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Uncovering Text–Music Connections with a Relational Database: Towards an Objective Measurement of Melodic Pitch Diversity in Relation to Literary Themes in Bach's Church Cantata Recitatives

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Abstract. Bach's cantatas are particularly rich in text imagery, and they typically employ chromatic melodies to accentuate the more piquant literary images, especially in recitatives. Heretofore theories about the intentionality of Bach's compositional choices in this regard have necessarily remained conjectural. In the following study, an objective measurement of pitch diversity in the vocal lines of Bach's church cantata recitatives in relation to literary themes was made possible with specially designed computer software allowing pertinent information to be entered efficiently into a relational database. Because the software tracked not only the 90,000 pitches constituting the vocal lines of these movements but also other attributes (e.g., overall length, presence or absence of accompaniment, opening and closing keys, chronological position, among others), interrelationships among the various attributes could be examined. Findings demonstrate clear correlation between pitch diversity and the degree of affective tension implied by particular textual subjects. While the findings do not prove exclusive causation (other factors such as tonal and structural considerations, social occasion, and evolution of style can also play a role), they do link the two elements, especially in light of Bach's method of composition as documented by Robert Marshall. This study is important for its systematic and comprehensive approach, its findings giving definition and clarity to commonly held generalizations about the relationships between melodic chromaticism (of which pitch diversity is an important aspect and indicator) and textual content. Furthermore, the software holds promise for additional studies of Bach's pitch materials and for studies in other stylistic contexts.

1. Bach and the Sacred Cantata

Bach's sacred cantatas culminated a long tradition of Lutheran "sermon music," whose primary function was to teach and persuade the listener. Having roots in the secular Italian theatrical style, the German church cantata was allowed to develop as fully as it did largely because it was regarded

among the clergy as a significant medium for the proclamation, amplification, and interpretation of scripture.[1] "According to Lutheran thinking everything finally depended on ... whether ... new musical forms ... could become 'vessels and bearers of ecclesiastical proclamation' and ecclesiastical confession."[2] This didactic role served to heighten the genre's emphasis on the text–music relationship, an emphasis already intrinsic to the secular operatic works that served as models.

Bach's cantatas are rich in text imagery and symbolism and his typically chromatic melodies and harmonies accentuate the more piquant literary images. Differences are particularly noticeable in the recitatives, which comprise the bulk of the textual content and derive their forms most directly from the content and inflection of the text.

In the Baroque era, setting emotion-laden words with chromatic melodies and harmonies (especially in recitatives) was standard procedure, a stock in trade.[3] For example, Johann David Heinichen wrote in 1711,

> Indeed, recitative style demands something completely different and more than some few hundred rules ... to say nothing of the fact that in this style, more than in any other, does a composer find the opportunity to show his art so that he does not only play with the notes blindly (as it were) without hurting the ear but is also able, at the same time, to effectively express the recitative's text. The latter, in particular, must be achieved either through emphatic changing of the notes or through clever dissonances: again [it is] the custom of some composers to set words of pain, despair, and the like in recitatives with such beautiful harmonies that it is a delight to hear."[4]

2. The Challenge

Unfortunately, the study of text–music relations in Bach's vocal works has been discredited in the eyes of some by the occasionally fanciful approaches taken by Albert Schweizer and W. Gillies Whittaker, among others.[5] Noting Bach's practice of reusing the music of arias and choruses in new textual contexts, a few scholars have even concluded that it "makes nonsense of the theory ... that Bach's music is infused with symbolism and that all his settings are intimately related to the words."[6] To proceed on a more solid footing it is necessary to devise comprehensive, empirical methodologies that document the nature and extent of any existing relationships and thereby test traditionally held suppositions. An objective approach promises several benefits:

- By using an inductive process rather a deductive one, it replaces "anecdotal" evidence (whose selection might be influenced by presup-

positions and is therefore open to the charge of subjectivism) with objectively collected empirical evidence.

- It gives definition and clarity to generalizations about the relationships between aspects of Bach's musical language and textual content.
- It identifies which literary themes were, for Bach, most suitable for a particular musical treatment, and provides some indication of which themes he favored.

The present study measures one important aspect and indicator of chromaticism – melodic pitch diversity – in relation to subject matter in Bach's sacred cantata recitatives. To keep the project within manageable limits, the harmonic context of the pitches was not addressed.[7]

Recitatives are the most logical point of departure for studying the relationship between a composer's choice of pitch materials and textual themes for they were traditionally shaped according to the inflection and meaning of individual words and phrases.[8] Clearly, Bach's recitatives are no exception. Robert Marshall observes,

> In no other form does Bach's music approach the early baroque ideal of treating the text as the "mistress" of the music so closely as in the recitative. While this ideal, which theoretically would involve the suppression of an independent musical logic, is never entirely realized in the Bach recitative (just as it was never realized in the best examples of early baroque music), the musical elements in this form are often so strongly bound to the text that it becomes difficult to discern an autonomous musical organization.[9]

> In view of the singularly dependent nature of its musical elements it should not be surprising that Bach eventually adopted the practice ... of writing down the complete text in a naturally spaced, legible hand after he had set up the systems for the movement but before he had composed the first note, a procedure totally different from the one ... in the four-part chorales and from the one ... in the arias and choruses.[10]

Evidently Bach's musical conception was still unformed when he wrote out the text. Thus Marshall observes, for example, that "the disposition of text beneath a long melisma indicates that the text was present before the music was written, and that Bach did not yet have the melisma in mind when he wrote down the text."[11]

Bach's next step was apparently to invent and write the vocal part, perhaps a passage at a time. Marshall writes,

> While the Leipzig recitative autographs reveal unambiguously that Bach began their composition by entering the text for the complete movement below the vocal staff, it is not so clear how he then continued. The evidence

suggests that Bach drafted the vocal part before he wrote down the continuo part.[12]

That Bach invented the vocal line before he had a finished conception of the underlying harmonic progression is suggested by the spacing of notes and corrections made to the vocal part (apparently for the purpose of adjusting it to the continuo line). Marshall cites several examples to illustrate the process.[13] Of course, Bach must have had at least a basic conception of the harmonies he would use. Nevertheless, given Marshall's observations about the vocal part serving as Bach's compositional starting point in recitatives, we conclude that not only harmonic considerations, but also other factors sometimes cited as contributors to increased chromaticism (e.g., structural considerations, social occasion, and evolution of style) were less influential here. Therefore it seems reasonable to restrict this study to Bach's recitative "melodies" and their texts.

3. Methodology

3.1. The program

An empirical approach to uncovering the connections between pitch diversity and Bach's textual themes required that all individual pitches be recorded, and the resulting pitch sets cross-referenced with generic text themes. To accomplish this enormous task we commissioned the design of computer software,[14] which allowed pertinent information to be recorded and a number of quantitative operations to be carried out. The following data were recorded:[15]

- basic information about the recitative: movement identification, length in measures, opening and closing keys, scoring information (voice type, presence or absence of accompaniment), chronological position in Bach's sacred cantata output, date the work was composed or first performed,
- theological/literary themes including summaries found in Melvin Unger's *Handbook to Bach's Sacred Cantata Texts*,[16]
- general observations,
- pitches of the vocal part,
- number of measures in which the entire set of 12 pitch classes[17] appeared (if at all).

Calculations for each recitative included the following:

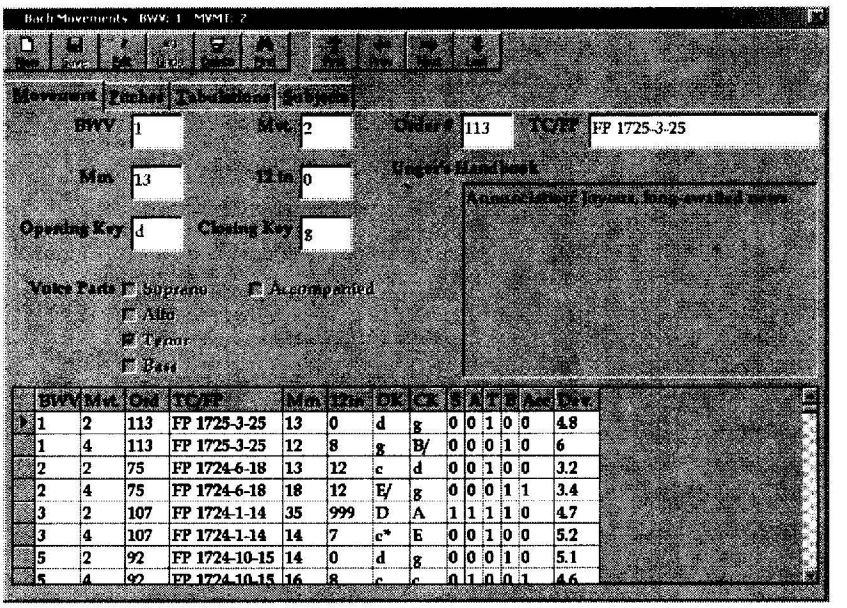
- frequency of appearance of each notated pitch (without regard to register but preserving enharmonic differentiations)[18], expressed as a percentage,

- pitch class distribution (expressed as a percentage of each pitch class present in the recitative),[19]
- total number of sharps and flats (inclusive of those signified by the key signature),[20]
- pitch diversity expressed as the average deviation from 8.3% (if all 12 pitch classes are represented equally, they each constitute 8.3% of the whole).[21]

3.2. THE PROCEDURE

While the visual layout of the data entry is not critical to the research design, we provide screen shots here to help the reader grasp the procedure used in our study (and its underlying reasoning) as well as the software program's potential for future studies. Data entry was done according to the following sequence.

- General information for each movement was entered in the General Information window (see Figure 1). This included movement identification (*BWV* number and movement number), length in measures, opening and closing keys, scoring information (voice type, presence or absence of accompaniment), chronological position in Bach's sacred cantata output, and the date the work was composed or first performed,



BWV	Mvt.	Ord	TC/FP	Mm.	12in.	OK	CK	S	A	T	B	Acc	Div.
1	2	113	FP 1725-3-25	13	0	d	g	0	0	1	0	0	4.8
1	4	113	FP 1725-3-25	12	8	g	B/	0	0	0	1	0	6
2	2	75	FP 1724-6-18	13	12	c	d	0	0	1	0	0	3.2
2	4	75	FP 1724-6-18	18	12	E/	g	0	0	0	1	1	3.4
3	2	107	FP 1724-1-14	35	999	D	A	1	1	1	1	0	4.7
3	4	107	FP 1724-1-14	14	7	c*	E	0	0	1	0	0	5.2
5	2	92	FP 1724-10-15	14	0	d	g	0	0	0	1	0	5.1
5	4	92	FP 1724-10-15	16	8	c	c	0	1	0	0	1	4.6

Figure 1. Pitchtrak: General Information window.

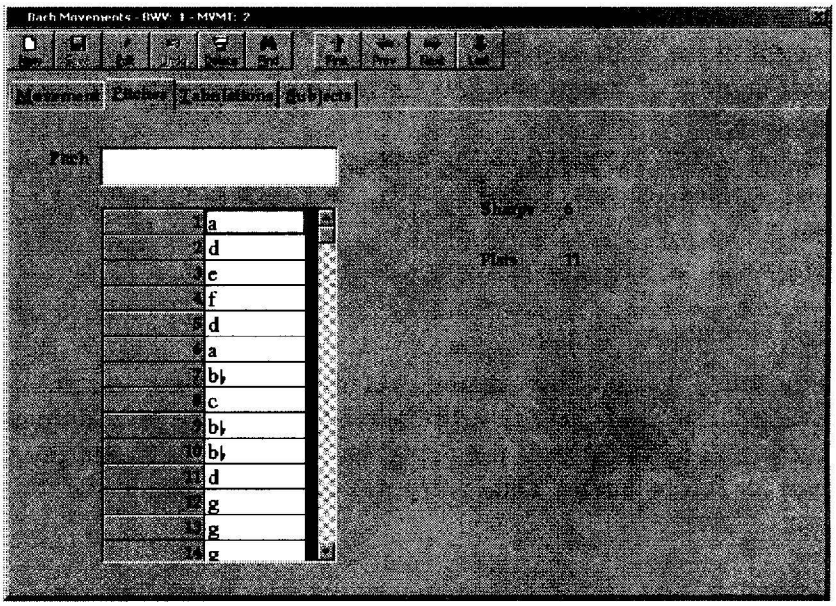


Figure 2. Pitchtrak: Pitches window.

and the theological/literary summary captions found in Melvin Unger's *Handbook to Bach's Sacred Cantata Texts.*

- Pitches were entered manually in the pitch field of the Pitches window, appearing automatically in a scrolling, numbered list (see Figure 2). To facilitate rapid data entry the program links flat signs with forward slashes and sharps with asterisks: notes could be entered quickly on a standard computer keyboard, the left hand resting in its normal position, the right hand on the number pad.

  / = ♭

  // = ♭♭

  * = ♯

  ** = x

  The program then converted the symbols using the Bach font.[22] In some recitatives, where particular phrases of the libretto were set with obviously increased melodic pitch diversity, we measured the relevant segments independently and entered these additionally.[23]
- Numerical counts and proportional representation of individual "real pitches" as well as pitch classes[24] and calculations regarding pitch diversity automatically appeared in the Tabulations window (see Figure 3).

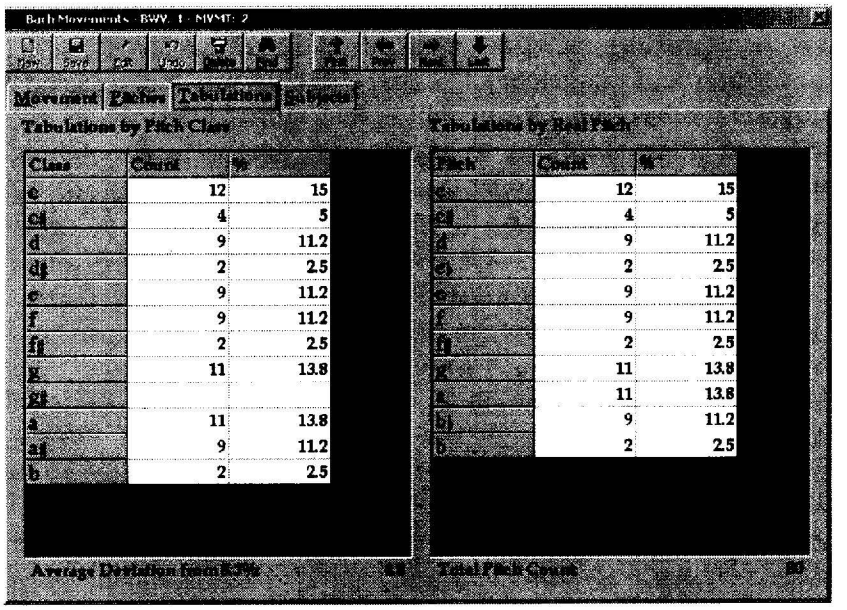


Figure 3. Pitchtrak: Tabulations window.

- Literary themes were entered in the Subjects window (see Figure 4). Six fields allowed up to six subject descriptors in accordance with order of priority or emphasis. Additional observations were entered in the

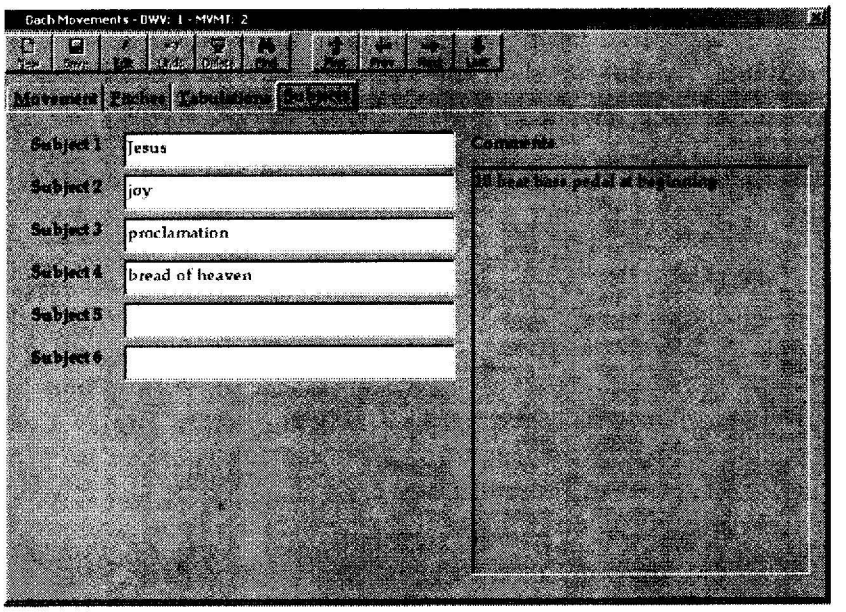


Figure 4. Pitchtrak: Subjects window.

"Comments" field. Continual cross checking of subject descriptors and the corresponding recitative texts ensured the greatest possible standardization and consistency.[25] Cross-checking was made easier by the program's subject search capability (see Figure 5). Search results could be sorted either according to priority (i.e., the particular subject's priority in the recitative text) or according to the degree of pitch diversity found in the vocal line (i.e., by average deviation score). A "wild card" feature enabled searches for words that appear within other descriptors (e.g., "blood" in "redemption-blood," "propitiation-blood," or "cleansing-blood").

Because the software developed for our study was capable of tracking not only the 90,000 pitches constituting the vocal lines of Bach's recitatives but also other attributes of these movements (as listed above), we entered more information than our immediate investigation required, recognizing that the resulting database could form the basis of several subsequent studies.[26] Furthermore, while the software was designed primarily to record hard data, it also included a field where we could enter observations regarding unusual structures or elements: bass pedals, alternation among voice types (S-A-T-B), intermingling of chorale and recitative sections, arioso segments, bass lines with infrequent notes, obvious scriptural quotations or allusions, and rhetorical figures (e.g., trembling figures). We took the cantatas in chronological order (as opposed to their catalog [*BWV*] order) so that we could incidentally observe developmental trends (if any). That Bach *did* change at least one

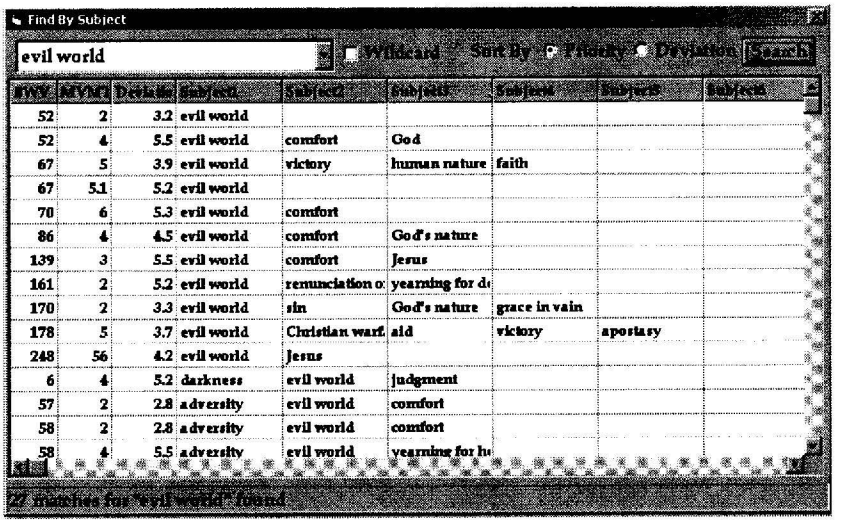


Figure 5. Pitchtrak: Find-by-subject window.

aspect of his approach to recitative composition is documented in Marshall's study.[27] However, our focus remained on answering the following empirically verifiable questions:

(1) Did pitch diversity change with time?
(2) In how many measures does a complete set of (all 12) pitch classes occur? Are there any discernible patterns with regard to complete pitch sets and their textual settings?
(3) What text themes appear most often and in what proportion?
(4) Are there demonstrable relationships between text themes and pitch diversity?

4. The Results

4.1. Chronological trends in Bach's use of pitch diversity

Our study demonstrates that Bach employed greater pitch diversity in the recitatives of his Leipzig period (i.e., from 1723 until his death in 1750). Since Bach evidently composed no sacred cantatas in the immediately preceding years while at the Cöthen court (1717–1723), the contrast between his early and mature cantatas is all the more evident.[28] As for the works from his Leipzig period, at least one trend can be observed. Contrary to what one might have supposed – that the second yearly cycle of cantatas (the chorale *Jahrgang*) would be characterized by a simpler pitch vocabulary since Bach was apparently trying to ease the demands placed on the choirboys (especially the sopranos) by basing the cantatas on hymn tunes[29] – pitch diversity in the recitatives actually increased.[30]

4.2. Complete sets of pitch classes[31] in particular spans

The question of whether Bach employed all twelve pitch classes in structurally significant spans, and if so, whether this fact suggests an intended symbolic meaning related to the text, is one of the more intriguing ones arising out of this study. As has been explored elsewhere, recitatives in Cantatas 48 and 78 suggest this hypothesis.[32] The present study counted pitch classes in 418 recitatives. Table I documents the number of recitatives that incorporate all 12 pitch classes in the vocal part, and the number of measures required to achieve the complete set. In some cases, it seemed more appropriate to measure inner spans. These appear in the database as 13 separate and additional entries (identified as such) and are not included here in the totals proper.[33]

Table I. Number of recitatives in which all 12 pitch classes appear (sorted according to relevant span lengths in measures)

Span (mm)	Number of recitatives
0[a]	180 (+4 segments entered into the database in addition to the entire recitative)[b]
3	1 (+2 segments entered separately into the database)
4	5 (+2 recitative segments entered separately into the database)
5	10 (+2 segments entered separately into the database)
6	19
7	29 (+1 segment entered separately into the database)
8	27 (+1 segment entered separately into the database)
9	29 (+1 segment entered separately into the database)
10	31
11	12
12	17 (+1 segment entered separately into the database)
13	9
14	7
15	2
16	3
17	1
18	2
19	Not found
20	1
21	1
22	Not found
23	1
24	1
25	Not found
26	Not found
27	1
28	1
37	1
999[c]	27
Total	418 recitatives + 14 repeated recitative segments = 432 records in the database

[a] "0" is the designation used for recitatives in which the complete set did not appear.
[b] In some cases, it seemed worthwhile to study a segment of a recitative in isolation, and it was entered into the database separately, i.e., in addition to the entire recitative. As a result the database has 3 additional entries showing "12 in 0."
[c] "999" is the designation used for longer recitatives (or recitatives with interpolations, etc., in which it seemed pointless to continue to count pitch classes.

In 180 recitatives (43% of the total) a complete pitch set does *not* appear. In the recitatives that do include the entire chromatic gamut, the span ranges most typically from 10 to 14 measures, with 7-, 8-, 9-, and 10-measure spans accounting for 116 of the instances (27.75% of the total number of recitatives). Since the number of instances for each of these spans is almost identical (29, 28, 29, and 31, respectively) it is difficult to infer any conscious design on Bach's part with respect to a text-related meaning of these numbers, the cited examples from Cantatas 48 and 78 notwithstanding. Indeed one might argue that when Bach chose to write chromatic melodies, the *coincidental result* was that he included a complete pitch set within spans of seven to 10 measures. In short, it appears impossible to demonstrate conclusively that Bach counted pitch classes as he composed, incorporating complete sets in significant spans for symbolic purposes.

4.3. Bach's text themes

Because Bach's recitative texts frequently introduce several literary themes, in varying relationships, and with various degrees of emphasis, categorizing the subject matter in a consistent and systematic manner was no easy task. The computer program was designed to accept up to six subjects, which were entered in different fields according to priority or emphasis (see Figure 4). To bring some consistency to the process, the list of subjects was constantly monitored in a dynamic process: new data continually informed readjustment of existing categories.[34] Table II provides the comprehensive list of subjects in its final form, sorted by frequency of appearance so that the reader can see the relative weight each subject is given in Bach's recitatives. Calculations were based on tallies resulting from searches (usually) without the wildcard.[35] That is, the table identifies the literary content of the recitatives by consolidating the hierarchical list of subjects for each movement (Figure 6).[36] While the categories are generally fairly inclusive, some finer distinctions nevertheless had to be made. For example, "anxiety" was distinguished from "no anxiety" and "rejection of anxiety" because the conceptual emphasis (and hence the affect) of the respective settings is obviously very different.[37] In some cases, where particular phrases of the libretto were set with obviously increased pitch diversity, the relevant segments were measured independently. These appear in the database as independent (additional) entries, creating duplicate subject entries, which are subtracted here. It is also important to note that, while there are a number of theme categories appearing very infrequently (e.g., one to three times), their uniqueness suggests that they *not* be subsumed in other categories.[38] The results are given here as percentages.

Table II. Subjects sorted by frequency of appearance

Subject	Appearances	% of total recits.
Ambassador	1	0.2392
Body and blood of Christ	1	0.2392
Darkness	1	0.2392
Great Commission	1	0.2392
No anxiety	1	0.2392
No repentance	1	0.2392
Poverty spiritual	1	0.2392
Rejection of anxiety	1	0.2392
Spirit	1	0.2392
Success	1	0.2392
Bread of heaven	2	0.4784
Eternal damnation	2	0.4785
Infinite duration	2	0.4785
Light	2	0.4785
No mercy	2	0.4785
Original sin (inherited disposition to evil)	2	0.4785
Positive (as qualifying descriptor)	2	0.4785
Voice of God	2	0.4785
Weak faith	2	0.4785
Apostasy (turning to other gods or teachings)	3	0.7177
Baptism	3	0.7177
Body and soul (i.e., whole person)	3	0.7177
Efficacy of word	3	0.7177
Miracles	3	0.7177
Second coming	3	0.7177
Anxiety	4	0.9569
Divine enlightenment	4	0.9569
Doubt vs. faith	4	0.9569
Imminence	4	0.9569
Jesus-shepherd	4	0.9569
Nature (includes animals)	4	0.9569
Worldly honor (see also worldly pleasures)	4	0.9569
Yearning for God	4	0.9569
Covenant	5	1.1962
Forgiveness (see also mercy)	5	1.1962
Gospel	5	1.1962
Grace in vain	5	1.1962
Heaven	5	1.1962

Table II. (Continued)

Subject	Appearances	% of total recits.
Scripture-partial (quoted)	5	1.1962
Worldly pleasures (see also worldly honor)	5	1.1962
Christ dialogue	6	1.4354
Covenant fulfilled	6	1.4354
Glorification	6	1.4354
Human reasoning	6	1.4354
Voice of Christ	6	1.4354
Dialogue	7	1.6746
Discipleship (following Christ in day-to-day life, cross-bearing)	7	1.6746
Healing	7	1.6746
Compassion	8	1.9139
Entreaty in vain (includes idea of being forsaken by Jesus)	8	1.9139
Grace	8	1.9139
Proclamation	8	1.9139
Transience of earthly life (see also earth vs. heaven, renunciation of earthly life)	8	1.9139
Union (mystic union "Christ in me or with me," wedding imagery)	8	1.9139
Word	8	1.9139
Earth vs. heaven (see also renunciation of earthly life, transience of earthly)	9	2.1531
God's love	9	2.1531
Inversion principle	9	2.1531
Law	9	2.1531
Propitiation (atoning, substitutionary sacrifice; appeasement)	9	2.1531
Spiritual nourishment	9	2.1531
Yearning for death (as opposed to yearning for heaven)	9	2.1531
Ascension	10	2.3923
Commitment to God (volitional response, includes reception of Christ by faith)	10	2.3923
God's nature (includes divine attributes of love, mercy, compassion)	10	2.3923
Lowliness of humankind	10	2.3923
Victory (can include rescue from attack)	10	2.3923
Wedding	10	2.3923
Yearning for Jesus (not necessarily in heaven)	10	2.3923
Angels	12	2.8708

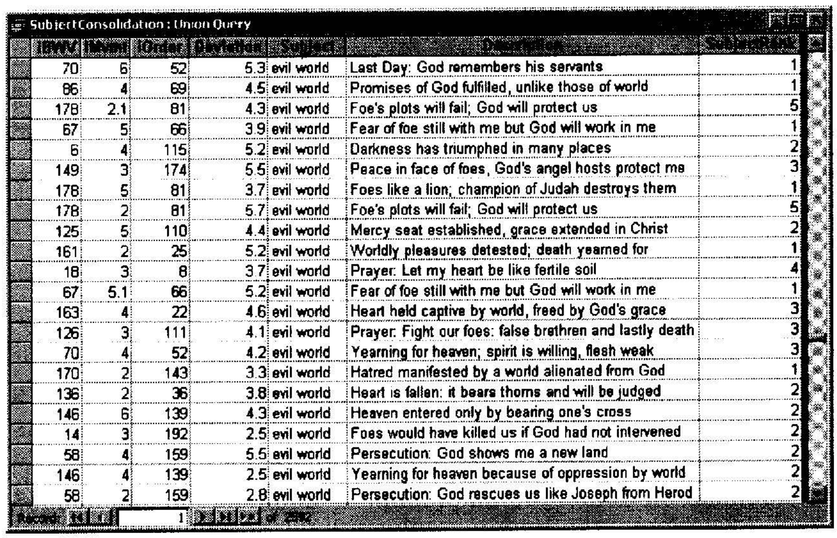
Table II. (Continued)

Subject	Appearances	% of total recits.
Satan	13	3.1100
Mercy	14	3.3493
Resurrection	14	3.3493
Yearning for heaven (as opposed to yearning merely for death)	14	3.3493
Sin	15	3.5885
Renunciation of earthly life (see also earth vs. heaven, transience of earthly life)	16	3.8278
Fear (several sub-categories)	17	4.0670
Christian warfare (includes an element of fighting back or battle imagery)	18	4.3062
Divine indwelling	18	4.3062
Civic	20	4.7847
Cleansing	20	4.7847
Faith	20	4.7847
Repentance	20	4.7847
Adversity	21	5.0239
Human nature (understood to be evil; tendency to do evil)	22	5.2632
Incarnation	23	5.5024
Aid (includes protection)	24	5.7416
Judgment	24	5.7416
Narration	24	5.7416
Redemption (rescue by payment, liberation from bondage or indebtedness)	24	5.7416
Devotion (affection)	25	5.9809
Evil world (emphasis on evil actions)	26	6.2201
God (about God, devotion to God; divine references without reference to Jesus)	27	6.4593
Death	28	6.6986
Joy	31	7.4163
Praise	34	8.1340
Submission to God (compliance, can include cross-bearing*)	34	8.1340
Scripture (quoted)	36	8.6124
Suffering (includes suffering of Christ, grief)	36	8.6124
Exhortation	40	9.5694
Blessing	43	10.2871
Entreaty	47	11.2440

Table II. (Continued)

Subject	Appearances	% of total recits.
Jesus (about Jesus, devotion to Jesus)	57	13.6364
Comfort	67	16.0287
	1277	

* Also: clothing oneself with Spirit's gifts, prayer for loving disposition.



70	6	52	5.3	evil world	Last Day: God remembers his servants	1
86	4	69	4.5	evil world	Promises of God fulfilled, unlike those of world	1
178	2.1	81	4.3	evil world	Foe's plots will fail; God will protect us	5
67	5	66	3.9	evil world	Fear of foe still with me but God will work in me	1
6	4	115	5.2	evil world	Darkness has triumphed in many places	2
149	3	174	5.5	evil world	Peace in face of foes, God's angel hosts protect me	3
178	5	81	3.7	evil world	Foes like a lion; champion of Judah destroys them	1
178	2	81	5.7	evil world	Foe's plots will fail; God will protect us	5
125	5	110	4.4	evil world	Mercy seat established, grace extended in Christ	2
161	2	25	5.2	evil world	Worldly pleasures detested; death yearned for	1
18	3	8	3.7	evil world	Prayer: Let my heart be like fertile soil	4
67	5.1	66	5.2	evil world	Fear of foe still with me but God will work in me	1
163	4	22	4.6	evil world	Heart held captive by world, freed by God's grace	3
126	3	111	4.1	evil world	Prayer: Fight our foes: false brethren and lastly death	3
70	4	52	4.2	evil world	Yearning for heaven; spirit is willing, flesh weak	3
170	2	143	3.3	evil world	Hatred manifested by a world alienated from God	1
136	2	36	3.8	evil world	Heart is fallen: it bears thorns and will be judged	2
146	6	139	4.3	evil world	Heaven entered only by bearing one's cross	2
14	3	192	2.5	evil world	Foes would have killed us if God had not intervened	2
58	4	159	5.5	evil world	Persecution: God shows me a new land	2
146	4	139	2.5	evil world	Yearning for heaven because of oppression by world	2
58	2	159	2.8	evil world	Persecution: God rescues us like Joseph from Herod	2

Figure 6. Microsoft Access subject consolidation union query.

While a comprehensive analysis of these numbers is beyond the scope of this paper, a few observations are in order.

(1) The topics (as differentiated in this study) are numerous. Thus, of the 1277 subject occurrences, the most prevalent one ("comfort," which appears 67 times) constitutes only 5.25% of the total number of subject occurrences and appears in only 16% of the recitatives.

(2) The defining Lutheran concepts of *sola fide* and *sola scriptura* appear less often than one might expect. *Faith* ("faith" + "weak faith" + "doubt vs. faith") appears only 26 times (6.2% of the recitatives), while *scripture* ("Word" + "efficacy of Word") appears only 11 times. Of

course these ideas sometimes appear in other contexts (i.e., contexts in which they are not primary emphases).

(3) Topics with largely negative sentiments are plentiful. Thus, for example, the total number of occurrences of the themes of adversity (21), suffering (36), anxiety (4), fear (17), death (28), and yearning for death (9) is 115 (representing over one-quarter of the recitatives)! Similarly the themes evil world (26), human nature – understood to be evil (22), Christian warfare (18), and earth vs. heaven (9) produce a total number of 75 (17.9% of the recitatives).

(4) Pietistic/mystic themes are also plentiful. This emphasis can be seen in the number of references to mystic union (8), devotion (25), yearning for Jesus (10), worldly pleasures – usually understood to be evil (5), renunciation of earthly life (16), not to mention more general references to Jesus (57), yearning for God (4), wedding imagery (10), or comfort (67).

(5) In keeping with the cantata's didactic function in the Lutheran liturgy of Bach's day, there is great emphasis on exhortation (42 occurrences).

4.4. Relationships between text themes and pitch diversity

Once the literary themes had been identified and categorized, connections between textual content and pitch diversity could be explored. The following table lists the pitch diversity scores (expressed as average deviations from 8.3%, the percentage of times each pitch appears if the 12 are equally represented) for all subjects without regard to their ranked priority in their respective musical settings, and compares them with the scores of first rank appearances only (i.e., instances where those subjects were considered to be the primary emphasis of their respective recitatives and consequently were entered in the first field of the Subjects window). Some subjects do not appear in the second column because they were never considered a primary emphasis (i.e., never entered in the first rank field). The number of first rank appearances is given in parentheses.

To put these scores in context we remind the reader that average deviation scores can theoretically range from 0 to 15.25 (see note 13). The actual scores of Bach's recitatives range from 2.5 to 7.7. The average (arithmetic mean) of all recitative scores is 4.782. The average score of all subjects appearing in the recitatives (without regard to rank, i.e., recitatives with multiple subjects are represented more than once in the calculation) is 4.755. Generalizations about Bach's predilection with regard to pitch diversity in relation to subject matter become more reliable as the number of occurrences tested increases.[39] Findings demonstrate the following:

Table III. Alphabetical list of subjects with deviation scores (lower scores indicating greater pitch diversity)

Subject	Average score	
	All ranks	First rank only
Adversity	4.09	4.075 (12)
Aid	4.445	6.1 (1)
Ambassador	7.1	
Angels	5.533	4.65 (4)
Anxiety	4.15	
Apostasy	3.35	3.2 (1)
Ascension	5.53	5.6 (5)
Baptism	4.2	
Blessing	4.981	4.96 (10)
Body and blood of Christ	6	
Body and soul	3.667	
Bread of heaven	4.8	
Christ dialogue	5.317	
Christian warfare	4.516	4.633 (9)
Civic	4.888	
Cleansing-blood	4	
Comfort	4.883	5.573 (11)
Commitment to God	5.155	5 (3)
Compassion	5.033	4.8 (1)
Covenant	5.3 (4)	5.7 (1)
Covenant fulfilled	4.98 (5)	4.55 (2)
Covenant fulfilled-shepherd	5.4 (1)	5.4 (1)
Darkness	5.2	5.2 (1)
Death	4.119	4.158 (12)
Devotion	5.036	5.18 (10)
Dialogue	3.7	4.55 (2)
Discipleship	4.557	3.8 (1)
Divine enlightenment	3.825	3.8 (1)
Divine indwelling	5.239	5.478 (9)
Doubt vs. faith	4.75	
Earth vs. heaven	4.85	5.467 (3)
Efficacy of Word	4.68	5.4 (3)
Entreaty	4.644	4.705 (37)
Entreaty in vain	3.838	3.867 (6)
Eternal damnation	3.15	3.15 (2)
Evil world	4.215	4.464 (11)

Table III. (Continued)

Subject	Average score	
	All ranks	First rank only
Exhortation	4.778	5.1 (23)
Faith	4.763	4.375 (4)
Faith vs. works	5.4	5.4 (1)
Fear	4.411	4.6 (1)
Fear vs. comfort	4.133	4.65 (2)
Fear vs. faith	4.55	4.55 (2)
Fear vs. hope	3.4	
Fear vs. joy	5.2	5.2 (2)
Forgiveness	3.917	
Glorification	4.983	4.8 (1)
God	5.042	4.86 (5)
God's love	4.788	4.96 (5)
God's nature	4.9	4.7 (3)
God-shepherd	3.9	
Gospel	4.86	5.8 (1)
Grace	4.457	
Grace in vain	4.08	3.5 (1)
Great Commission	4.3	4.3 (1)
Healing	4.18	
Heaven	5.175	
Human nature	4.114	3.655 (11)
Human reasoning	4.583	4.933 (3)
Imminence	4.425	
Incarnation	5.043	5.075 (12)
Inversion principle	4.7	
Jesus	4.787	4.695 (19)
Jesus-shepherd	5.575	6.05 (2)
Joy	5.113	5.014 (7)
Judgment	4.272	4.156 (9)
Law	4.3	4.2 (4)
Law fulfilled	5	5.3 (1)
Light	6	
Lowliness of humankind	4.91	5.8 (1)
Mercy	4.293	4.15 (4)
Miracles	3.55	
Narration	5.571	5.576 (21)
Nature	5.025	5.05 (2)

Table III. (Continued)

Subject	Average score	
	All ranks	First rank only
No anxiety	3.8	
No mercy	3.7	
No repentance	3.6	
Original sin	4.158	4.225 (4)
Positive	5.4	
Poverty spiritual	4.3	
Praise	5.203	5.14 (15)
Proclamation	4.922	4.867 (3)
Propitiation	4.567	4.167 (3)
Redemption (all)	4.692	5.525 (4)
Rejection of anxiety	6.2	
Renunciation of earthly life	5.093	4.725 (4)
Repentance	4.195	4.333 (3)
Resurrection	5.057	5.075 (8)
Satan	4.277	4.5 (1)
Scripture	5.739	
Scripture-partial	4.3	
Second coming	4.933	
Sin	4.233	4.6 (6)
Spirit	5.7	5.7 (1)
Spiritual nourishment	5.311	
Submission to God	5.058	4.77 (10)
Success	5.6	
Suffering	4.381	4.357 (14)
Transience of earthly life	4.875	4.62 (5)
Union	5.463	5.7 (1)
Victory	4.92	5.2 (1)
Voice of Christ	6.15	7.1 (1)
Voice of God	4.6	5.8 (1)
Weak faith	5	4.3 (1)
Wedding	5.111	5.46 (5)
Word	5.063	5.167 (3)
Worldly honor	4.925	5.65 (2)
Worldly pleasures	4.4	4.4 (2)
Yearning for death	4.6	4.317 (6)
Yearning for God	3.425	
Yearning for heaven	4.621	3.975 (4)
Yearning for Jesus	4.56	4.5 (3)

(1) Emotionally "positive" topics[40] tend to have higher scores (i.e., they are set with less pitch diversity) than average. Striking examples include:[41]

7.1	Voice of Christ (when it is the primary subject)
6.0	Light
6.2	Rejection of anxiety
6.1	Jesus-shepherd (when it is the primary subject)
5.8	Gospel (when it is the primary subject)
5.8	Voice of God (when it is the primary subject)
5.6	Comfort (when it is the primary subject)
5.5 and 5.6	Ascension
5.4 and 5.7	Mystic union
5.4	Efficacy of Word (when it is the primary subject)
5.3	Spiritual nourishment
5.25	Redemption (when it is the primary subject)
5.2	Heaven
5.5 and 5.5	Divine indwelling
5.2 and 5.1	Praise
5.1 and 5.5	Wedding
5.1 and 5.0	Joy
5.0 and 5.2	Devotion
5.0 and 5.2	Word
5.0 and 5.3	Law fulfilled
5.0	Incarnation

(2) Topics with emotionally "negative" components score lower (i.e., they are set with greater pitch diversity). Striking examples include:

3.15	Eternal damnation
3.35 and 3.2	Apostasy
3.4	Yearning for God
3.4	Fear vs. hope
3.6	No repentance
3.6 and 3.9	Entreaty in vain
3.7	No mercy
4.0	Yearning for heaven (when it is the primary subject)
4.6 and 3.8	Discipleship
4.1 and 3.6	Human nature
4.2 and 4.2	Original sin

4.3	Satan
4.6 and 4.3	Yearning for death
4.4	Suffering
4.4 and 4.6	Fear
4.5	Yearning for Jesus (when it is the primary subject)

(3) The "first rank" scores of subjects deviate more from the overall average than do the scores of these same subjects when all ranks are taken into consideration. Apparently the "positive" or "negative" character of these subjects affected pitch diversity to a greater extent when it was the primary idea of the recitative in question. Some examples of striking differences based on rank for "positive" subjects include:

6.2 vs. 7.1	Voice of Christ
5.4 vs. 5.7	Mystic union
5.6 vs. 6.1	Jesus-shepherd
4.9 vs. 5.8	Gospel
4.6 vs. 5.8	Voice of God
4.9 vs. 5.6	Comfort (when it is the primary subject)
4.9 vs. 5.6	Worldly honor[42]
5.4 vs. 5.7	Mystic union
4.7 vs. 5.4	Efficacy of Word (when it is the primary subject)
4.7 vs. 5.25	Redemption (when it is the primary subject)

Some examples of striking differences in score based on rank for "negative"[43] subjects include:

4.6 vs. 3.8	Discipleship
4.6 vs. 4.0	Yearning for heaven (when it is the primary subject)
4.1 vs. 3.5	Grace in vain

(4) There are some anomalies, where scores do not fit the observed pattern.

While "rejection of anxiety" has a high score (6.2), "no anxiety" has a very low score (3.8). Appearing as a subject of "third rank" in Cantata 198, this theme (i.e., absence of anxiety) is clearly overshadowed by the overall funereal tone of the cantata, which was written in 1727 for the memorial service of Christiane Eberhardine, protestant wife of August the Strong.[44]

The discrepancy in the scores for "dialogue" (3.7 for all ranks; 4.6 for the primary rank) is perhaps best explained by the fact that the term is a structural descriptor, not an affective one. Where the primary observation about the recitative concerns its dialogical nature, pitch diversity is average. Where the specific emotional content is more important than the dialogical structure, pitch diversity is great.[45]

Somewhat surprisingly, the score for "healing" is in the "negative" range (4.18). However, in the seven relevant recitatives,[46] "healing" is never the primary subject. Similarly, the presumably "positive" subjects of divine enlightenment (four examples), and miracles (three examples) have scores of only 3.8 and 3.55, respectively. These scores are hard to rationalize since the primary subject descriptors for these recitatives are not necessarily negative either.

"God-shepherd" has a score of 3.9 (but this score is based on a single example and "God-shepherd" is not the primary descriptor). The subject "Great Commission" also scores in the "negative" range (4.3); however, this score, too, is based on a single example in which the term is not the primary descriptor. "Weak faith" has a high score when all ranks are taken into consideration (5); when it is the primary subject it more predicably scores in the "negative" range (4.3).

5. Conclusion

The data provided above demonstrate a clear correlation between pitch diversity and the degree of affective tension implied by particular textual subjects in the vocal lines of Bach's sacred cantata recitatives. Pitch diversity, because it can be empirically measured, provides a useful point of reference in studies of text–music relations. Since more data were generated in this study than could be analyzed here, they promise to form the empirical base for several further studies of the relationships among the various attributes of Bach's cantata recitatives, including the relationships between subject matter and the absolute and relative number of sharped and flatted notes in the vocal line, recitative length, presence or absence of accompaniment, opening and closing keys, and chronological position, among others.[47] The value of the software developed for this study lies not only in the large body of data it generated for this and subsequent studies of Bach's recitatives but also in its potential usefulness for studies of pitch materials and subject matter in other contexts.

Acknowledgements

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Notes

[1] Günther Stiller (1984), *Johann Sebastian Bach and Liturgical Life in Leipzig*, translated by Herbert J.A. Bowman, Daniel F. Poellot, and Hilton C. Oswald, edited by Robin A. Leaver (St. Louis, Missouri: Concordia, 1984), p. 151.

[2] Stiller, p. 143; Melvin P. Unger (1990), *The German Choral Church Compositions of Johann David Heinichen (1683–1729)* (New York: Peter Lang, 1990), p. 64.

[3] However, George Buelow (2001) notes, "a concept of stereotyped musical figures with specific affective connotations never existed in the Baroque composer's mind or in theoretical explanations." See "Rhetoric," in *The New Grove Dictionary of Music and Musicians* II (2001), 21: 269.

[4] Johann David Heinichen (2000), *Neu erfundene und gründliche Anweisung zu vollkommener Erlernung des General-Basses* (Hamburg, 1711, facsimile ed., Kassel: Bärenreiter, 2000), p. 11.

[5] Albert Schweitzer (1962), *J. S. Bach*, trans. Ernest Newman, 2 vol. (London: Breitkopf and Härtel, reissued Boston: Bruce Humphries Publishers, 1962); W. Gillies Whittaker (1959), *The Cantatas of Johann Sebastian Bach*, 2 vols. (London: Oxford University Press, 1959, reissued, 1964).

[6] Jack Westrup (1969), *Bach's Cantatas* (London: British Broadcasting Corporation, 1966, Seattle: University of Washington Press edition, 1969), 17–18.

[7] While it would be informative to know the harmonic function of each pitch, Bach's recitatives are often tonally transient. Documenting the harmonic function of each pitch would be a herculean task, and the results open to debate. It should be noted that other factors such as structural characteristics and evolving styles also contribute to aspects of chromaticism.

[8] A few rare examples of parodied recitatives occur in Cantatas 134 (1724 version; in a later version, Bach composed new recitatives), 173, and 184. If recitatives exhibited primarily arioso characteristics they were usually omitted from this study. Thus, for example, 73/1 was not included.

[9] Robert L. Marshall (1972), *The Compositional Process of J. S. Bach. A Study of the Autograph Scores of the Vocal Works* (Princeton: Princeton University Press, 1972), 1: 90. For a contrary view see Hermann Melchert (1988), "Das Rezitativ der Bachschen *Johannespassion* (Wilhelmshaven, 1988), 152. Cited in Michael Märker (1999), "Johann Sebastian Bach und der rezitativische Stil" in *Bach und die Stile. Bericht über das 2. Dortmunder Bach-Symposion. 1998*, ed. Martin Geck (Dortmund: Klangfarben Musikverlag, 1999), 53–54: "Schon in seiner Grundform, als Idee, [ist das Rezitativ] ... *prinzipiell arios*, textunabhängige Melodie, selbständige Musik."

[10] Marshall, *Compositional Process*, 1: 91.

[11] Marshall, *Compositional Process*, 1: 91.

[12] Marshall, *Compositional Process*, 1: 93.

[13] Marshall, *Compositional Process*, 1: 95–96.

[14] Using Visual Basic.

[15] Microsoft Access.

[16] Melvin P. Unger (1996), *Handbook to Bach's Sacred Cantata Texts, an Interlinear Translation with Reference Guide to Biblical Quotations and Allusions* (Lanham, Md: Scarecrow Press, 1996).

[17] Pitch class refers to the pitch of a note without regard to the register (octave) in which it occurs or its spelling. Thus, for example, all B♭s and all A♯s belong to one pitch class.

[18] Pitches that are identical but have different spellings are called enharmonic equivalents (e.g., A♯ and B♭ when sounded in the same register).

[19] Of course, all 12 pitch classes are not necessarily represented in every recitative.

[20] Counting sharped and flatted notes within a particular recitative without relation to key obviously tells one nothing about chromatic inflection (i.e., notes extraneous to the key) since most keys have sharped or flatted notes as part of their basic series. Furthermore, since recitatives often migrate from key to key, deciding which key should be used as the tonal point of reference at any given moment in a recitative is problematic. Rather, the significance of our totals is that they provide information useful for future inquiries about Bach's possible symbolic intention in using sharps or flats. For example, as numerous writers have suggested, Bach may have intentionally used sharps to denote suffering or "cross-bearing," since the German word for sharp (*Kreuz*) also means "cross."

[21] Average deviation scores can theoretically range from 0 (if all 12 pitch classes are each represented 8.3% of the time) to 15.25 (if a recitative had no pitch diversity at all: i.e., if it consisted of a single repeated pitch class). Of course the latter case is entirely hypothetical: one pitch class would appear 100% of the time (a deviation of 91.7), the others 0% (a deviation of 8.3). The calculation would then be: $((8.3 \times 11) + 91.7) \div 12 = 15.25$.

[22] Developed by Yo Tomita, Queen's University, Belfast. See http://www.music.qub.ac.uk/~tomita/bach-mf.html. A "summary window" appearing at the bottom of the opening screen shows the original symbols (slashes and asterisks) because it is an exact replication of the information in the database.

[23] The movements in question are *BWV* 10/3, 10/6, 33/2, 44/5 (two segments), 67/5, 70/2, 132/2, 163/2, 165/4, 178/2, 180/3, 186/2, and 248/38, constituting 14 additional entries in the database.

[24] "Real pitches" are differentiated on the basis of spelling (but without regard to register). "Pitch classes" are differentiated on the basis of sound alone – a particular class includes all like-sounding pitches regardless of spelling or register. Thus, for example, A♯, B♭ and C𝄫 represent three different "real pitches" but all fall into the same pitch class because they sound the same (the program calls this pitch class A♯).

[25] Categories were invented as the recitatives were studied in succession. Throughout the process lists of subject categories were periodically generated from the database so that similar-sounding descriptors could be identified, and their corresponding recitative texts compared. The descriptors were then refined, and the categories more clearly differentiated or amalgamated as needed.

[26] The program does *not* identify which pitches were stressed (presumably for rhetorical purposes) agogically or melodically. However it does have the potential to answer other questions regarding the relationships among pitch diversity, keys, number of sharped or flatted notes, chronology, voice types, accompaniment (accompanied vs. secco), and subject matter. At the time of writing there are plans to refine the software to allow the identification of augmented fourths and diminished fifths as well as B-A-C-H strings (both transposed and non-transposed).

[27] After describing Bach's Leipzig practice of writing the text out in its entirety before beginning to compose the music (see quotations provided above) he writes, "In the pre-Leipzig recitatives the music was usually written down before the words. (Marshall, *Compositional Process*, 1: 92.)

With regard to accompaniments Marshall notes,

> Accompagnato [i.e., accompanying] parts were not composed until the vocal and continuo parts were already worked out .... The accompagnato parts themselves were filled in from

top to bottom .... The autograph scores of the recitatives reveal, finally, that Bach often thought of the accompanying instruments and hence the basic harmonic rhythm as proceeding essentially in half-note values and consequently composed these parts one half-measure at a time. (Marshall, *Compositional Process*, 1:94–95.)

[28] The pre-Leipzig cantatas scored an average deviation of 5.1, the Leipzig cantatas, 4.7.

[29] See Alfred Mann (1992), *Bach and Handel. Choral Performance Practice* (Chapel Hill: Hinshaw Music, Inc., 1992), 40: "All that the soprano section now had to sing was the plain hymn melody."

[30] The Leipzig *Jahrgang* I scored 4.7, while *Jahrgang* II (the chorale cycle) scored 4.6. The *Christmas Oratorio's* recitatives, on the other hand, evidence less pitch diversity with a score of 5.6.

[31] That is, all 12 pitch classes in no set order.

[32] In Cantata 48, "Ich elender Mensch," a particularly dramatic recitative dealing with the subject of human nature and original sin manifests a disjunct melodic chromaticism so extensive, it incorporates all 12 tones in the first seven measures of the voice part and yet again in the next six. A comparable example is the third movement of Cantata 78, "Jesu, der du meine Seele." The melody of this recitative, too, employs great melodic diversity – it incorporates all 12 chromatic tones in the first seven measures of the vocal part, and does so again in the following seven. The possible symbolic significance of these numbers has been explored in Melvin Unger, "'Ich elender Mensch': Bach on the Soul's Torment," a paper presented at *Passion, Affekt und Leidenschaft in der Frühen Neuzeit*, 11th Congress of the Wolfenbütteler Arbeitskreises für Barockforschung, Wolfenbüttel, April 2–5, 2003 (publication of conference proceedings forthcoming). An expanded version of the article entitled "Ich elender Mensch': Bach on the Soul's Measure" is scheduled to appear in *Festschrift in Honor of Thomas Dunn* (Bloomington, Indiana: Indiana University Press, forthcoming).

[33] An inner span from *BWV* 10/6, for example, is identified as 10/6.1.

[34] See note 25.

[35] The wildcard feature of the program expands its search capability. Since simple subject searches locate only movements whose descriptors in the database are identical to the search string, the wildcard feature must be used to search for single words or parts of a descriptor. The feature is particularly useful for general searches, or where descriptors in the database have been extended with modifiers. Thus, for example, a search for "covenant" does not locate "covenant fulfilled," and a search for "covenant fulfilled" does not locate "covenant fulfilled-shepherd" unless the wildcard feature is enabled. See also Figure 6 for a screen image of a union query done in the Access database.

[36] Since subjects appear in various combinations and in varying degrees of emphasis, a more accurate reflection of subject emphasis might result if each occurrence of a subject were given a weighted score in relation to its priority in the recitative (rank) and the length of the recitative. The scores for each subject would then be totaled, allowing comparison with other subjects. The following formula could be used to arrive at a weighted score:

$$\text{Subject weighted score (for each occurrence)} = \frac{\text{Rank Points}}{\text{number of measures}}$$

(6 for first rank, 5 for second rank, etc.)

[37] To find all examples of a particular concept (whether it plays a primary role in the text or not), the "wild card" feature must be engaged. Using this feature, we can learn, for example, that the concept of "sin" appears in 74 (78 minus 4) records, even though it registers as a fundamental theme in only 15 (17 minus 2) of them.

[38] Since Bach's recitatives vary greatly in length and therefore explore differing numbers of text themes one might want to distinguish between the representation of a particular subject

in relation to the total number of recitatives (provided in Table 2) and the representation of that subject in relation to the total number of subjects explored in all the recitatives. (Theoretically, for example, a subject could appear in 50% of the recitatives but only represent 15% of the total subject entries.) Since the total number of subject entries is given as 1277 the latter percentage can be calculated easily.

[39] The subject "ambassador," for example, appears in only one recitative (*BWV* 32/2). One should not infer too much from its deviation score (7.1) other than that, in this instance, Bach chose to employ considerably less pitch diversity than usual.

[40] The terms "positive" and "negative" are used here in a general sense to indicate polarity. Emotionally "positive" topics reference contexts characterized by happiness, contentedness, hopefulness, etc. Emotionally "negative" topics reference emotional states that are unhappy, unsettled, despairing, etc. Thus, for example, we have called "yearning for God" "negative" because the corresponding texts have little of the hopefulness found in "yearning for heaven" or "yearning for Jesus" texts. Admittedly, calling subjects "positive," "negative" or "neutral" is somewhat speculative since Bach's recitative texts fall on a continuum ranging from clearly positive to clearly negative. Furthermore, some subjects appear in both positive *and* negative contexts. While we have tried to account for secondary or modifying perspectives by ranking subjects with regard to emphasis in each recitative, nuances of emotional explicitness and intensity preclude dividing all subjects into arbitrary categories.

With regard to the dual or ambiguous affects typical of certain subjects, Isabella van Elferen has shown that baroque texts dealing with mystical love often mix sweetness with bitterness. See "'Recht bitter und doch süße': Textual and Musical Expression of Mystical Love in German Baroque Meditations of Christ's Passion" (English version of a paper read at *Passion, Affekt und Leidenschaft in der Frühen Neuzeit*, 11th Congress of the Wolfenbütteler Arbeitskreises für Barockforschung, Wolfenbüttel, April 2–5, 2003, forthcoming in *BACH*, Journal of the Riemenschneider Bach Institute).

[41] Where two scores are given, the second is the "first-rank" score, i.e., the score for instances where the subject in question was the primary one.

[42] These scores are somewhat surprising since the Lutheran position was that worldly honor was fleeting and deceptive.

[43] "Negative" here can simply mean "painful" or "bitter." Thus, in the context of Lutheran theology, "discipleship," with its emphasis on "denying self" and "cross-bearing" is a painful or "negative" subject.

[44] As Electress of Saxony Christiane Eberhardine had endeared herself to her people by remaining true to the Lutheran faith when her husband converted to Catholicism to assume the Polish crown, and she was mourned greatly when she died. While the text of 198/6 emphasizes her serenity in death (by which she nobly exemplified the "ars moriendi"), this theme is overshadowed by the mournful cast of the entire libretto – a funeral ode by Johann Christoph Gottsched. The cantata has four recitatives, whose pitch diversity deviation scores are all low: 2.9, 3.4, 3.8, 4.8 (an average of 3.725). Since the texts are all basically laments, these scores are not surprising, the princess's lack of anxiety notwithstanding.

[45] One could surmise that the high degree of pitch diversity is due to the nature of the subject matter; in part it may also be the result of tension inherent in dialogue.

[46] *BWV* 17/4, 23/2, 25/4, 35/6, 48/5, 135/2, 165/4.

[47] Some questions that bear investigation are: Did length of recitatives change with time? Did type of subjects change with time? Did the number of subjects within a single recitative change with time? Are there demonstrable relationships between keys and subjects? Are there more augmented fourths or diminished fifths for certain subjects? Where (if at all) do B-A-C-H strings (non-transposed or transposed) appear?

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