

# LITURGICAL CONDITIONS OF CATHOLIC AND REFORMED CELEBRATIONS AND THEIR RELATIONSHIP WITH ARCHITECTURAL AND ACOUSTICAL CHARACTERISTICS OF CHURCHES

PACS REFERENCE: 43.55.Gx

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## ABSTRACT

Liturgical differences between Catholic and Reformed celebrations in Switzerland were studied by a temporal analysis of 16 worships. The importance of speech, music, and silence and the participation of the priest, assembly and organist are analysed. Data from 190 churches show that Reformed churches present a smaller average volume, a denser occupation of space and a shorter reverberation time than Catholic churches. The geometrical and acoustical characteristics of Reformed churches favour speech intelligibility whereas music is advantaged in Catholic churches, which agrees with the observed liturgical differences.

## INTRODUCTION

To determine the desirable acoustical conditions of a church, it is necessary to precisely know their conditions of use. Many are the theories and opinions that circulate over the distribution and the duration of the various types of interventions during Sunday celebrations in churches. However, in the absence of objective data, those cannot be checked. The first part of this study, based on the temporal analysis of sixteen Christian Sunday services in Switzerland [1], tries to objectively describe the duration of the activities in those services and to analyze the differences between Reformed worships and Catholic masses, and also between standard and festive celebrations. The importance given to the various types of activities (speech and music) and to the various participants (minister, reader, organist and assembly) are also analysed. The second part of this study analyzes, on the basis of statistical analysis of 190 churches in Switzerland [2, 3], how these liturgical differences are translated at the architectural and acoustical level.

## ANALYSIS OF THE LITURGIES

To objectively determine the duration of the various interventions during religious celebrations a statistical analysis was done for the temporal distribution of the liturgical activities by a detailed study of sixteen services (eight Reformed worships and eight Catholic masses).

Only the relatively standard liturgies were taken into account (the celebrations including more particular interventions like baptisms or weddings were discarded). The celebrations were generally recorded, with a post-analysis. This study does not analyze the chronological course of the celebrations but tries only to temporally quantify the various types of interventions. This study concerns only the accumulated duration of the various types of activities during a celebration. A distinction was made according to the religious confession (Catholic or Reformed/Protestant) and to the various participants (minister, lay-officiants, musicians and congregation).

According to a statistical analysis, a **standard Reformed worship** lasts on average a little more than  $56 \pm 8$  minutes [in our notation,  $\pm n$  will represent  $\pm 1$  standard deviation of the sample values]. It is possible to distinguish three groups of equal duration in a Reformed worship (Figure 1) such as preaching, the other spoken interventions (speech, spoken liturgy, readings and prayers) and the musical parts (hymns of the assembly and organ). The preaching, with a third of the total duration, remains the principal part of a standard Reformed worship, but it varies from one worship to another (between 24% and 39% of the total time) and can last less than 13 minutes to more than 25 minutes. The musical parts are shared equally between the choral singing of the assembly ( $18 \pm 5\%$  of the total time, on average) and the organ music ( $17 \pm 4\%$ ). Little space is left for "silence" in the Reformed worship (1% of the total duration). In a general way, the structure of worship is relatively simple, and it is made of long interventions with few changes of speakers. The structure of the worship, relatively free, can vary substantially from one celebration to another.

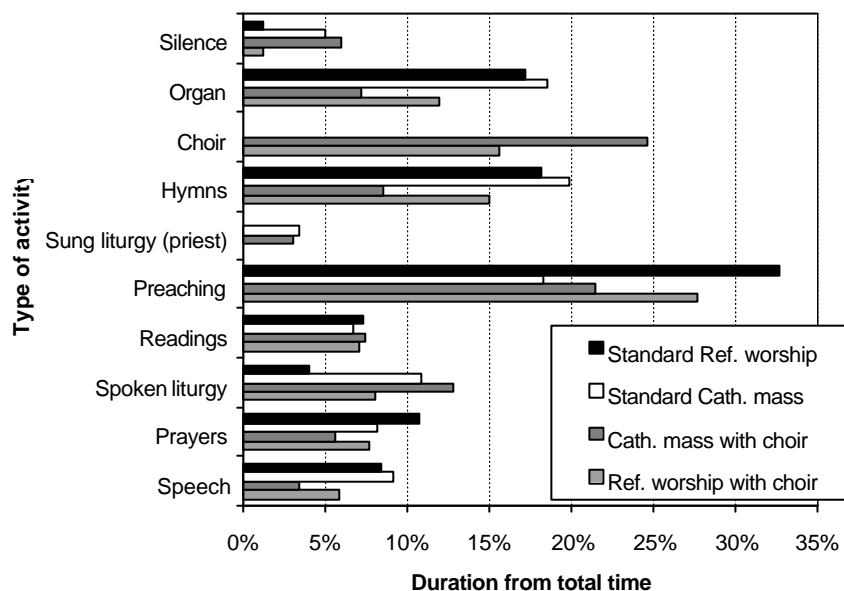


Figure 1 - Temporal distribution of the liturgical activities during Reformed worships and-Catholic masses (average values)

The average duration of a **standard Catholic mass** (without choir) is comparable to a standard Reformed worship ( $55 \pm 6$  minutes). At a mass, one can schematically distinguish four groups of activities of about equal duration (Figure 1): the spoken interventions, in particular liturgical (speech, spoken liturgy and prayers); the Scriptures readings and the homily; the sung parts (hymns of the assembly and sung liturgy) and the more contemplative moments (organ or silence). The mass is particularly distinguishable from a Reformed worship by the abundance and the richness of the liturgical interventions (in particular those sung by the priest, 3% of total time, but up to 9% in the conservative liturgies). The statistical analysis shows indeed that the spoken liturgical interventions are much more significant in the Catholic masses (11% of total time on average against 4% for a Reformed worship). The prayers are as numerous but generally shorter and last less than in the Reformed worships (8% of total time on average against 11% for a worship). The duration of the homily is definitely shorter (6 to 18 minutes) than the Reformed preaching, but it varies even more from one mass to another (between 10% and 30% of total time, the standard deviation between masses being 8%). The musical interventions, longer than in the Reformed worships, are shared equally between the choral singing of the assembly (20% of total

time on average) and the organ pieces (19%). The duration of hymns sung by the assembly (including the sung liturgical interventions) and the interventions of the organ (between 13 and 27% of total time) vary from one parish to another. Contrary to the Reformed worship, the Catholic mass leaves more space to silence (5% of the total duration). The structure of the mass, which seems more complex and more dynamic than the Reformed worship, has only small variations from one celebration to another.

The **presence of a choir**, generally in the more festive celebrations, changes somewhat the course of a Sunday service. When it is present, a choir takes an active part in the celebration, particularly in the Catholic masses (25% of total time, 16% for the Reformed worships). The organist, leads the hymns, reduces his/her participation as a soloist, particularly in the Catholic masses (from 19% without choir to 7% with choir, and from 17% to 12% in a Reformed worship). It is also in the masses that the presence of a choir involves the greatest reduction in the hymns sung by the congregation (from 20% without choir to 9% with choir, and from 18% to 15% in a Reformed worship), because the choir now sings most of the liturgy usually sung by the congregation. The participation of a choir induces a decrease in the duration of speech, especially in the masses (drops by 6%; 2% for the Reformed worships) and also for the prayers (drops by 2% for the masses and 3% for the worships). The greeting, gathering and the dismissal are then prolonged in a certain way by the intervention of the choir.

The choir induces a decrease in the length of preaching in the Reformed worships (from 33% to 28% with choir) that can be explained by the need to release time for the choral interventions by concentrating the message of preaching. On the contrary, the homily lengthens in the Catholic masses with choir (from 18% to 21% with choir), which are more solemn and where the priest takes more time to deepen into his message. Only the spoken liturgical elements become more consequent in the presence of a choir, in particular in the Reformed worships, which is explained by the more festive and solemn aspect of the celebrations which translates by a reinforcement of the liturgical interventions (spoken but also sung) and in particular by the celebration of the Last Supper in the analyzed worships. Lastly, the presence of a choir does not affect the liturgy sung by the priest or the duration of the silences.

The analyzed categories were then joined together in three groups consisting, in part, of activities based on a cognitive communication asking for a good speech **intelligibility** and, on other, by the activities based on a more emotional approach (**music**) asking for a certain environment, resulting in particular from the rather long reverberation in the church and finally in the moments of **silence**, supported by a sufficiently low background noise.

The results of this research show (Table 1) that the principal place is given to the activities related to speech and this, whatever the celebration. This tendency is however definitely more marked in the standard Reformed worships (63% of the total time consists of speech) than during the standard Catholic masses (53%). The standard masses leave more space to music and silence. These distributions however, vary from one celebration to another (the standard deviation among celebrations by the spoken and musical contributions is 8% for the Catholic masses and 6% for the Reformed worships). The participation of a choir appreciably increases (7%) the contribution of the musical elements in the worships, but it has only a little influence in the distribution at the Catholic masses.

Table 1 - Distribution for speech, music and silence (average values)

	Speech	Music	Silence
Reformed standard worship	63%	36%	1%
Catholic standard mass	53%	42%	5%
Catholic mass with choir	51%	43%	6%
Reformed worship with choir	56%	43%	1%

The analyzed categories were also divided into four groups according to the type of **participants**. We distinguished the ministers, the participants (lay-readers), the musicians (organist, eventual instrumentalists and choir) and the congregation.

At a standard Reformed worship, the minister intervenes more than half the time (53%), which is definitely more than the assembly (19%), the organist (17%) or the participants (9%). The congregation, which gets involved less than one-fifth of the total time, is thus relatively passive keeping in mind that an attentive listening obviously constitutes a form of participation.

Contrary to all expectations, the priest, in spite of his significant implication at the liturgical level (in the form of speech as well as singing), intervenes less during the Catholic mass (45% of the total duration), leaving more space to the participation of the congregation (25%) and to the organist (19%). The place left to the worshipers during a standard Catholic mass is due to the systematic presence of dialogued parts (spoken or sung responses) and of liturgical texts recited by the worshipers (Creed, Our Father, etc.). Owing to the fact that the priest carries out the reading of the Gospel, the participation of a reader is slightly weaker in the Catholic mass (7%) than in the Reformed worship. The presence of a choir induces a clear increase in the participation of the musicians (32% of the total time in the masses, 28% for the worships) that is done with the detriment of the participation of the worshipers (reduction of 15% for the masses, but only 3% for the worship), especially in the sung parts.

This analysis of the liturgical characteristics of the Reformed worships and the Catholic masses made it possible to objectively show the significant proximity between these celebrations and a few small denominational specificities. The importance given to speech and music, closely equivalent in the two confessions, shows the current similarity of the acoustic requirements for the Protestant and Catholic churches.

## ARCHITECTURAL AND ACOUSTICAL CHARACTERISTICS

The statistical analysis of 190 churches in Switzerland [2, 3], makes it possible to study, at the architectural and acoustic level, the denominational differences in churches, generally built at times when the liturgical differences were much more significant.

By analyzing the variations of the room **mean volume** according to the confession, it was noted that the Protestant churches (in particular those built after the Reform) are, on average, smaller than the Catholic churches (3864 m<sup>3</sup> against 5793 m<sup>3</sup>), of which there are more examples of buildings with a large size (> 5000 m<sup>3</sup>).

The **average height** of the Catholic churches (9.0 ± 3.2 m) is, in general, larger than that of the Reformed buildings (8.2 ± 3.2 m). The most frequent heights are 5 to 6 m for the Reformed churches and 7 to 8 m for the Catholic churches. The extreme heights (less than 3 m and larger than 20 m) are a prerogative of the Catholic churches.

The Reformed churches generally have a rather low **specific volume**, the majority of them having 5 to 8 m<sup>3</sup>/person (some have even less than 4 m<sup>3</sup>/person and only a very few exceed 19 m<sup>3</sup>/person). The Reformed churches present a rather dense occupation of space, which favours speech intelligibility when the church is fully occupied. The Catholic churches, on the contrary, have generally a more significant specific volume, typically from 8 to 10 m<sup>3</sup>/person, which is more favourable for music. The variation is relatively weak at Romanesque and Gothic times, but it increases with the Baroque, when the tendencies adopted by the two confessions were opposite. The Reformists densified the occupation of space (average of 7 m<sup>3</sup>/person) whereas the Catholics notably increased the size and specific volume of their churches (average of 26 m<sup>3</sup>/person). Later, the differences between confessions became again less significant (variation of the means of 5 and 3 m<sup>3</sup>/person in the Neoclassic and Modern times, respectively).

With regard to the **spatial arrangement of the assembly** (Table 2), the majority (71%) of churches in Switzerland show a longitudinal seating distribution. This proportion is slightly more significant in the Catholic (74%) than in the Reformed churches (69%). The remainder of churches is equitably divided, among the orientations in "fish-bone", quadrangle and half-circle.

These proportions vary somewhat according to the time of construction of the churches. Among modern churches, there is a reduction in the longitudinal orientation, which remains however preponderant (59%), as well as the orientation in quadrangle (4%). The modern buildings show an increase in the orientations in half-circle (22%) and "fish-bone" (15%). The orientation in quadrangle, whose origin comes from the first churches adapted or built after the Reform, is more widespread (19%) among the Protestant churches of the Baroque.

Table 2 - Statistical results of the spatial orientation of the assembly

Orientation	Catholic	Reformed	Total
Long	74%	69%	70%
Fish-bone	8%	10%	10%
Quadrangle	9%	9%	9%
Half-circle	9%	12%	11%

The mean values of the **reverberation time** (average value of the octave bands centred on 500 and 1000 Hz) according to architectural style and confession appear in Figure 2.

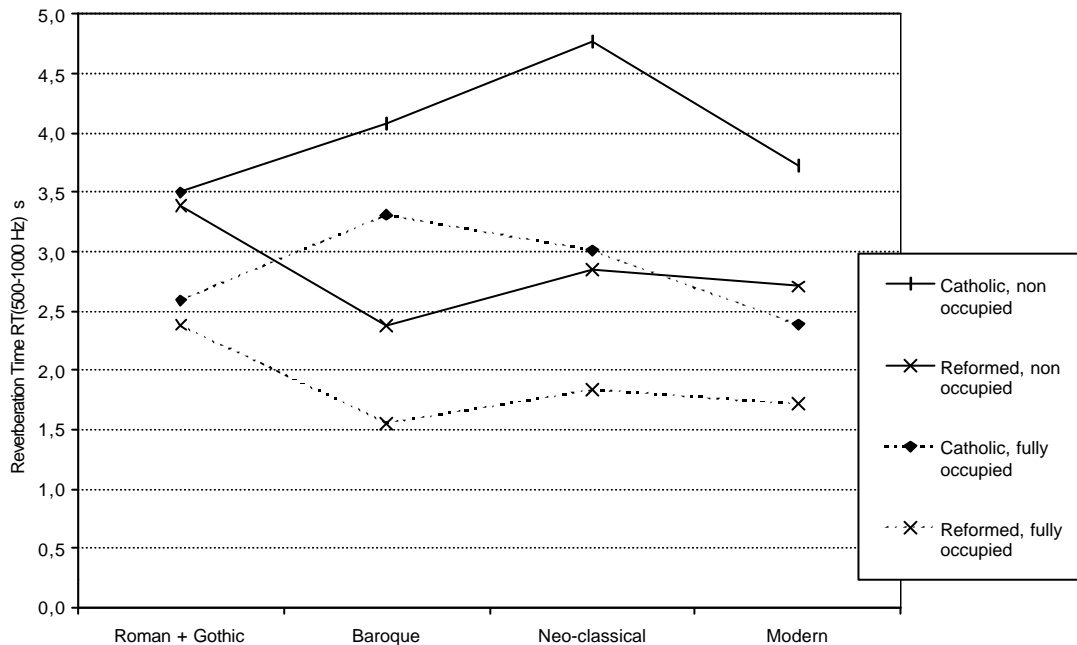


Figure 2 - Mean reverberation time (500+1k Hz) according to architectural style and confession

The results confirm the assertion that reverberation time is normally longer in Catholic than in Reformed churches. This conclusion applies however only for churches built after the Reform (the Romanesque and Gothic churches were built before the schism of the beginning of sixteenth century). This difference between confessions confirms that the Reformed worship that gives more importance to speech (and to its comprehension) privileged a rather dry acoustics (with a weak reverberation time). On the contrary, the Catholic mass that privileged the ambience (in particular musical) led to the construction of more reverberating churches. The Second Vatican Council, which involved a profound change of the liturgy and design of Catholic churches, introduced an increased need for speech intelligibility. That resulted in an increase of the number of seats, a reduction of the average volume and a decrease in the reverberation time in the churches (average of 3.7 s for non occupied and 1.5 s to occupied churches in the tested sample). The mean reverberation times in fully occupied churches in the two confessions then tends to draw closer. At the level of the spectral evolution of the reverberation time, Catholic churches present a reduction a little faster at the higher frequency-bands but less important at the low frequencies than Reformed churches, which is explained by the significant volume and reverberation of Catholic churches.

By comparing **intelligibility** (RASTI) according to the confession (Table 3), it was found that it is better in Reformed than in Catholic churches, and this, with or without a sound system. This observation is explained by the fact that Catholic churches have, on average, a higher reverberation time and a more significant area than Reformed churches. The values of speech intelligibility in the empty churches are, in all cases, very weak [4].

Table 3 - Speech intelligibility (RASTI - average values) according to confession

Confession	Without sound system			With sound system			Mean Improvement (=RASTI <i>with</i> - RASTI <i>without</i> )
	min.	max.	avg.	min.	max.	avg.	
Catholic	0.32	0.46	0.37	0.35	0.47	0.41	0.04
Reformed	0.39	0.51	0.44	0.41	0.54	0.48	0.03

## CONCLUSION

In general, the structure of the Reformed worship is simple (rather long interventions with few changes of speakers) and rather flexible (many possible variations from one celebration to another). On the contrary, the structure of the Catholic mass is more complex and dynamic (fast succession of relatively short interventions with many changes of speakers) but more rigid. The Reformed worship is divided equally between preaching (which remains the essential and central worship point with one-third of the total time), other spoken interventions (speech, spoken liturgy, readings, or prayers) and musical parts (hymns and organ). The Catholic mass, which is characterized by its liturgical richness, can be divided in four equal parts between spoken interventions, in particular liturgical (speech, spoken liturgy, and prayers), the Scripture readings and homily, sung parts (hymns and sung liturgy) and the more contemplative moments (organ or silence). The standard celebrations (in the absence of a choir) are made up, especially in the case of the Reformed worships, of spoken interventions. The standard Catholic masses leave more space to music and silence. The participation of a choir appreciably increases the contribution of the musical elements at the Reformed worships, but it has only little influence in the distribution between speech and music at the Catholic masses. At the common Reformed worship, the minister intervenes more than the priest during a Catholic mass in spite of his significant implication at the liturgical level.

The statistical analysis of 190 churches in Switzerland shows that the liturgical differences between Catholics and Protestants, which were more significant in the past, result in architectural and acoustical specificities according to the confession. Indeed, on the architectural level, Catholic churches are in average larger and higher than Reformed churches. The specific volume is larger there and the assembly is more often directed longitudinally.

At the acoustical level, Catholic churches show, on average, a higher reverberation time than the Reformed churches, which results in weaker speech intelligibility. These differences at the architectural and acoustical level confirm that Catholic churches favour the music whereas Reformed churches support more the speech.

However, the comparison of both current liturgies do not show, any more, very significant differences between Catholics and Protestants, mainly because of the importance given again to speech after the Second Vatican Council of the Catholic Church. It seems then necessary to adapt the acoustic conditions of Catholic churches to this liturgical revolution, like the Protestants did it after the Reform a few centuries ago.

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