology of Music*, and how has the research of the intervening years necessitated (if at all) changes in the way we think about the scientific study of musical behavior? (And to what extent are those changes reflected in the second edition of the book?)

The growth of Music Psychology as a field of inquiry

The past seventeen years have seen a considerable amount of activity in music psychology. Among the milestones: the establishment of 5 major societies (the Society for Music Perception and Cognition (SMPC), the European Society for the Cognitive Sciences of Music (ESCOM), the Society for Research in the Psychology of Music and Music

Education (SRPMME), the Japanese Society for Music Perception and Cognition, and the Australian Music and Psychology Society; 3 regularly-scheduled conferences (SMPC, ESCOM, ICMPC); 3 healthy journals (Music Perception, Musicae Scientiae, and Psychology of Music) and major monographs by Bregman, Butler, Dowling & Harwood, Handel, Krumhansl, Lerdahl & Jackendoff, Narmour, Serafine, and Sloboda.

How can we quantify this growth in the field of music psychology? One method, although somewhat crude, is to simply tally the number of articles addressing this subject as indexed in *PsychInfo* (the APA's electronic database of articles and book chapters from 1885-present). The results of a search of psychology chapters and articles whose subject contained the keyword "music" for each decade of the twentieth century are shown in Figure 1, with the number of "hits" for this search shown on the left-hand ordinate; superimposed on this graph are the results of a more restrictive search for chapters and articles whose subjects are either "music cognition" or "music perception," with the number of "hits" shown on the right-hand ordinate. There were of course many more articles in the first category than in the second, but the *shape* of the curves is remarkably similar. It is worth noting the distinct peak in the curve in the decade ending 1940, which is almost certainly due to Carl Seashore's work. Both curves are well fit by an exponential function, the parameters of which tell us that with each passing decade of the present century, the number of articles addressing the psychology of music - whether defined by either the liberal or conservative criteria noted above - nearly doubled each decade (the growth factor is approximately 1.8). An additional search to track the growth of *psychology* as a field this century was performed by tallying the number of articles appearing in PsychInfo by decade, regardless of topic; as it turns out, the same exponential function (with only a change in the scaling coefficient) describes these data. Thus, psychology and music psychology have grown together across the past one hundred years at similar rates. Notice also in Figure 1 that the period of largest growth (from 276 music cognition and perception articles to nearly 800) occurs during the two decades following the publication of Deutsch's book (marked by a dashed vertical line in the figure). The rapid changes implied by this exponential growth of knowledge in the field easily justifies a new edited volume on the psychology of music, but it does not necessarily justify revising this *particular* book; for that one must ask: What has been the impact of *The Psychology of Music, First edition?*

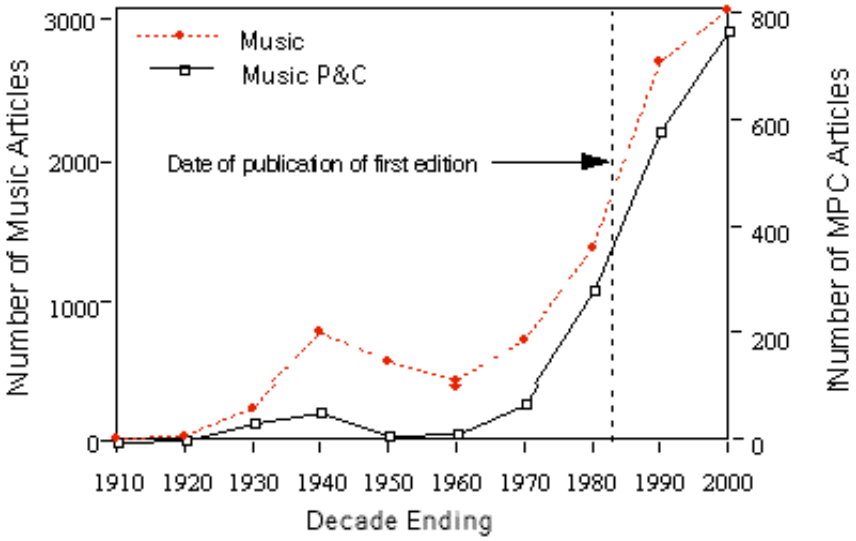

Figure 1. The number of articles published during each decade of this century with the words "music" (left ordinate) or "music perception" or "music cognition" (right ordinate) in the subject field, as indexed by PsycINFO.

Quantifying influence

One rough way to quantify the impact of the First edition is to count the number of citations of it in the Social Sciences Citation Index. The results of such a search for each year following the publication of the book, tracking references to individual chapters, is shown as the upper line, and totals for the book-as-a-whole are shown as the lower line in Figure 2. From its initial publication in 1982, there was a linear growth of citations (to a peak of 40 citations to individual articles during 1988), followed by a slow decay.

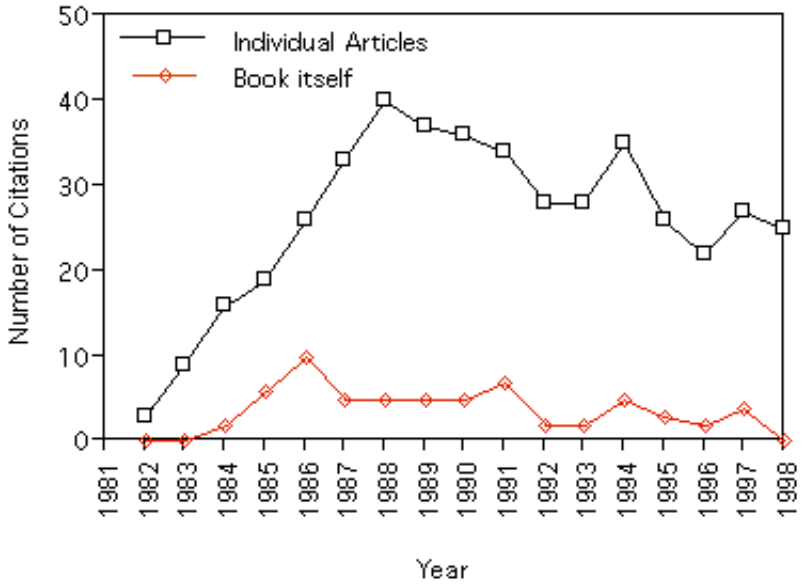

Figure 2. Number of citations to Deutsch's *The Psychology of Music* for each year since initial publication (as indexed by the Social Sciences Citation Index).

In the 17 years since its publication, Deutsch's book and its contents were cited a total of 510 times (as indexed by SSCI). Some 411 of these articles contained "music" as a subject and were also indexed in PsycInfo (note that two databases must be used in this analysis because one tracks citations and the other tracks published articles; note also that the two databases do not have perfect overlap of coverage). From 1982 to present, PsycInfo lists 4806 psychology articles published with the subject word "music," indicating that on average, over 8% of articles written about music psychology cited *The Psychology of Music* in whole or in part. Adopting the narrower search criterion, 1162 articles listed in PsycInfo were published on the topic of music perception or music cognition between 1982 and 1998, so that on average, a remarkable 35% of these articles cited *The Psychology of Music.*

Which chapters were cited most? Excluding any citations by the authors to themselves in subsequent publications, the top five cited chapters were those by Fraisse (93 citations), Dowling (53), Shepard (50), Ward & Burns (47), and Ward (47); the book as-a-whole was cited 70 times. There can be no doubt (and most certainly among readers of this journal) of the influence of the original collection of 18 papers - it is not hyperbole to say that it ranks among the most important works in our field. Because the first edition was so widely cited, and there has been such demonstrated growth in the field, a second edition seems both timely and potentially very useful.

Structural differences between the first and second editions

Thirteen of the 18 chapters from the first edition return in updated form in the second edition (see Table 1). In ten cases, the original authors rewrote their chapters with appropriate updates of text and references. Three chapters were assigned to new authors who addressed the original topic afresh with their own perspective. Five chapters were omitted in the second edition, and in their place five new chapters on different topics were added.

Table 1. Comparison of chapter topics between the First and second editions of *The Psychology of Music.* 1. Substantially the same content with updated information and references. 2. New author writing on a similar topic. 3. Chapter omitted from the second edition.

First Edition		Second Edition	
Title	**Author**	**Title**	**Author**
The perception of musical tones	Rasch & Plomp	The perception of musical tones1	Rasch & Plomp
Exploration of Timbre by Analysis and Synthesis	Risset and Wessel	Exploration of Timbre by Analysis and Synthesis1	Risset and Wessel
Perception of Singing	Sundberg	Perception of Singing1	Sundberg
Grouping Mechanisms in Music	Deutsch	Grouping Mechanisms in Music1	Deutsch
The Listener and the Acoustic Environment	Rasch & Plomp	Concert Halls: From Magic to Number Theory2	Schroeder
Rhythm and Tempo	Fraisse	Rhythm and Timing2	Clarke
Timing by Skilled Musicians	Sternberg, Knoll, Zukofsky	3	3
Intervals, Scales, and Tuning	Burns & Ward	Intervals, Scales, and Tuning1	Burns
The Processing of Pitch Combinations	Deutsch	The Processing of Pitch Combinations1	Deutsch
Melodic Processes and the Perception of Music	Rosner & Meyer	3	3
Structural Representations of Musical Pitch	Shepard	3	3
Musical Ability	Shuter-Dyson	Musical Ability1	Shuter-Dyson

Melodic Information Processing and Its Development	Dowling	The Development of Music Perception and Cognition[1]	Dowling
Absolute Pitch	Ward & Burns	Absolute Pitch[1]	Ward
Neurological Aspects of Music Perception and Performance	Marin	Neurological Aspects of Music Perception and Performance[1]	Marin & Perry
Music Performance	Sloboda	Music Performance[2]	Gabrielsson
Social Interaction and Musical Preference	Konecni	[3]	[3]
New Music and Psychology	Erickson	[3]	[3]
		Chapters New to this Edition	
		The nature of musical sound	Pierce
		Comparative Music Perception & Cognition	Carterette & Kendall
		Music and the Auditory System	Weinberger
		Hierarchical Expectation and Musical Style	Narmour
		Neural Nets, Temporal Composites, and Tonality	Bharucha

The content of the second edition

The book opens with one of the new-to-this-edition chapters, this one by John R. Pierce called "The nature of musical sound," a tip of the hat to his successful 1984 book, "The science of musical sound." Pierce provides an appropriate introduction to the book - a whistle-stop tour through nearly every concept important to the *perception* end of music psychology, touching on major findings in the physics of sound, time resolution of the ear, theories of consonance, pitch perception, Fourier analysis and spectra, the science of singing, speech, timbre, scales and tuning.

In the last decade, the precise and realistic simulation of reverberant environments with computers has been attained (an auditory first step toward virtual reality devices), and Manfred Schroeder's Chapter 2 (replacing Rasch & Plomp's from the first edition) describes the state of the art in "Concert halls: From magic to number theory." Some of the best built concert halls in history were those built by the ancient Greeks. How did they

do it? Without modern equipment and tools for construction, building one amphitheater could take decades - an ancient Greek designer was lucky to see *one* of his designs completed. Iterative design as we know it was impossible - if his first hall had poor acoustics, our Greek architect wouldn't live long enough to correct his mistakes in his next project. Schroeder describes modern attempts to understand the mathematics of acoustical design - a science apparently known to some extent by the Greeks and now being rediscovered. Along with his own seminal work, he discusses the co-evolving theories and mathematics of acoustic modeling, diffusors based on number-theoretic designs, and algorithms for the digital simulation of both real and imagined acoustic environments.

Norman Weinberger's Chapter 3 ("Music and the auditory system"), also new to this edition, is an indispensable review of auditory system anatomy, functional organization of the auditory pathway, attention and learning. He concludes with an overview on the neurobiology of music and this provocative hint of things to come:

"Within neurobiology, several types of findings point to a view of the auditory system as more dynamic than previously recognized...One implication for music perception is the possibility that the analysis, perception, and storage of information concerning a musical entity may all involve the same region of the auditory system, perhaps even the same neurons." (p. 81).

In Chapter 4, a revised version of their first edition chapter "The perception of musical tones," Rudolf Rasch and Reinier Plomp explain that the perception of complex tones can be conceived as a pattern recognition process. The presence of a complete series of harmonics is not a necessary condition for the pitch recognition process to succeed. Jean-Claude Risset & David Wessel completely reorganized their chapter on timbre (Chapter 5, "Exploration of timbre by analysis and synthesis") with new sections on global/non-linear synthesis, sampling, controlling musical prosody in Real Time Synthesis, an expanded section on physical modeling, and over 150 (!) new references. "The perception of singing" (Chapter 6), updated by Johan Sundberg, explains that the choice of acoustic characteristic of vowel sounds that singers learn to adopt represents deviations from typical, normal speech for specific requirements of performance and intelligibility; as in the first edition, Sundberg also explains morphological distinctions between the vocal organs in singers of the various voice classifications, and how these give rise to perceptual distinctions.

Chapter 7 ("Intervals, scales and tuning" by Edward Burns) comprises an essential treatment of psychophysical and perceptual studies relating to the human perception of pitch and pitch relations. The chapter has been completely reworked, and Burns employs smoothly pellucid prose, making it my favorite chapter of the book (tied with Dowling's). "Absolute pitch" (Chapter 8, by Dixon Ward) is an updated, comprehensive overview of 100 years of research, summarizing key theories and a host of methodological traps in the

study of this poorly understood ability.

Next are Chapter 9, "Grouping mechanisms in music," and Chapter 10, "The processing of pitch combinations," both by Diana Deutsch. Chapter 9 surveys the literature on auditory scene analysis, stream segregation, and the attempts to find *auditory* correlates to the Gestalt principles of *visual* grouping. Deutsch describes the ways in which perceptual grouping might occur for individual tones as well complex tonal sequences (such as orchestral works), based on myriad stimulus attributes such as pitch, temporal synchrony, spatial location, etc. In Chapter 10 (with 78 new references), Deutsch discusses feature abstraction and its neural substrates, local vs. global processing, hierarchical encoding (invoking the work of Lerdahl & Jackendoff, Meyer, Narmour, Schenker, and others), memory for music, and a thorough review of the various auditory illusions and paradoxes that Deutsch has been studying for more than 20 years.

The third entry new to this edition is Chapter 11, Jamshed Bharucha's "Neural nets, temporal composites, and tonality." The first modern statement of neural network modeling was published four years *after* Deutsch's first edition (Rumelhart, McClelland & the PDP Research Group, 1986) and Bharucha has been one of the leading network modellers working on problems of musical learning and representation. Neural nets have demonstrated (with varying degrees of success) learning of pitch class, chords, keys, and musical style, and provide "a framework in which aspects of cognition can be understood as the result of the neural association of patterns" (p. 413). Bharucha presents a fenestral introduction to the field, including a network account of frequency tuning of neurons, tuning to abstract features of a stimulus, and a brief tutorial of vector spaces as depictions of neural representations. Bharucha further describes how some of the properties of conceptual prototypes might be implemented through *composite* patterns (defined as the resultant of representational vectors in Cartesian space), discusses temporal composite memory, and describes his own influential networks (e.g. MUSACT) as well as those of P. Todd and others.

In Chapter 12, "Hierarchical expectation and musical style," Eugene Narmour gives a cogent overview of his implication-realization model enhanced by his more recent ideas about the role in music listening of bottom-up and top-down processing, schemata, and "filling in" of missing (or implied) tonal elements. Narmour's paper is new to this volume, and perhaps was intended as a substitute for Burton Rosner and Leonard Meyer's "Melodic processes and the perception of music" from the first edition, but apart from the fact that both chapters address implication, expectation, and style, their content and approach are so different that it is perhaps more accurate to consider Narmour's chapter the fourth of the five "new" chapters in the second edition.

Eric Clarke's "Rhythm and timing in music" (Chapter 13) replaces Paul Fraisse's "Rhythm

and tempo." Clarke surveys research on rhythmic grouping, meter, perception and production of timing, and the relation between musical timing and movement. Alf Gabrielsson's entry on "Music performance" (Chapter 14), an apparent substitute for John Sloboda's 1982 chapter of the same name, reviews the literature on performance planning, sight-reading, improvisation, feedback, motor processes, measurements, physical, psychological, and social factors affecting performance, and performance evaluation. Although at 102 pages (and some 500 references!) this is the longest chapter in the book, Gabrielsson's clear and buoyant writing makes for quick reading. Because Gabrielsson and Sloboda render the topic differently, it would be a mistake to consider one chapter a replacement for the other: The serious reader interested in performance will no doubt want to consult *both* chapters.

Jay Dowling's update of "Development of music perception and cognition" (Chapter 15) adds ten pages, over 60 new references and an expanded list of topics. In his conclusion, Dowling artfully links his own research program (and that of others on musical development) with Narmour's main thesis when he writes that "adults bring a large store of implicit knowledge to bear in listening to music. This knowledge includes implicit representations of the tonal framework of the culture in terms of which expected events are processed efficiently and in terms of which pitches are interpreted in their musical context." (pp. 620-621). Dowling further concludes that there is a converging body of evidence suggesting that "memory for music typically operates in terms of more precise representations of particular stimuli than has been generally thought," (p. 620) and with this makes an important link to current "multi-trace theories" of memory. Rosamond Shuter-Dyson's contribution on "Musical ability" (Chapter 16) has improved in organization with reworked sections on concepts, methods, and studies of musical aptitude, achievement, and ability, as well as investigations into correlations between music and other cognitive abilities.

Perhaps the greatest strides in music psychology have come from investigations into the neural underpinnings of musical behavior, most notably from the laboratories of Isabelle Peretz, David Perry, Michael Petrides, and Robert Zatorre (and all this work is being done in one city - Montreal!). Perry signs on here as co-author with Oscar Marin for this revision of "Neurological aspects of music perception and performance" (Chapter 17), the best single source of information on the topic. Topics include amusia, auditory agnosia and verbal deafness, and the current state of knowledge about functional localization of various component abilities in music perception, understanding, and production. Capping the volume is Edward Carterette and Roger Kendall's Chapter 18, "Comparative music perception and cognition," which roves across the ethnomusicological landscape with a fairly in-depth treatment of pitch systems (including structural, perceptual, and tonality issues in Indian and other Asian musics). They briefly touch on studies of animal and infant music cognition, neuropsychology, and close with conjecture about the nature of

cognitive musical universals.

The eighteen chapters offer a picture of a coherent field with well-established paradigms and a clearly defined mission - far from the Kuhnian predicament of a young science looking for its own identity. The goal of music psychology expressed in these chapters is the understanding of musical behavior through science, using the principles and perspectives of cognitive psychology, psychophysics, neuroscience, musicology, and music theory.

On the other hand ...

The book does have its biases which trace their roots to the first edition, and chief among them is that it focuses almost exclusively on the *cognitive psychology* of music, a bias I can understand given that Deutsch is a cognitive psychologist. As it is, the book is so eminently *coherent* that it would be a mistake to change it or add to it; but it would have been more accurate to title it "The Cognitive Psychology of Music," so as not to lure readers interested in topics not covered. In particular, there is minimal coverage of music therapy, personality and individual differences, learning, music education, musical imagery, musical savants, the social psychology of music, or the role of music in people's lives. And not covered *at all* are the following intrinsically interesting, and potentially important topics: musicogenic epilepsy (e.g., Critchley, 1977; seizures induced by music listening, often by listening to one's favorite song!); memory for music in naturalistic contexts, á la Wallace and Rubin (1988a; 1988b); the nature of talent (whether musical ability is learned or genetically transmitted, as was insightfully explored by Howe, Davidson & Sloboda, 1998); chromesthesia and other synesthesias (Baron-Cohen & Harrison, 1997; Cytowic, 1989; Rogers, 1987); and theories of musical emotion. After reading the entire book I am no closer to understanding why music moves us; why we like music; or why, as Stewart Hulse (1985) asked in his review of the first edition, yesterday's noise becomes today's musical favorite. I am not faulting the book for this - at 800 pages it is already long enough - I only point this out so that readers (and potential purchasers) will know what to expect. And to be fair, the answers to these last three questions are probably not known, but I would at least have liked to read about the struggle to deal with them.

Although there are a number of linguists, anthropologists, and computer scientists interested in the scientific study of music, none are represented as authors here. The interested reader would do well to seek out other sources for this information, such as Marc Leman's "Music, Gestalt, and Computing," (Leman, 1996) an excellent resource on the Cognitive Science of Music. Somewhat frustrating is that two of the most interesting long-term research programs in the last 20 years, those of Krumhansl and Repp, appear as only minor notes in other chapters. Shepard's chapter on mathematical models of pitch was inexplicably not included in this edition; although much of its content is duplicated in

a *Psychological Review* article (Shepard, 1982) and it remains accessible in the first edition, its omission leaves an important area of theoretical work unrepresented.. The first edition chapters by Erickson ("New Music and Psychology") and Konecni ("Social Interaction and Musical Preference") are absent as well, but perhaps these topics did not warrant a revision due to slower growth in these areas of the discipline. I miss the chapter on timing by Sternberg et al., yet the study of timing has evolved into its own sub-discipline more-or-less (led by Ivry, Keele, Kristofferson, Povel, Wing, and others) and so perhaps it has grown apart from Music Psychology.

Conclusions

Aristoxenus (364 - 304 BCE) was probably the first music psychologist, arguing that music appreciation can only be understood by studying the *mind* of the listener, not the external collection of sounds that impinge upon the ear. It was two millennia before Helmholtz brought modern scientific methods to the study of musical experience, and it is well known that the Gestalt psychology movement of Wertheimer, von Ehrenfels, Köhler *et al*. was launched to investigate problems in the coherence and form of musical *melodies.* Partly owing to the establishment of cognitive psychology as a discipline, partly owing to the comparative ease with which auditory stimuli could be preserved and presented (thanks to magnetic tape technology and computers), Music Psychology has experienced a renaissance in the latter portion of the twentieth century. Much of that growth - influenced by the first edition - is captured in the second edition.

I have on the shelf next to my desk several *dozen* excellent books about music perception and cognition, but none is more dog-eared or more used than "The Psychology of Music, first edition." With that 1982 text, Deutsch accomplished for our field what Neisser did for Cognitive Psychology in 1967. By her choice of topics and authors, Deutsch made a bold claim to define those problems that ought to interest us (and in fact *did*). The second edition includes five excellent new chapters (worth the price of the book on their own) and substantially updated versions of the remaining thirteen chapters. The first edition's influence on the field makes a compelling argument for the purchase of this updated and revised version, certain to be a blueprint for new research and a leading resource for many years to come.

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1 . The curves are well fit by the equation y=a * 10^0.026x; Pearson's r > 0.96 for the fit.
2 . Address correspondence to Daniel J. Levitin, Center for Computer Research in Music and Acoustics, Stanford University, Stanford, CA 94305 (email:

levitin@ccrma.stanford.edu). Author's Note: I am grateful to Lewis Goldberg, Jay Kadis, Michael Posner, Bruno Repp, and Caroline Traube for editorial suggestions; a nd to Jean-Claude Risset for teaching me about Aritoxenus.

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