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Source: *Music Perception: An Interdisciplinary Journal*, Vol. 29, No. 1 (September 2011), pp. 23-36
Published by: University of California Press
Stable URL: http://www.jstor.org/stable/10.1525/mp.2011.29.1.23
Accessed: 20/10/2011 11:05

Music Perception and Cognition Research from 1983 to 2010: A Categorical and Bibliometric Analysis of Empirical Articles in *Music Perception*

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IN THIS REVIEW WE SOUGHT TO DOCUMENT THE LONGITUDINAL course of empirical studies in the journal *Music Perception,* from the journal's first issue in 1983 to 2010. The aim was to systematically characterize the nature of empirical research in one of the principal peer-reviewed outlets for work in our field, and to consider these data as a sample representing the overall course of research across the last three decades. Specific domains examined within each article were: Topics, Participants, Stimuli, Materials, and Outcome Measures. In total, 384 empirical articles in the journal were examined. In addition, relevant details were extracted from the full set of 578 articles regarding geographic and disciplinary (departmental) distribution of the authors. Together, the data we report allow an examination of 26-year trends in music research. These are made available in a database that is fully searchable or sortable by interested researchers.

Received January 27, 2011, accepted June 25, 2011.

Key words: music perception, music cognition, historical analysis, trend analysis, meta-analysis

Music perception is now an established field of research within psychology and within music. This has been greatly facilitated by, and reflected within, the journal *Music Perception,* now in its 29th year of publication, and the largest journal in the field. Given its long and distinguished history, a three-decade retrospective of the journal could be both useful and instructive. Research on music perception has shown a surge of activity over the past thirty years (Levitin, 2010), and *Music Perception (MP)* has been one of the principal outlets for documenting this growth.

MP publishes empirical research as well as theoretical analyses, book reviews, and editorial material. Interdisciplinary in nature, it presents music perception research drawn from a host of fields including experimental psychology, music theory, musicology, computer science, biology, psychophysics, neuroscience, and linguistics. *MP* covers a wide range of topics, including the perception of distinct musical elements (such as pitch, rhythm, or timbre), audience reactions to large-scale musical works, quantitative modeling, the effects of music training, theoretical/structural analyses of music, and the study of special populations.

Our aim was to systematically review every empirical article in *MP* in order to provide a guided and objective perspective of research trends in the field. In 1999, an empirical analysis of trends in psychological science advised this objective method about a given field's evolution (Robins, Gosling, & Craik, 1999). Here we take as a model the article by Mogil, Simmonds, and Simmonds (2009) that analyzed research articles published in the journal *Pain.* We adapted their model here, extending it to the field of music perception and cognition. Like them, our goal was to characterize the nature of primary empirical articles published in a specialty journal devoted to a particular field of scientific inquiry.

We coded data into domains that corresponded to information typically provided by scientists in their research articles. These include the Topics of the articles, the types of Participants employed (including age and levels of music training), the kind of Stimuli used in the experiment (e.g., excerpts from "real" music vs. isolated tones), Materials used to present stimuli, and types of Outcome Measures. Compiled across 384 empirical articles, information within these particular domains allowed for analyses demonstrating the frequency over time of distinct themes, participant samples, stimulus types, and the nature of experimental tasks performed. We also examined the number of articles that used physiological, as opposed to behavioral data collection methods (*measurement approaches*). Although the data come from a single journal, and are subject to a myriad of biases and selection effects, we believe that the articles published within *MP* provide a reasonable view of, and

Music Perception volume 29, issue 1, pp. 23–36. issn 0730-7829, electronic issn 1533-8312. DOI: 10.1525/mp.2011.29.1.23

can be considered a proxy for, the field of music perception and cognition at large.

Method

INCLUSION CRITERIA

Our principal aim was to track reports of *experiments*; that is, empirical work in the journal. These include descriptive, correlational, and "true" (controlled) experiments with human or animal subjects. In addition to these, *MP* features a range of other articles that do not fall within the scope of this mandate, such as theoretical articles, review articles, methodological articles, errata, editorials, and book reviews. The total number of articles published during the period under review was 578. For the purposes of the present study, only empirical articles presenting newly acquired data were coded (5 articles from this period reported previously acquired data for reanalysis and these were included only in the geographical and departmental analyses). An additional decision was to exclude case studies, as our principal aim was to include traditional experiments on groups of participants (case studies pose unique problems of method and generalization; 6 were thus excluded). We also excluded studies that reported analyses and modeling of musical works (29 were excluded). Consequently, we coded 384 out of a possible 424 empirical articles (91%), ranging from Vol. 1, No. 1 (Fall, 1983) to Vol. 27, No. 4 (April, 2010, the cut-off date for collecting data for the present article). Descriptive statistics are reported for these 384 articles, whereas trends are reported based on 381 articles published between 1984 and 2009. (Three empirical articles were deleted from the trend analysis because 1983 had only one empirical article and 2010 was only analyzed through April; in this way annual tallies refer to full calendar years).

In addition, a secondary aim was to examine the association between discipline (e.g., music, psychology, neuroscience) and the types of articles written and published in the journal (theoretical or empirical). To this end, 154 theoretical articles, as well as the 40 empirical articles omitted from the main analyses (i.e., case studies, analyses of musical works, or reports on previously collected data) were included to examine departmental affiliation of authors for all 578 articles published. The breakdown of articles in the different categories just discussed are tabulated in Table 1.

We also examined bibliometric information from this full set of 578 articles. The ISI Web of Science® database (http://apps.isiknowledge.com) and the bibliometric analysis and visualization software HistCite® Bibliometric Analysis and Visualization Software (v.9.8.24) (http://www.histcite.com) were used to examine citation information and geographic affiliation of authors.

DOMAIN CODING

The journal articles were examined for, on average, 5–7 minutes each, and coded for specific features in each of the following broad domains: Topics, Participants, Stimuli, Materials, and Outcome Measures. Each domain was assigned 3–14 codes to represent features common to the articles, and each accounted for a range (3% to 95%) of occurrences. Articles were required to have at least one code in each domain, and in many cases were given multiple codes if more than one applied. Full lists of the codes and their definitions are provided in Tables 2–6. In some cases, because the inclusion criteria are extensive, only a partial set of salient items is listed.

PRE-COMPOSED MUSIC CODING

Musical stimuli used in experiments were either composed specifically for the experiment, or already existed in the musical repertoire. We refer to the latter as "pre-composed music," and we compiled and analyzed information about these from the method sections of articles. Excerpts were not counted twice if used in multiple experiments in one article. Different excerpts taken from the same music were counted once (including multiple movements of one larger piece). Different pieces by the same composer were counted individually.

In addition to identifying the number of pre-composed works used, several fields were created and coded in the manner stated above, including: Nationality of Composer, Century, Style, and Stimulus Presentation (i.e., via a pre-recorded performance from live musicians, via computer sequence, or a combination of the two).

BIBLIOMETRIC INFORMATION

Three types of bibliometric information were examined:

(1) those works published in *MP* that are most highly cited across all journals indexed by HistCite® and Web of Science® (but not necessarily cited in *MP*);

TABLE 1. Breakdown of Selection of Articles Included in this Review.

Empirical Articles Retained for Main Analyses (162 with pre-composed music)	384
Articles Reporting Analysis of Musical Works but no Participants Tested	29
Empirical Articles Reporting Previously Collected Data	5
Case Studies	6
Theoretical Articles	154
Total Articles in Period Covered	578
Empirical Articles Retained for Main Analyses	384
Partial Years Due to Start and End Dates	-3
Total Articles Used in Trend Analysis	381

TABLE 2. Topics Domain Code Definitions.

Code	Definition
Pitch Perception	Studies designed to examine perception of individual sounds or pitches, isolated intervals and/or chords, absolute pitch, pitch encoding, pitch intensity
Temporal Perception	Studies designed to examine the perception of musical time, including rhythm, meter, tempo
Melody Perception	Studies designed to examine the perception of melody, cadence, tonal patterns, melodic expectancy/contour/mode/key
Timbre Perception	Studies designed to examine the perception and identification of different musical instruments, salience of instrumentation
Musical Memory	Studies designed to examine memory for isolated musical pitches or pitch sequences, the effect of music as a memory aid, music training, and memory ability
Aesthetics	Studies designed to examine the perception of music as pleasant or unpleasant, including preference judgments, music appreciation, aesthetic judgment, judgment of congruence, consonance/dissonance
Performance	Studies designed to examine some aspect of musical performance, including rating musical performances, gesture, musical sight-reading, performance style, performance ability, training performance skills
Emotion	Studies designed to examine perception of emotion and meaning in music, the effect of music on mood/arousal
Development	Studies designed to examine the development of music perception across the lifespan, including infancy, childhood, adolescence
Measurement	Studies designed to examine the utility of a particular instrument in measuring music perception (e.g., response time, EEG, ERP), development of empirical methodologies, measurements of musical experience
Music & Language	Studies designed to examine some aspect of the relationship between music and speech/language
Cross-Cultural	Studies designed to examine music perception from a cross-cultural perspective, including studies that use "non-native" music
Neural/Brain	Studies designed to examine music perception from a neurological standpoint (e.g., fMRI, ERP)
Transfer	Studies designed to examine the effects of music training on non-musical domains

TABLE 3. Participants Domain Code Definitions.

Code	Definition
Musicians, 1–5	Includes subjects with music training between 1 and 5 years (average was used when provided)
Musicians, 5–10	Includes subjects with music training between 5 and 10 years
Musicians, 10+	Includes subjects with music training equal to or above 10 years
Expertise Unstated	Includes adults and children identified as musicians, expertise unquantified, subjects who have > or < than a specific amount of music training (where coding in stated categories was not possible), subjects who conform to different criteria than years of music training (e.g., grade-level qualifications or performance on experimenter-devised musicality tests)
Nonmusicians	Includes subjects with <1 year or 0 years of music training
Adults	Includes adult subjects (over the age of 18)
Children, 0–5	Includes child subjects up to the age of 5 years (average age was used when provided)
Children, 5–10	Includes child subjects between the ages of 5 and 10
Children, 10–15	Includes child subjects between the ages of 10 and 15
Children, 15–18	Includes child subjects between the ages of 15 and 18
Special Populations	Includes AP possessors, quasi-AP possessors, tone deaf individuals, ASD, Asperger's, Williams Syndrome, neurologically impaired, multiple sclerosis, congenitally deaf (cochlear implant), prelingually deaf, stroke patients
Animals	Includes non-human subjects, such as birds, monkeys, rats, ewes

TABLE 4. Stimuli Domain Code Definitions.

Code	Definition
Pre-composed Music	Includes the use of musical stimuli not specifically designed for the experiment
Sound – Isolated	Includes presentation of isotones (including "probe tones"), tone pairs (simultaneous or sequential), tone intervals, tone chords, using pure tones, wide-band noise, white noise, pink noise, and tone bursts
Sound – Sequential	Includes presentation of tone sequences greater than 3 tones using clicks, pulse trains, Shepard tones, tone bursts, computer generated sinusoids, sine-squared waves, square-wave tones, noise bands, clapped rhythms, pure tones, click patterns, metronome pulses
Music – Isolated	Includes presentation of note pairs, isolated chords, dyads, triads, intervals, triadic intervals, single notes, interval pairs, tetrachord pairs using complex (musical) tones
Music – Sequential	Includes presentation of melodies, songs, arpeggios, harmonic progressions, chord progressions, scales, or any sequence of three notes or more, using complex (musical) tones
Speech	Includes presentation of speech stimuli, including note names, syllables, nonsense syllables, sentences, speech sounds, sung vowels, birdsong
Visual	Includes presentation of videos, as well as primarily visual vs. auditory stimuli (e.g., point-light representations of beat patterns)

TABLE 5. Materials Domain Code Definitions.

Code	Definition
Piano	Includes several models of acoustic, MIDI, and electric pianos (e.g., Steinway, Bösendorfer, Roland, Yamaha Disklavier)
Instrument (other)	Includes any instrument besides piano used in stimulus generation (e.g., flute, clarinet, electronic drum pads, percussion instruments)
Synthesizer	Includes the use of synthesizers (e.g., DMX, Roland, Korg, Yamaha, Kurzweil)
Sound Booth	Includes anechoic testing rooms, semianechoic chambers, sound-attenuated chambers, soundproof booths, recording chambers, sound studios
Headphones	Includes several models of headphones (e.g., Grason-Stadler, Yamaha, Beyer, Philips, Sennheiser)
Loudspeakers	Includes several models of loudspeakers, (e.g., Ampex, Marantz, Heybrook, Philips, Yamaha)
Amplifiers	Includes several models of amplifiers, (e.g., Macintosh, Marantz, Crown, Yamaha, Peavey)
Tape Player/Recorder	Includes several models of tape players/recorders, (e.g., Revox, Sony, Marantz, AIWA)
Digital Player/ Recorder	Includes several models of digital players/recorders, (e.g., Sony, OROS), as well as digital audio tape (DAT), CD players, and digital voice recorders
MIDI	Includes MIDI devices (e.g., Roland, FORTE, Akai)

(2) those works most highly cited by *MP* articles, but not necessarily published in *MP;*

(3) the geographical origin of all works published in *MP*.

Citation reports were generated using the bibliometric analysis and visualization software HistCite®, and results verified in Web of Science®. In order to chart geographic origin, the countries of the authors' affiliation were tracked by HistCite® (for multiple author articles, the country associated with each author's institutional address was tallied). In addition, we used 2009 population counts—the most recent year for which these were available—from the top ten countries of *MP* research using online information from the CIA World Factbook 2009 (www.photius.com/rankings/population/population_2009_0.html) in order to examine the number of published articles weighted by each country's population.

DEPARTMENTAL AFFILIATION CODING

To examine the disciplines covered in the journal, the full set of 578 articles was used. This set included 154 theoretical articles, and 424 empirical articles (the 384

TABLE 6. Outcome Measures Domain Code Definitions.

Code	Definition
Perception Task	In general, any task in which the participant was asked to make a judgment based on listening (as opposed to the subject having to *produce*, or to recall). Some of these include magnitude estimation, same/different ratings, qualitative ratings (e.g. clarity, purity, pleasantness), judgment of perceived structure, melody discrimination, judgment of key membership, judgment of emotion or expressivity, match-to-sample recognition tasks, categorization tasks, melody matching to facial expressions, sound localization, duration adjustment towards equality, perception of narrowness/wideness of musical intervals.
Production Task	In general, any task in which the participant was asked to produce music/sound as part of the experiment. Some of these productions include tapping, clapping, humming, and singing. This category also includes the production of a nonmusical task (e.g., paper folding and cutting, movements without music).
Memory Task	In general, any task in which the participant was asked to recall music/sound as part of the experiment. Includes recognition of melodies (heard/not heard before), measurement of recall latency, same/different judgments where interfering stimuli are inserted between melodic presentations, familiarity, pitch recall, ordering segments from previously heard piece, and memory for word lists.

empirical articles that reported newly collected data plus the remaining 40 empirical articles that reported on analyses of musical works, previously collected data, and case studies). This set was compiled and coded into 30 disciplinary domains, based primarily on the listed departmental affiliation of the authors: e.g., Music, Psychology, Medicine, Physical and Mathematical Sciences, Engineering, Technology/Information/Computing, Education, Philosophy, Anthropology, and Linguistics. (We stipulate that the listed departmental affiliation may not always be the most accurate description of an author, for example, when a psychologist is a member of a music department, but this method has the advantage of objectivity and accuracy for the largest number of cases.)

Results

The full primary data set (a 900 KB Excel 2004 v11.5.5 spreadsheet file) can be found online at http://www.psych.mcgill.ca/labs/levitin/MusicPerceptionTrends.htm. Also included is a separate spreadsheet comprising an inventory of the pre-composed music used in articles reviewed herein. Further explanation of these materials is included in the Appendix.

DOMAIN CHARACTERIZATION AND TRENDS

Figure 1 illustrates overall percentages of the coded features within each domain (Figure 1a–e) and for the style of the pre-composed music (Figure 1f). In addition, regression analyses were conducted on all domain codes, with "Year" as the predictor variable. A trend was considered significant if the associated ß-value (the slope of the regression line) was significant. Figure 2 illustrates overall trends within each domain (Figure 2a–e), and the trend for style of pre-composed music (Figure 2f).

The five most frequent Topics studied were found to be: Melody Perception (25%), Performance (20%), Pitch Perception (18%), Temporal Perception (17%), and Emotion (15%). Three topics yielded regression lines with significant beta values, two were upward trends, Temporal Perception (ß = .45, $p < .05$) and Emotion Perception (ß = .43, $p < .05$). One downward trend, Pitch Perception, neared significance (ß = -.39, $p = .051$). Because the trends in topics might be affected by the special issues published by the journal, the significant trend for Temporal Perception was separately examined with and without data points from the years when special temporal perception issues were published. The upward trend remained significant ($p < .05$) after excluding data points from 1984 (special issue "Rhythm and Meter") and 2005 (special issue "Rhythm Perception and Production"). However, the downward trend in Pitch Perception decreased in magnitude when data points from 1984 were removed ($p = .23$; special issues "Dedicated to Helmholtz" and "Pitch Structures and Tonality").

In the Participants domain, 95% of articles employed adult samples, whereas 8% reported child samples (note that here, as in many cases, totals exceeded 100% because of coding in more than one domain, i.e., some studies used both). Musicians were employed as participants in 75% of studies. Levels of music training of these musicians were not categorizable by us in most cases because average years of formal music training were not reported; however, in the cases where these data were reported, the majority of participants tended towards higher levels of music training; that is, 10 or more years (23%) versus 5–10 years (16%) and 1–5 years (15%). Nonmusicians

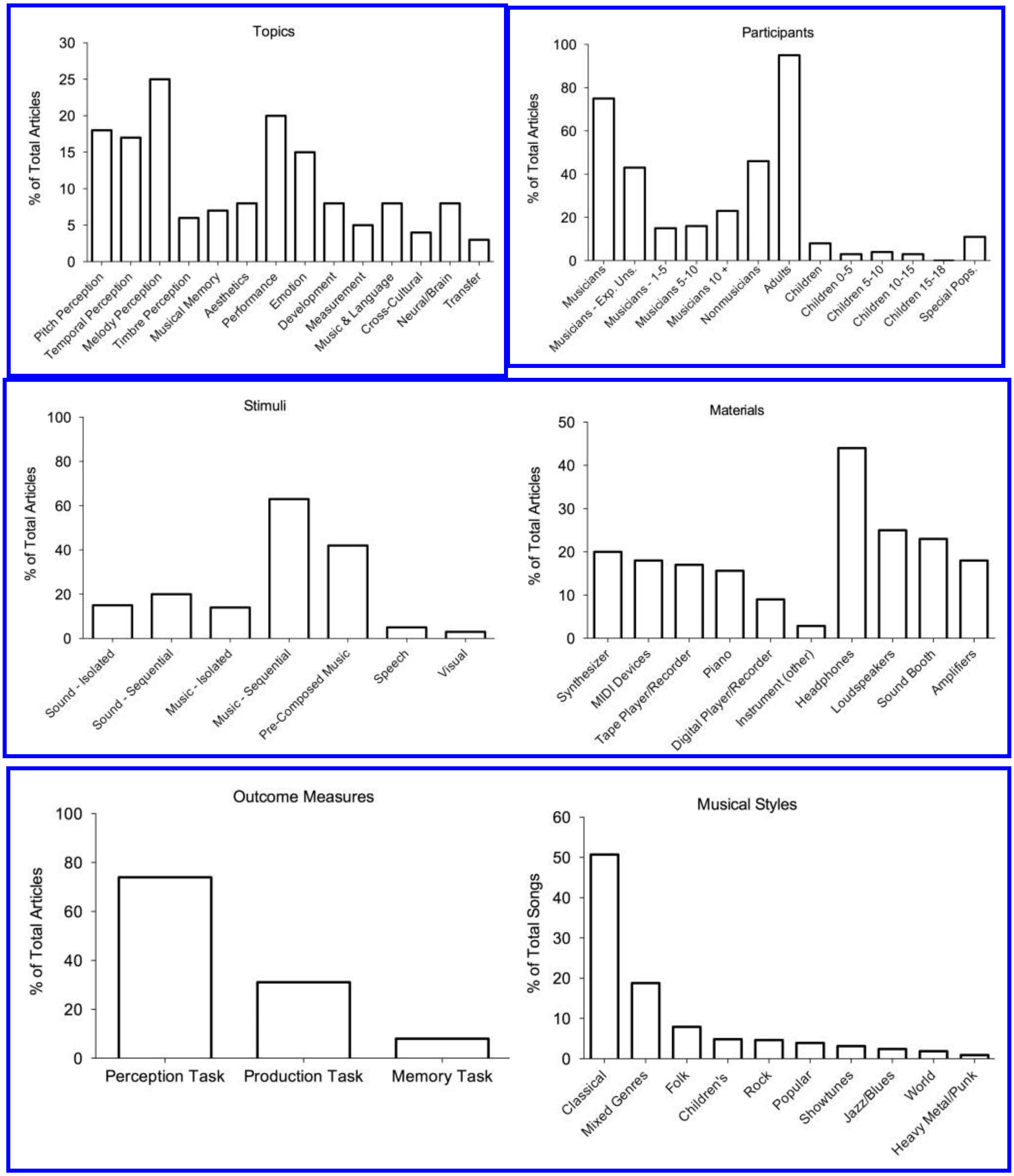

FIGURE 1. Percentage of the 384 total articles published in MP between 1983 and April, 2010 with particular features (codes) in the domains of (a) Topics, (b) Participants, (c) Stimuli, (d) Materials, (e) Outcome Measures, and (f) Musical Styles (see Tables 2–6 for definitions of domain codes).

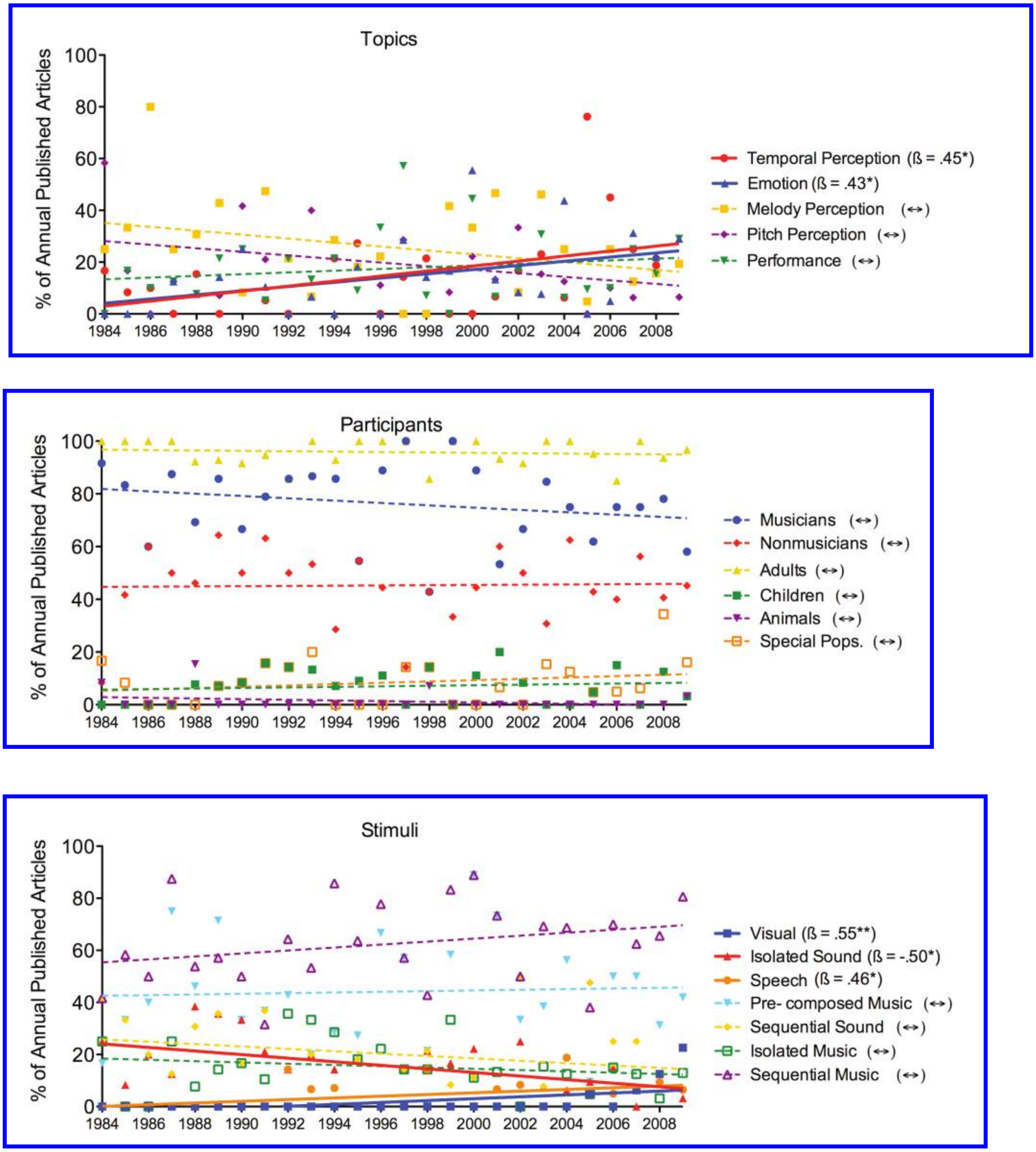

FIGURE 2. Trends in MP between 1984 and 2009 with particular features (codes) in the domains of (a) Topics, (b) Participants, (c) Stimuli, (d) Materials, (e) Outcome Measures, and (f) Musical Styles (see Tables 1–5 for definitions).

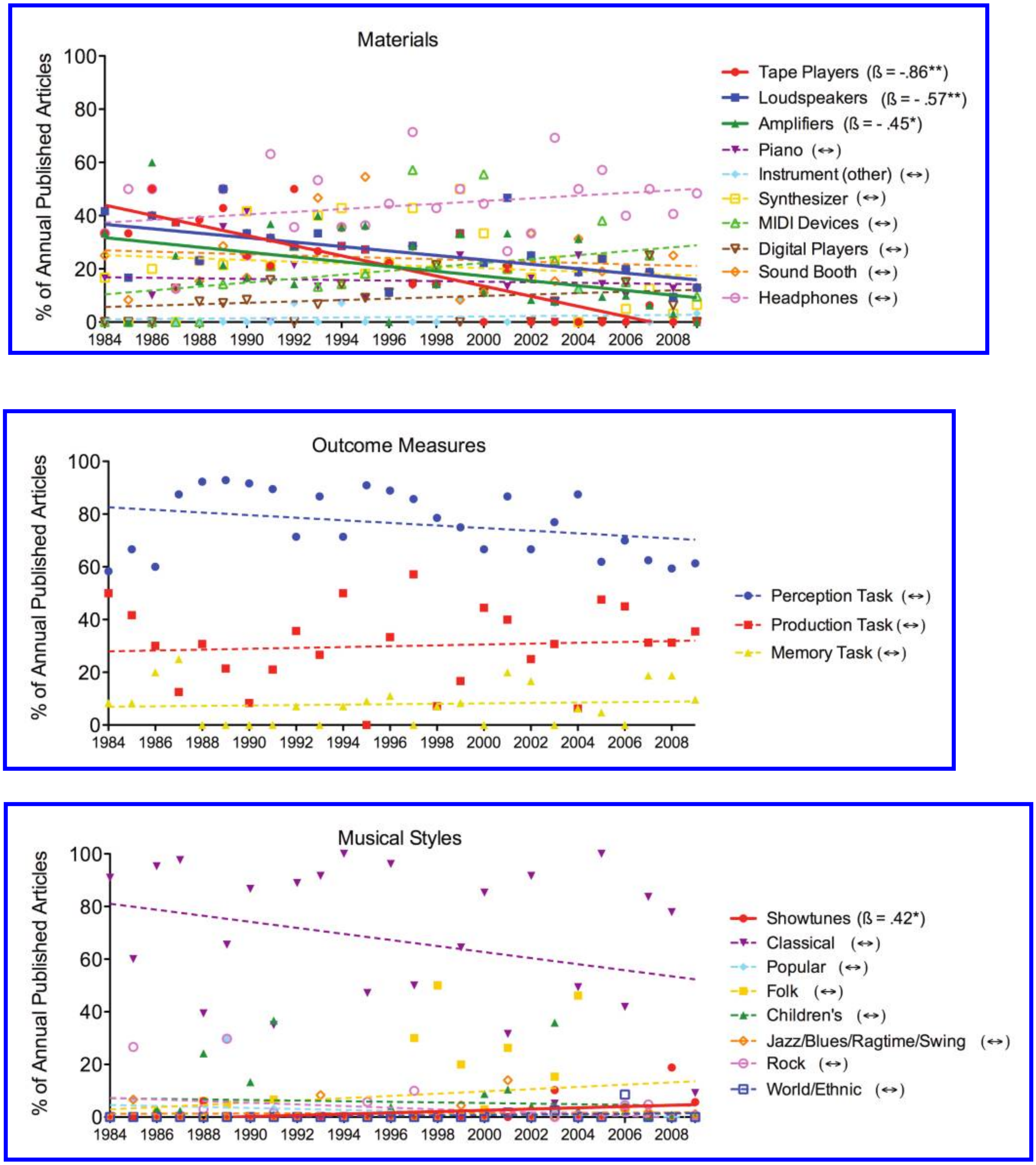

FIGURE 2. (Continued).

were used in 46% of studies. In this domain, across all codes, no significant trends emerged.

In the Stimuli domain, experiments employed sequential music (anything more than three notes, but typically pieces or excerpts from those pieces) in 63% of the total articles; 42% of this music was pre-composed, as distinguished from sequences composed specifically for the experiment. Non-musical sounds (beeps, noise bursts, etc.) were used as stimuli in 35% of the articles; 20% were sequential sounds, and 15% were isolated sounds. Here, three trends emerged: a decrease over 26 years in the use of isolated sounds (ß = -.50, $p = .01$), an increase in the use of speech stimuli (ß = .46, $p < .05$), and an increase in the use of visual stimuli (ß = .55, $p < .01$).

In the Materials domain, the most frequent materials used to present the stimuli were synthesizers (20%), MIDI devices (18%), and pianos (16%). Listening was accomplished with headphones (44%), or external loudspeakers (25%), took place in sound booths (23%), and with the use of amplifiers (18%). Tape players/recorders were used (17%), as were digital players/recorders (9%). In this domain, we observed downward trends in the use of the following presentation materials: loudspeakers (ß = -.57, $p < .01$), amplifiers (ß = -.45, $p < .05$), and tape recorders (ß = -.86, $p < .001$).

In the Outcome Measures domain, 74% of total articles used perception tasks, 31% production tasks, and 8% memory tasks. There were no significant trends observed.

We also tracked the *measurement approaches*. Many studies collected and measured participant responses via computer keyboards, mouse, pencil and paper, tape recorders, piano keyboards, video cameras—which we collectively considered to be *behavioral measures.* This is in contrast to those studies that used *physiological measures* (sometimes alongside behavioral measures) such as EEG, galvanic skin response, heart rate, PET, fMRI, etc. As defined, we found that physiological measures were used in 11% of the studies. Behavioral measures were thus used in 89% of the studies; of those studies, assessment measures (usually standardized tests) were used in 9% of studies. We observed an increase over time in the use of two data collection instruments: assessment measures (ß = .40, $p < .05$), and physiological measures (ß = .39, $p = .05$).

PRE-COMPOSED MUSIC CHARACTERIZATION AND TRENDS

Information on pre-composed music is provided as a 537 KB Excel spreadsheet file at the website mentioned previously.

A total of 1,985 pieces from 162 articles was extracted. In 10 articles comprising 818 pieces, the corpus was large with various unidentified composers and mixed genres. These articles were considered "outliers" and the pieces removed from the total set. After removal of outliers, the most frequent birth nations of composers were: Austria (15%), Germany (14%), U.S.A. (8%), U.K. (5 %), and Italy (4%). A small proportion of nationalities were unknown (3%). We observed a significant upward trend in the use of pre-composed music from Japanese composers (ß = .40, $p < .05$), a category which represented 1% of total pieces used. The most frequent eras of pre-composed music were: 19th century (19%), 18th century (18%), and 20th century (14%); in 4% of the cases, the century was not specified. We observed a significant upward trend in music composed in the 21st century (ß = .49, $p = .01$), a category which represented 1.5% of the total pieces used.

For the remaining analyses, the outliers were not removed. The most common styles were: Classical (51%), Mixed Genres (19%), Folk (8%), Children's Music (5%), Rock (5%), Popular (4%), and Showtunes/Soundtracks (3%). Trends were calculated for all the musical styles that comprised over 1% of total pieces. One trend emerged, an increase in the use of showtunes/soundtracks (ß = .42, $p < .05$). In addition, we examined whether pre-composed music was performed (48.1%), synthesized (19.8%), or a hybrid version of the two (e.g., original performance altered by computer; 8%). Many authors left this unclear (24.5%), primarily in cases where other information about the pre-composed music, such as the performer, was also unknown.

BIBLIOMETRIC INFORMATION

Tables 7–8 display the 20 most highly cited works. Table 7 shows those articles originally published in *MP* that are the most highly cited across a wide range of scientific journals (according to HistCite® and Web of Science®), showing both this total number of citations and, for comparison, the number of times each one was cited in *MP*. Table 8 shows works most often cited in articles published in *MP,* regardless of where they were originally published.

We tallied the countries from which *MP* articles most commonly originated, and the top five are the USA, Canada, the UK, the Netherlands, and France. Figure 3a displays the top ten citations and the count per country. As Figure 3b shows, roughly half of the articles published come from outside the USA. In addition, we divided the number of articles published in each country by that country's population in order to normalize the output as a count of research articles per million population (ppm), that is, to provide a weighted index of national productivity as opposed to raw output (see Figure 3c). The top five countries from this

TABLE 7. Top 20 Most Highly Cited Articles Published in Music Perception.

Article	Finding/Topic	# of citations[a]
Povel, D. J., & Essens, P. (1985), *2*, 411–440.	Perception of temporal patterns	206 (33)
Todd, N. (1985), *3*, 33–58.	A model of expressive timing in tonal music	126 (24)
Bharucha, J. J. (1987), *5*, 1–30.	Music cognition and perceptual facilitation	125 (38)
Parncutt, R. (1994), *11*, 409–464.	Pulse salience and metrical accent	122 (25)
Hartmann, W. M., & Johnson, D. (1991), *9*, 155–184.	Stream segregation and peripheral channeling	89 (3)
Schmuckler, M. A. (1989), *7*, 109–150.	Expectation in music: Melodic and harmonic processes	82 (20)
Heaton, P. et al. (1998), *15*, 291–305.	Autism and pitch processing	82 (7)
Panksepp, J. (1995), *13*, 171–207.	Emotional sources of "chills"	79 (10)
Lerdahl, F. (1988), *5*, 315–349.	Tonal pitch space	78 (21)
Nowicki, S., & Marler, P. (1988), *5*, 391–426.	How do birds sing	75 (0)
Krumhansl, C. L. (1996), *13*, 401–432.	Perceptual analysis of Mozart's Piano Sonata K.282	68 (25)
Balkwill, L.-L., & Thompson, W. F. (1999), *17*, 43–64.	Cross-cultural perception of emotion in music	68 (13)
Deliège, I. (1987), *4*, 325–360.	Grouping conditions in listening to music	66 (14)
Monahan, C. B., & Carterette, E. C. (1985), *3*, 1–32.	Determinants of musical space	62 (9)
Lewin, D. (1986), *3*, 327–392.	Music-theory, phenomenology, and modes of perception	62 (2)
Drake, C., & Palmer, C. (1993), *10*, 343–378.	Accent structures in music performance	58 (16)
Butler, D. (1989), *6*, 219–242.	Theory of intervallic rivalry	53 (26)
Juslin, P. N.(1997), *14*, 383–418.	Emotional communication in music performance	52 (7)
Desain, P. (1992), *9*, 439–454.	A (de)composable theory of rhythm perception	52 (11)
Kastner, M. P., & Crowder, R. G. (1990), *8*, 189–202.	Perception of the major minor distinction	50 (13)

[a]Total number of citations overall. The number of citations within the journal *MP* is shown in parentheses.

TABLE 8. Top 20 Works Published in Forums Other Than Music Perception, Which are Most Highly Cited by *MP* Articles.

Book/Article	Finding/Topic	# of citations
Lerdahl, F., & Jackendoff, R. (1983). *A generative theory of tonal music.*	Music theory & cognitive science	123
Meyer, L. B. (1956). *Emotion and meaning in music.*	Music & emotion	76
Krumhansl, C. L. (1990). *Cognitive foundations of musical pitch.*	Music cognition/musical structure	72
Krumhansl, C. L., & Kessler, E. J. (1982). *Psychological Review, 89,* 334–368.	Cognition of harmonic & tonal structure	62
Dowling, W. J., & Harwood, D. L. (1986). *Music Cognition.*	Music perception & cognition	53
Narmour, E. (1990). *The analysis and cognition of basic melodic structures.*	Implication-realization model	53
Dowling, W. J. (1978). *Psychological Review, 85*, 341–354.	Theory of memory for melodies	51
Bregman, A. S. (1990). *Auditory Scene Analysis.*	The perceptual organization of sound	49
Krumhansl, C. L., & Shepard, R. N. (1979). *Journal of Experimental Psychology: Human Perception and Performance, 5,* 579–594.	Tonal functions within a diatonic context	46
Krumhansl, C. L. (1979). *Cognitive Psychology, 11,* 346-374.	Musical pitch in a tonal context	44
Jones, M. R., & Boltz, M. (1989). *Psychological Review, 96,* 459–491.	Dynamic attending and responses to time	39
Sloboda, J. A. (1985). *The musical mind.*	The cognitive psychology of music	38
Deutsch, D., & Feroe, J. (1981). *Psychological Review, 88,* 50–-522.	Representation of pitch in tonal music	37
Bharucha, J. J. (1984). *Cognitive Psychology*, *16*, 485–518.	Anchoring effects in music	33
Cooper, G. W., & Meyer, L. B. (1960). *The rhythmic structure of music.*	Tempo, rhythm, meter	33
Palmer, C. (1989). *Journal of Experimental Psychology: Human Perception and Performance, 15,* 331–346.	Musical thought to musical performance	32
Deutsch, D. (1982). *Psychology of music.*	Music psychology	30
Cuddy, L. L. et al. (1981). *Journal of Experimental Psychology: Human Perception and Performance, 7,* 869–883.	Rules governing auditory sequences	29
Narmour, E. (1992). *The analysis cognition of melodic complexity.*	Implication-realization model	28
Bartlett, J. C., & Dowling, W. J. (1980). *Journal of Experimental Psychology: Human Perception and Performance, 6,* 501–515.	Recognition of transposed melodies	28

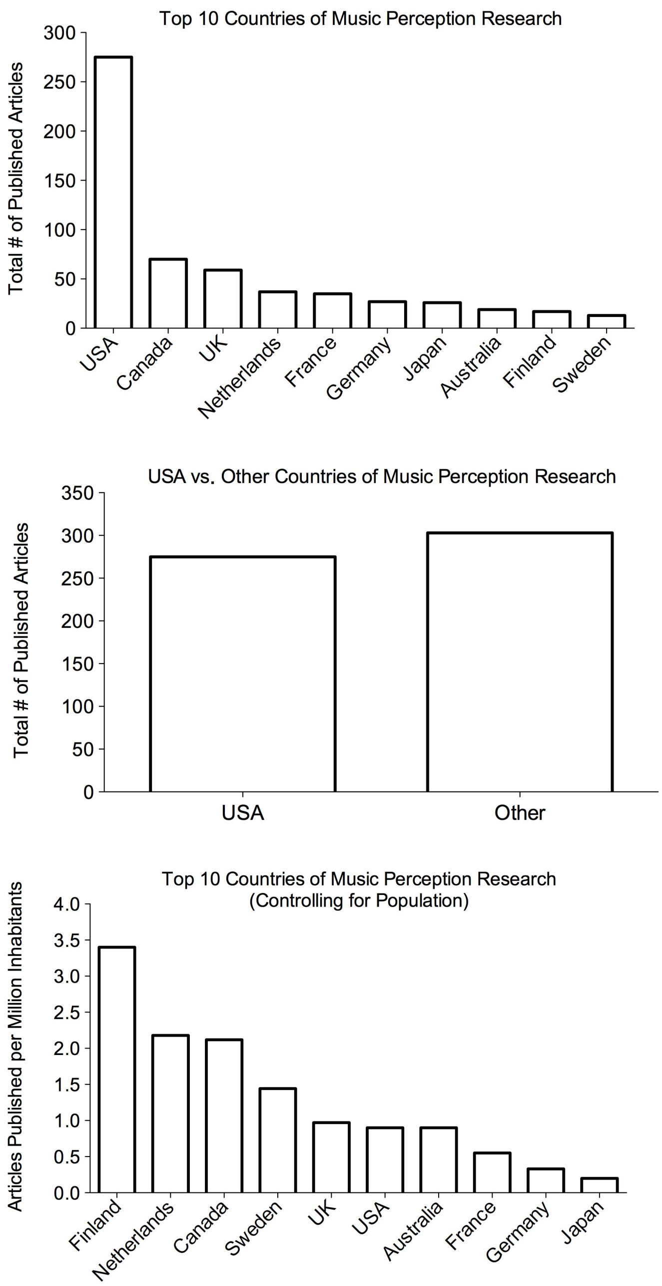

FIGURE 3. (a) Top 10 countries of MP Research, (b) USA versus Top 9 other countries of MP Research, (c) Countries of MP Research controlling for population size.

analysis are Finland, the Netherlands, Canada, Sweden, and the UK.

DEPARTMENTAL AFFILIATION

The types of articles written might be influenced by authors' home departments, a reasonable proxy for the discipline within which they work. For departmental affiliation, we observed that of the 424 empirical articles examined, 108 originated from music departments and 200 originated from psychology departments. Others included neuroscience (33), Haskins Laboratories (19), and technology/computer science (17). In contrast, of the 154 theoretical articles, 71 originated from music departments and 30 originated from psychology departments. Others included neuroscience (10), technology/computer science (8), and cognitive science (5).

Discussion

Our analysis has yielded a particular set of findings, and we emphasize that this is only a subset of a large number of analyses that could be generated from these data. However, some noteworthy points emerge from the present analysis.

Several significant trends over time emerged. In the Topics domain, the significant increase over time in the study of temporal perception shows an interesting direction of current research interests in the field. One might ask whether this increase in Temporal Perception research was accompanied by a corresponding reduction in Pitch Perception research. One can argue either way from the data. On the one hand, we did find a corresponding decrease in Pitch Perception research over the same time, suggesting that early research in the field may have focused more heavily on the perception of pitch structures, whereas the increase in the perception of temporal structures occurred later. However, when the special issues on pitch perception were removed, this downward trend was no longer significant, suggesting that special issues generated more research articles on pitch than otherwise might have been the case. It is possible that special issues occur because of increased interest in a domain such as pitch perception, or conversely, because the call for a special issue targets ongoing work that might be submitted elsewhere.

The significant increase in studies on Emotion Perception is consistent with subjective observations that its study is a relatively recent trend in the field (Ball, 2010; Levitin, 2010; Thompson, 2008). Indeed, an international conference on music and emotion is holding its second annual meeting this year (http://www.music.uwa.edu.au/research/power-of-music/icme).

In the Participants domain, no significant trends over time were observed, indicating that the types of participants employed in music perception studies has been relatively stable. Overall, the majority of studies have been conducted with adult musicians, many with high levels of music training. The second highest group comprised participants with little or no formal music training, often referred to as nonmusicians. This finding suggests that in many cases, nonmusicians were employed, perhaps in order to investigate human music perception in a general sense (i.e., in the absence of formal music training) or in order to compare musicians to nonmusicians on some particular outcome measure.

In the Stimuli domain, the significant decrease in the use of isolated sound stimuli observed may suggest that whereas researchers in the field may have begun studying the perception of individual pitches presented in a somewhat isolated fashion, this trend is decreasing. The corresponding increase (though not statistically significant) in the use of sequential music suggests that the field is moving towards the presentation of what we would normally think of as natural ecologically valid *music* (as noted in Levitin, 2007).

In the Materials domain, significant decreases in tape players/recorders, loudspeakers, and amplifiers were observed. The decrease in tape players reflects obvious advances in and decreased costs of digital technology (tending towards compact disc players or other forms of digital media). Another trend to support this point is a corresponding upward trend in the use of MIDI devices (ß = .37, $p = .07$) for stimulus presentation. Decreased use of loudspeakers and amplifiers may be indicating an increased reliance on computers that may have built-in speaker systems (not explicitly mentioned in the methods sections) or headphones (ß = .28) as listening tools.

In the Outcome Measures domain, the predominance of perceptual outcomes points to the fact that the research published in *MP* is indeed dedicated to measuring primarily Perceptual tasks, as opposed to Production or Memory tasks.

For *measurement approaches,* we found a significant increase in the use of standardized assessment measures of both musical and nonmusical abilities. This could be related to an increase in the study of so-called transfer effects; for example, whether music instruction is correlated with (or leads to) achievement in non-musical domains such as reading and mathematics. However, we did not observe a significant trend in Transfer studies in *MP*, although the regression line moves in an upwards direction (ß = .14, $p = .50$). Alternatively, the increase in Assessment instruments could be pointing to an increasing interest in the measurement of musical abilities, or the study of special populations such as individuals with congenital amusia or Williams Syndrome, where assessment measures are often necessary in determining areas of proficiency/deficiency. Furthermore, an examination of specific articles coded for Assessment measures does indicate that several articles were indeed examining the relationship between musical abilities and either phonological processing (Forgeard et al., 2008) or spatial abilities (Črnčec, Wilson, & Prior, 2006; Husain, Thompson, & Schellenberg, 2002). The significant increase in physiological measurement tools reflects the overall "neuralization" of the behavioral and social sciences, seen broadly in the field of psychology over the same period (Gazzaniga, Heatherton, & Halpern, 2010).

The examination of pre-composed music showed that approximately half the music used in experimental studies comes from the classical style. This finding suggests that music perception research relies heavily on human responses to a single style of music. This may be a function of many factors. Classical music has a richer music-theoretic tradition than popular music or jazz, and music cognition research has historically employed classical music, perhaps leading current researchers to do so in order to more directly compare findings. There also exists, however, a longstanding bias that only classical music is "serious" music worthy of scientific study. The use may also reflect the researchers' own taste and familiarity with that style over others. Despite the prevalence of this particular style, it was also observed that the trend in the use of classical music is decreasing (ß = - .31, $p = .13$), although not significantly so. One significant trend that did emerge was an increase in soundtracks and showtunes, indicating a possible increase in research involving responses to music in film or popular television shows.

The bibliometric analyses reveal the most influential articles in the field published in *MP,* and also compile works published outside the journal highly relevant to *MP* authors. Interestingly, Sloboda (1986) identified a precise moment in history at which he claims the field of music psychology experienced its "coming of age": this moment was the publication of Lerdahl & Jackendoff's book *A Generative Theory of Tonal Music* (1983). Sloboda (1986) provided several reasons for the importance of this publication: the book is one of the most comprehensively reviewed in the field; it is designed to apply at several levels of description or analysis within a musical piece, from a small excerpt of music up to an entire symphonic movement; and it is empirically informed. In 2010, *A Generative Theory of Tonal Music* remains the top cited work in *MP,* demonstrating its continued influence. In addition, the citation reports reflect the important contributions of many other researchers in the field.

Regarding geographical origin, the research in *MP* spans all six inhabited continents: North America, South America, Europe, Asia, Africa, and Oceania. This indicates that *MP* represents music perception and cognition research on a global scale. The majority of articles have been published by American researchers. However, this demonstrably reflects the large population of the USA; a measure of articles published per million inhabitants of each country shows that Finland has generated more publications per capita in *MP* than any other country, and this is driven in large part by the work of Toiviainen, Tervaniemi, and their colleagues.

As one might expect, theoretical articles about music perception most commonly originate from music departments, whereas empirical articles originate most frequently from psychology departments.

LIMITATIONS AND FUTURE DIRECTIONS

An obvious limitation of the current study is our journal-specific approach in documenting trends in an entire field of research. There are many other journals that publish high quality work on these topics. Authors may or may not favor publishing in *MP* for many reasons. For example, authors of major music theoretic findings may prefer to publish in the *Journal of Music Theory* or *Music Theory Spectrum;* authors of major findings with a neurobiological context may choose *Nature, Science, Neuron,* or a host of related domain-specific journals; findings with a clear cognitive psychological basis may be published in, for example, *Cognition, Memory and Cognition,* or one of three *Journal of Experimental Psychology* publications. Yet many authors have submitted important and influential works to *MP,* as evidenced by the large number of citations to *MP* articles we found in the ISI Web of Science, and the broad range of publications across which *MP* articles are cited.

Another limitation is that the observed trends are undoubtedly influenced by fluctuations in the number of empirical articles that are published in any given year (e.g., 7 articles coded in the year 1997 versus 32 in 2008). A third limitation is in the subjective nature of the code definitions — although the codes were applied consistently, other researchers may have defined domains and codes differently.

Sloboda's (1992) review of the first 10 years of *MP* differed from ours. The majority of his article was dedicated to a detailed and critical analysis of several key studies and their implications for the field. Such an analysis would clearly be a useful adjunct to the present article, but was beyond the scope of what we set out to do.

The goal of our article was to characterize the nature of this field by systematically examining several areas which we deemed compelling for those interested in the history of music perception and cognition as a field of study. This examination included both descriptive information and trends over time for the purposes of observing the prevalence of particular topics, subject samples, stimuli (including pre-composed music), outcome measures, certain kinds of bibliometric information, and how these have evolved over 26 years. This undertaking has allowed for a data-driven perspective of the field at large. Our primary data set is available for those researchers who may be interested in pursuing any number of further analyses regarding the study of music perception and cognition as represented in *MP.*

Author Note

This work was submitted by the first author in partial fulfillment of the requirements for the Ph.D. in School/Applied Child Psychology in the Department of Educational and Counselling Psychology at McGill University under supervision by the second author, and funded by a grant from NSERC to the second author. We are grateful to Eugene Narmour, Lola Cuddy, Richard Parncutt, and Jeffrey Mogil for helpful comments, to Samantha Menzies for help with the data acquisition and analysis, to Michael Lifshitz for help with the graphs, and to Sara Florence for research assistance.

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Appendix

The data reported herein are available in searchable form online at http://www.psych.mcgill.ca/labs/levitin/MusicPerceptionTrends.htm.

The primary datafile is an Excel file named "MPDomainCoding.xls."

Named tabs within the workbook signify specialized spreadsheets. In the "MASTER" worksheet, individual articles are listed in rows in chronological order. Column headings, from left to right, show year of publication, identifying information for the article including volume and issue number, authors, title, page numbers, and special issue of the journal, if applicable. Following these are columns with the domain code categories, in the following order: Topics, Participants, Stimuli, Materials, Outcome Measures. An "x" in any given column indicates that an article was coded for the presence of that particular feature, and these are tallied in the totals row at the bottom of the spreadsheet and represented also as percentages of total articles. The "Code Definitions" worksheet includes a list of codes presented in the first column, followed by a complete list of cases in which the codes were applied in the second column.

To facilitate further study of the specific pieces of music used in experiments reviewed herein, we also include an Excel file named "MPPreComposedMusic.xls." Data are presented in a similar fashion to the full data set under the "MASTER" worksheet. From left to right is the identifying information of the article, name of the composer, nationality of the composer, identifying information of the piece of music, style, year composed, century composed, and how the music was prepared for presentation to participants.

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