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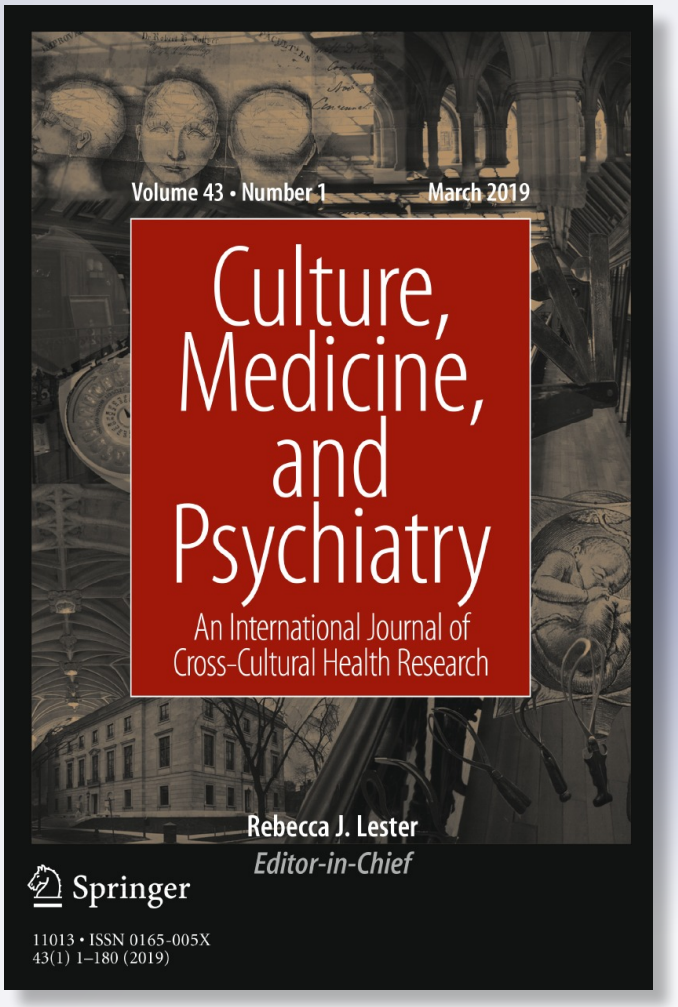
Culture, Medicine, and Psychiatry
An International Journal of Cross-Cultural Health Research

ISSN 0165-005X
Volume 43
Number 1

Cult Med Psychiatry (2019) 43:4-24
DOI 10.1007/s11013-018-9593-8



Springer

Cult Med Psychiatry (2019) 43:4–24
https://doi.org/10.1007/s11013-018-9593-8

ORIGINAL ARTICLE

Magic Moments: Determinants of Stress Relief and Subjective Wellbeing from Visiting a Cultural Heritage Site

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Published online: 12 July 2018

Abstract We provide an experimental evaluation of the impact of aesthetic experiences in terms of stress reduction (cortisol levels) and wellbeing increase. The test experience is a visit to the vault of the Sanctuary of Vicoforte, Italy. Data have been collected using a double step method. A structured interview in relation to the individual subjective well-being has been administered to a sample of 100 subjects. In addition, a sample of their saliva has been taken, and its cortisol level measured, before and after the experience, and likewise for momentary wellbeing measured on a Visual Analogous Scale. Subjects reported an average increase of 40% in well-being and a decrease of the 60% in the cortisol level. The recorded cortisol level values dropped on average well beyond the decrease normally associated to its circadian cycle. The modulating role of various variables has been appreciated, and profiling of the typical subjects who are wellbeing respondents/non-respondents and cortisol respondents/non-respondents has been carried out. We conclude that aesthetic experience seems to have a noticeable impact on individual physical and mental health. In both dominions, cultural participation intensity is significantly correlated to the response. The study underlines the potential of the arts and culture

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as a new platform for public health practices and new approaches to welfare policy design.

Keywords Culture · Heritage · Physical health · Mental health · Wellbeing · Cortisol · Stress

Introduction

The evaluation of the effects of the arts and culture on different aspects of human health has attracted an increasing attention in recent years (Bradt 2010; Vickoff et al. 2013; Bavishi, Slade, and Levy 2016; Sinclair et al. 2016; Hanna, Noelker, and Bienvenu 2015; Torrissen 2015; Archibald, Scott, and Hartling 2014; Anguera et al. 2013). Building on this rich, diverse although still fragmentary evidence, there is scope to affirm that the arts and culture may indeed have some positive impact on individual physical health (van der Heijden et al. 2015), mental health (Sapouna and Pamer 2016; Crociata, Agovino, and Sacco 2014), and wellbeing (Arts Council England 2014; Editorial 2014; Rapacciuolo et al. 2016). Consequently, the inclusion of arts and culture in therapeutic schemes to improve individual health conditions and wellbeing has become increasingly frequent, if not fully established yet. This is the result of a joint effort of cultural organizations focused on health-related art projects, and of selected health organizations that are successfully experimenting with arts and culture programs and even protocols in their daily practice (Daykin et al. 2016; Arts-in-health 2016).

The positive impact on arts and culture participation (and more generally leisure time) on health—and even life expectancy—has been confirmed by influential longitudinal studies (Konlaan, Bygren, and Johansson 2000; Konlaan, Theobald, and Bygren 2002), although the actual mechanisms at work still have to be clarified to a large extent. To the current state of knowledge, the channels through which arts and culture participation affects human biology are almost unknown, with partial exceptions such as the characterization of the neural pathways through which music affects the brain and allows rehabilitation (Särkämö et al. 2016). In this experimental study, we make a further step in the direction of the identification of actual physiological mechanisms through which arts and culture participation, and in particular their aesthetic dimension (Goldman 2001), affect human health and well-being, and relieve stress—focusing in particular on visual art experiences in a strongly characterized cultural heritage environment. Our aim is to describe potential determinants of subjective psychological response to visual aesthetic stimuli, in comparison with potential determinants of unconscious stress relief as reflected in (non-physiological) low salivary cortisol levels.

We can define visual aesthetic response as a pleasant sensory reaction, and related neurophysiological activity, to certain visual stimuli (Ulrich 1986). Recent studies have shown how aesthetic visual stimuli may be very beneficial for the physical and mental health of elderly (Reynolds 2010) or deprived (Renton et al. 2012) subjects, as well as of help in coping with severe chronic illness (Reynolds, Vivat, and Prior 2011).

The literature on the biological correlates of affective states, such as for instance the biological bases of the sense of well-being elicited by the emotional appreciation of culturally conspicuous settings, is still quite poor, however, if compared for instance with long-established research on the stress-reducing effects of exposure to natural environments (Ulrich et al. 1991). For example, literature concerning the effect of exposure to visual arts in terms of the blood levels of salivary cortisol, a well-known stress hormone (Maina, Palmas, and Filon 2008; Marchand, Durand, and Lupien 2013; Herman et al. 2005), is still lacking. There is, on the other hand, some research on the effects of exposure to music (Swaminathan and Schellenberg 2015), and in particular of its neurochemistry (Chanda and Levitin 2013) and of its psycho-neuro-immunological (Fancourt, Ockelford, and Belai 2014) and metabolic (Yamasaki et al. 2012) effects, and it has been found that music listening causes a reduction in stress levels, with a relevant mediating role of the social context (Linnemann et al. 2015; Linnemann, Strahler, and Nater 2016), and of musical education (Cervellin and Lippi 2011). These results provide a medium-specific elaboration of by now classical evidence (Konlaan, Bygren, and Johansson 2000) of the positive effects of physical exercise and cultural participation on the levels of blood lipids, blood pressure and prolactin, and of the possible pathways of the positive influences of participating in cultural activities via stress reduction that decreases the oxidative DNA damage and the formation of 8-hydrox-ydeoxyguanosine, whose high levels tend to be associated to increased susceptibility to diseases.

Clearly, well-being and stress are related conditions to some extent, as it is unlikely that a stressed out individual will report a high level of well-being. The available evidence confirms this intuition: high well-being is associated to low cortisol levels (Lindfors and Lundberg 2002). However, the *response* of well-being and cortisol levels to a specific, given stimulus need not be correlated, let alone equally relevant. It is therefore interesting to ask whether, and to what extent, specific forms of cultural participation reflect into significant variations of well-being and cortisol levels, and what are the variables that mediate such response.

In this study, we address such question by exploring the neuroendocrine and psychological correlates of a visual cultural/aesthetic experience, as a possible basis for evaluating the effects of simple cultural participation initiatives aimed at improving individual physical and psychological health. Our study may be regarded as an exploratory attempt at assessing the potential contribution of arts and culture to future welfare policies.

Methods

The Experiment: Context

Our experiment has involved a group of 100 volunteers that have been exposed to an intense cultural and aesthetic experience: a close encounter with the frescoed vault of the Vicoforte Sanctuary in Vicoforte, Piedmont, Italy. This vault is the largest known elliptical one in the world, and its spectacular religious-themed frescoes date

back to the mid-18th century. The vault has been recently restored and opened to the public in the context of the Magnificat project which, on a daily basis from April to October, offers to pre-booked visitors, 20 at a time, the possibility to participate in a guided visit to the vault, which includes the ascent to the church's upper levels so as to allow a close view of the frescoes. Our experimental subjects have thus been divided into groups, all of which participated in a visit session held in May 2016. All subjects were previously exposed to a historical introduction to the church's architecture and frescoes, provided by a specialized guide.

(Lack of) Controls

We are fully aware of the fact that the conventional procedure in an experiment like the present one would be to test our results against those of a control group. However, in this specific context carrying out a proper control is more problematic that it could seem. What the control group should be doing is, literally, remaining in a closed environment without any kind of aesthetic stimulus for the same amount of time spent by our experimental subjects in the vault. This would be a frustrating, extremely boring experience that would make the comparison with the experimental one biased in principle, with a likely *negative* impact on psychological mood and stress levels. Moreover, it would establish an unfairly favorable benchmark for our experiment: rather than sitting still and doing nothing for a long while, *almost every reasonably pleasant experience* would then be preferable in terms of subjective wellbeing and stress response. Finding a substantial improvement of the two experimental variables on the basis of this kind of benchmark would then be not very informative, let alone conclusive, as to the wellbeing and stress relief impact of our visit.

For this reason, we have chosen to benchmark our results against the experimental subjects' own wellbeing and stress values *before* the visit, keeping into account the circadian variation of cortisol levels, as described below. We do not rule out the possibility of building sophisticated controls for similar experiments in future research, but doing it in this first study could have easily led to drawing attention away from the experiment's core rationale, to focus instead upon the kind of control that was actually used as the benchmark.

Design

The study adopted an observational cross-sectional approach. The sample has been recruited on a voluntary basis among individuals visiting the Sanctuary or residing in its vicinity. Participants were identified and asked to fill a self-administered questionnaire. A full collection of socio-demographic data, habits, health condition, and lifestyle has been thus obtained. Participants have been divided into small groups of 10–15 subjects led by facilitators, who guided them into the experience. The distribution of subjects in subgroups was carried out without an a priori stratification, but according to the original reservation timing. Therefore, the groups typically included a certain number of family or friend connections. Seven groups in total were formed, three of which visited the Sanctuary in the morning and four in

the afternoon. The proportion of men and women and mean age were quite homogeneous across groups, without statistically significant imbalances. As access to cultural heritage sites has an inevitable social dimension, we did not specifically control for group effects.

Participants have been probed on four different dimensions:

A. *Wellbeing*
   - A1 The steady state individual subjective wellbeing referred to previous 4 weeks has been evaluated by means of the *PGWBI—Psychological General Well-Being Index,* a tool that has been validated by decades of clinical practice (see (Dupuy 1990) for a general presentation and a historical account of its development). The PGWBI has been originally developed as a tool to measure self-representations of intra-personal affective or emotional states reflecting a sense of subjective well-being or distress, and thus captures what we could call a subjective perception of well-being. Here, we have adopted the short form of PGWBI, consisting of a subset of six items that have been shown to explain more than 92% of the global variance of the data. This short version has been validated in a long-term project carried out from 2000 to 2006 in Italy (Grossi et al. 2006).
   - A2 The individual wellbeing referred to momentary status has been evaluated with the *Wellbeing visual analogue scale* (*VAS*). The VAS is a 10-cm long scale with two anchor points (wellness absent–maximum imaginable wellness) placed at both ends. Subjects are asked to position themselves on the level between 0 and 100 mm that they feel as corresponding to their current mental and physical state, in response to the question: Indicate the position on the line between the two extremes which is equivalent to your state of wellbeing at this time. The mean a priori VAS levels of the seven groups ranged between 51.04 and 65.38 mm. The mean a priori VAS value in the morning groups was 57.34, whereas it was 59.33 in the afternoon groups.

B. *Cultural participation* We have collected information on the cultural participation of subjects as a basis to assess their individual propensity to, and familiarity with, cultural experience. In this regard, 15 different form of cultural experience have been surveyed, in line with the prevailing practices in the relevant cultural participation literature, namely attendance in the previous year of: Jazz music concerts, Classical music concerts, Opera/ballet, Theatre, Museums, Rock concerts, Disco dance clubbing, Art exhibitions, Sport games, Movies, as well as number of novels and poetry books read in the last year, and Social activity and Local community events participation in the last year. Each subject had to fill a structured questionnaire on the daily frequency of access to all the activities listed above. The intensity of access to a specific cultural activity could thus be measured on a quantitative scale ideally ranging from 0 to 365. The cumulated sum of all undertaken activities is interpreted as a (general) cultural participation index.

C. *Religion* As reported in several studies, religious attitudes have substantial implications for both physical and psychological health and coping with pain

(Rippentrop et al. 2005; Wieck et al. 2009). In this perspective, the level of religiosity of subjects has been evaluated by means of the Italian version of the Duke University Religion Index (DUREL) Questionnaire, developed at Duke University (Koenig and Büssing 2010). DUREL is a five-item measure of religious attitude, and was developed for use in large cross-sectional and longitudinal observational studies. The instrument assesses the three major dimensions of religiosity that were identified during a consensus meeting sponsored by the National Institute on Aging, namely: organizational religious activity, non-organizational religious activity, and intrinsic religiosity (or subjective religiosity). The DUREL measures each of these dimensions by a separate subscale, and correlations with health outcomes should be analyzed by subscale in separate models

Subject Recruitment Criteria

Subjects included in the study conformed to the following criteria: age between 18 and 75 years; consent to voluntary participation; willingness to sign the informed consent form in advance of any of the procedures of the study, including the authorization to the processing of personal and sensitive data. In the absence of one of the above listed requirements, subjects were excluded from the study, with one exception: for opportunity reasons, we decided to accept also people over 75, up to a maximum age value of 81.

Experimental Setting

The recruited subjects were divided into groups of approximately 15 subjects, led by a guide/facilitator. The evening before the ascent to the vault, and half an hour after the descent, subjects were asked to carry out a VAS test specifically designed to measure their momentary psychological well-being. We avoided measuring the baseline level just before the ascent, since the expectation and the excitation for the event would possibly bias perceived wellbeing. Subjects were also instructed to provide two saliva samples at two different moments, before the ascent to the vault, and just after the descent. The subjects were then led by the facilitator to the upper level of the church, where they spent 2 h admiring the frescoes from a close view (see Fig. 1).

Thirty minutes before providing their saliva samples, subjects were also instructed not to eat any major meal, smoke cigarettes, drink caffeinated beverages (e.g. tea, coffee, soft drinks) or fruit juices, consume dairy products (e.g., yoghurt, milk, cheese). Saliva was collected using Salivettes (produced by Sarstedt, Ville St-Laurent, Quebec, Canada) using the pure-spit method, whereby a small quantity of saliva is guided by a straw into a tube. Samples were frozen at − 20 °C in a portable freezer, and then stored in an industrial − 20 °C freezer until final cortisol determinations.

Measurement of salivary cortisol values was carried out at the central Santa Croce Hospital laboratory in Cuneo, according to a high quality, validated method,

Fig. 1 The vault's frescoes, completed in 1752 by Mattia Bortoloni, a Rococo painter, and Felice Biella, a Milanese artist

i.e. the electro-chemiluminescence immunoassay ECLIA in use on immunoassay COBAS E. The test employs a monoclonal antibody directed specifically against the cortisol. The endogenous cortisol sample, separated from the binding proteins via danazol, competes with the cortisol derivative, exogenously added in tests and labeled with a ruthenium complex-a), for the biotinylated antibody binding sites. Frozen samples were brought to room temperature to be centrifuged at $15{,}000 \times g$ (3000 rpm) for 15 min. The range of detection for this assay is between 0.012 and 3 dl, and is assayed in duplicates that are then averaged.

Statistical Analysis

Statistical analysis was performed by means of SPSS 17.0 statistical package. Results are expressed as mean ± SD. Categorical variables were compared by χ^2 tests. Comparison of continuous variables among the different groups at follow-up was performed using one-way ANOVA followed by Bonferroni test, as appropriate. Either Pearson or Spearman correlation, as appropriate, tested the associations between variables.

In addition, a mapping method was employed in order to measure the *n*-to-*n* strength of association between variables. The semantic connectivity mapping method used was auto-CM (Buscema et al. 2008; Buscema and Grossi 2008), an ANN with especially high and robust performances in various kinds of classification and data mining tasks compared to more traditional computational methods (Buscema and Sacco 2016). Auto-CM produces a powerful graph-theoretic representation of the associations among variables, the minimum spanning tree (MST), where strengths of association are naturally translated into distances along the graph. This allows an intuitive and easily accessible visual mapping of the interdependences among variables.

Results

Sample Characteristics

As explained above, the study sample consisted of 100 subjects living in the area of the Cuneo Province of Piedmont, Italy, in the close vicinity of the Vicoforte Sanctuary or, otherwise, in the local surroundings. The effective age range of the sample was 19–81, of whom 49% female and 51% male. The average educational level was quite high in comparison to the national figures, with a remarkable share of university graduates (42%). In terms of occupation, a considerable portion of the sample is made of white collars, with only a minority of blue collars. Physical health of participants was also good on average, with only 11% of the sample reporting more than two concomitant diseases, and just 5% reporting three or more. With reference to the PGWBI and DUREL scales, the level of psychological wellbeing as measured through the short form of PGWBI resulted on average lower than that of the Italian population (70.8 vs. 78, respectively), and likewise for the cultural participation index (72 vs. 109, respectively). The religiosity index was also relatively low, although, as to this particular aspect, data at national level are lacking. Table 1 reports the main sample characteristics. For some categories, percentages do not sum up to 100% because of a few missing data.

Wellbeing Levels on the Evening Before the Experiment

Figure 2 shows the distribution of the Visual Analogue Scale (VAS) values for the measurement carried out the evening before the experiment. The distribution is bimodal, and reflects the different distribution of the values in the two genders, with higher values in females.

Salivary Cortisol Values Before the Experiment

In 26 out of 100 subjects, salivary cortisol levels were lower than the determination threshold of the method (0.05 μg/dl). Therefore, the analysis of the cortisol levels only considers the 74 subjects for whom salivary cortisol values were above threshold (36 females and 38 males). The average value was equal to 0.23 μg/dl, corresponding to 6.34 nmol/liter. The average value of the morning samples was equal to 0.26 μg/dl. Only four cases had undeterminable values. The average of the afternoon samples was 0.11 μg/dl. In the afternoon groups, 22 cases had undeterminable values, a figure that reflects the physiological decline in cortisol values in the afternoon. The distribution of values for the 74 subjects is showed in Fig. 3.

Changes in the Level of Wellbeing After the Experiment

Comparing the measured VAS values before and after the ascent to the vault, a net global increase of more than 40% was registered, with a shift from an average of

Table 1 Sample characteristics

Number of participants	100
Age (mean years)	43.27
Gender	
Male	51%
Female	49%
Civil status	
Single	50%
Married	44.90%
Widowed	1%
Divorced	4.10%
Schooling	
Primary school	2%
Secondary school	11.20%
High school	44.90%
University degree	41.80%
Diseases	
None	46%
1	38%
2	11%
3	2%
4	3%
PGWBI (mean)	70.80
Cultural participation index (mean)	72.00
Job	
White collar	71%
Blue collar	19%
Retired	9%
Religiosity index (mean)	1.33

58.7–81.5—a quite significant difference in statistical terms. Ninety per cent of participants registered a remarkable improvement of their wellbeing after the experience.

Changes in the Level of Salivary Cortisol After the Experiment

Comparing the measured cortisol values before and after the ascent to the vault, a net global decrease of more than 60% was registered, with a shift from an average of 0.23–0.09 μg/ml. Ninety-five per cent of participants registered a reduction of salivary cortisol after the experience.

Table 2 reports changes in cortisol values and their statistical significance. The overall change resulted as highly significant and both the morning and afternoon groups presented statistically significant changes in cortisol levels. Gender

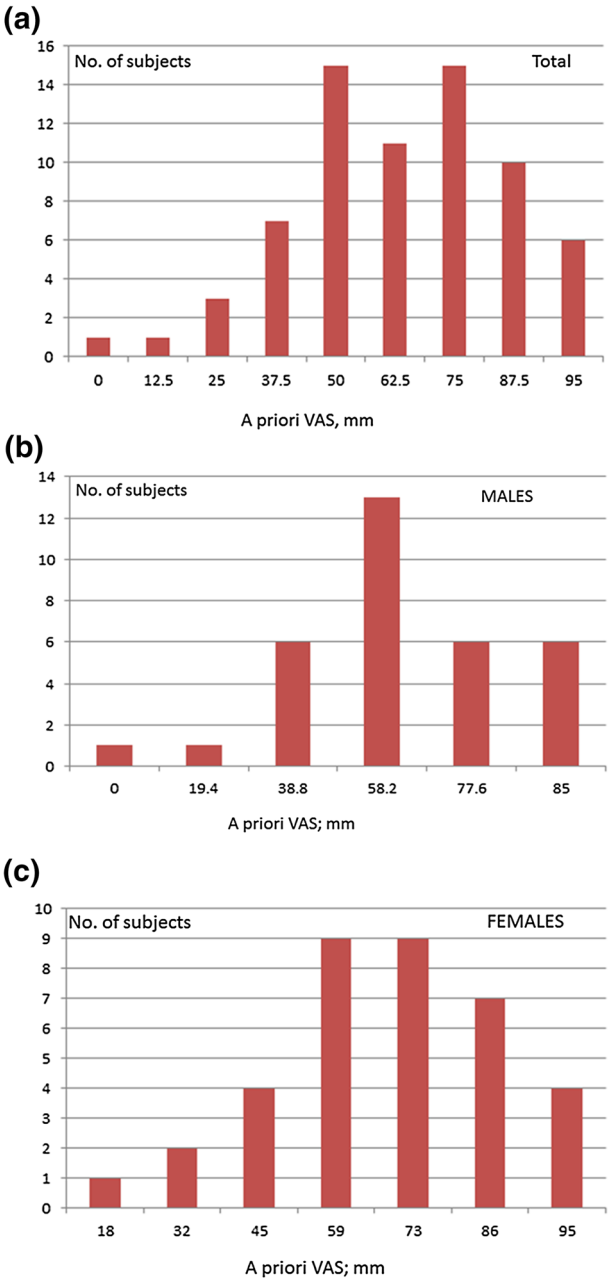

Fig. 2 Distribution of baseline VAS values in the sample. **a** Total; **b** males; **c** females

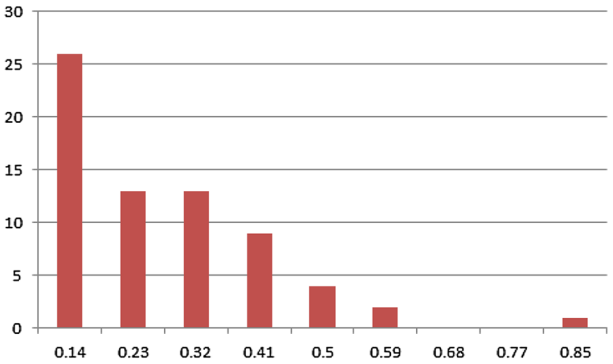

Fig. 3 Distribution of baseline cortisol values in the sample

Table 2 Mean values (μg/ml) of salivary cortisol before (time 0) and after the aesthetic experience (time 1), in tests carried out in the morning and in the afternoon

	Overall		Morning		Afternoon	
	$P < 0.0001$		$P < 0.0001$		$P < 0.0001$	
	Baseline	Post experience	Baseline	Post experience	Baseline	Post experience
Mean	0.23	0.09	0.29	0.15	0.15	0.08
SD	0.16	0.07	0.18	0.08	0.08	0.06

differences in cortisol drop levels were not statistically significant and are therefore not reported in the Table.

Given the known circadian variation in cortisol levels, the differences between morning and afternoon sessions are perfectly compatible, and indeed they corroborate the scientific consistency of the experiment, by reflecting changes in

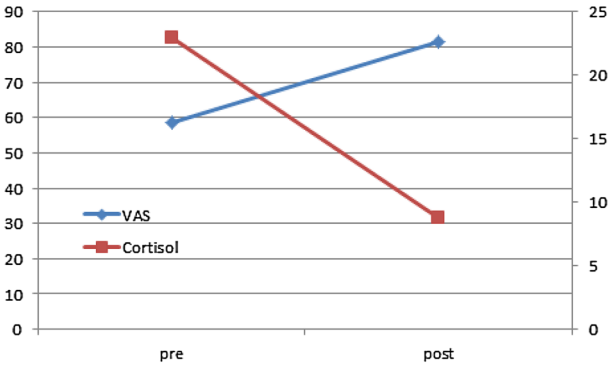

Fig. 4 Wellbeing score (left scale) and salivary cortisol levels (right scale) before and after the experience

environmental conditions in the expected direction. It is also interesting to note, in particular, that even in the afternoon when cortisol levels are generally lower, the reduction of cortisol levels after the experience remains statistically significant.

Figure 4 shows the average change in VAS score and cortisol levels before and after the aesthetic experience. Again, as gender differences are not statistically significant, they are not reported in the Table. The average trend shows a parallel decrease in cortisol values and an increase in wellbeing levels.

Responders Versus Non-responders

We defined operatively as 'responders' those subjects who registered at least a 33% increase in their VAS baseline value before the experience, and by non-responders those whose VAS increase was less than 33%. The 33% threshold is an arbitrary choice referring to an effect size which is generally taken as relevant from a clinical point of view (StLouis et al. 2007; Wenzel and Gennings 2005). According to this criterion, it turned out that 50 subjects were classified as responders and the other 50 as non-responders.

Table 3 Factors positively affecting wellbeing response (linear correlation index with wellbeing score)

Opera/ballet	**0.253**
Classic music concerts	**0.240**
High cultural index	**0.217**
Volunteering	**0.217**
Novels reading	**0.208**
Cultural index	0.188
Divorced/widowed	0.163
Theatre	0.161
Religiosity index	0.121
University degree	0.119
Art exhibitions	0.118
White collar	0.117
Male	0.116
Physical activity	0.107
Number of diseases	0.106
41–65 years	0.093
High school	0.079
Rock concerts	0.076
Jazz concerts	0.061
Retired	0.034
Cinema	0.031
Watching sport	0.012
Single	0.007

In bold, variables with statistically significant values of linear correlation

Table 4 Factors positively correlated with cortisol response

Rock concerts	**0.360**
Watching sport	**0.316**
Disco music	**0.308**
Single	**0.219**
Divorced/widowed	**0.196**
Jazz concerts	0.167
University degree	0.135
White collar	0.126
Delta post–pre	0.102
Delta VAS post–pre	0.102
Physical activity	0.101
Female	0.091
Cultural index	0.070
Post event VAS	0.036

In bold, variables with statistically significant values of linear correlation

Tables 3 and 4 list the linear correlation values between factors that are positively related to wellbeing response and cortisol response respectively. To facilitate reading, only correlation values larger than 0.06 and 0.03 are reported in Tables 3 and 4, respectively. Among the reported variables, it is interesting to point out the key role of variables related to cultural participation. In particular, subjective wellbeing response is significantly correlated to high cultural participation, whereas cortisol response to low cultural participation.

Correlation Between Cortisol and Wellbeing Variations

Table 5 presents the linear correlation matrix between six variables: baseline VAS, post event VAS, delta VAS (post event VAS minus Baseline VAS), baseline cortisol, post event cortisol, and delta cortisol (baseline cortisol minus post event cortisol).

Table 5 Linear correlation matrix among study variables

	Baseline cortisol	Post event cortisol	Delta cortisol	Baseline VAS	Post event VAS	Delta VAS
Baseline cortisol	1					
Post event cortisol	0.71	1				
Delta cortisol	0.92	0.37	1			
Baseline VAS	0.11	− 0.14	0.22	1		
Post event VAS	0.40	0.23	0.40	0.45	1	
Delta VAS	0.25	0.35	0.13	− 0.60	0.44	1

As it can be seen, the only strong correlations are delta cortisol with baseline cortisol, and delta VAS with baseline VAS. In other words, those who start from high cortisol values and low VAS (i.e., the most stressed out, wellbeing deprived subjects) manifest higher response in cortisol reduction and wellbeing gain. However, the correlation between delta VAS and delta cortisol is rather low. In particular, the two effects are weakly associated rather than concurrent.

Prototypes of VAS and Cortisol Responders

Forty-five out of 100 people were qualified as VAS responders. The prototype of this category is represented by male or female 42.56 years old, single or married, highly educated, in moderate-good health, white collar, with previous general wellbeing below average (65.1), average cultural index (71.2), and religiosity index above average (1.47).

On the other hand, 55 out of 75 people qualified as cortisol responders. As mentioned before, in 25 subjects the baseline cortisol levels were too beyond the lower limit of reference, and therefore cortisol response could not be calculated. The prototype of this category is represented by a female, 38 years old, single, highly educated, in good health, white collar, with an average level of previous general wellbeing (71.5), cultural index higher than average (79.17), and average religiosity index (1.2).

Finally, in the sample we find 30 people who turn out to be both VAS and cortisol respondents. The prototype of this category of subjects is relatively young (mean age 37.1), mostly unmarried (67%), highly educated (50%), white collar (80%), with some health problems (only 12 of them present no diseases), with a cultural participation index that only modestly exceeds the group average (78.8 vs. the group average of 72), and with a PGWBI level moderately lower than the group average (65 vs. 70).

For both VAS and cortisol respondents, the same discriminating 33% threshold criterion applies.

Semantic Connectivity Map (Auto-CM)

The experiment data have also been analyzed by means of the auto-CM Artificial Neural Network, to detect more elusive relations among variables, and a comprehensive global picture of the complexity, in accordance with previous studies in the medical field (Drenos et al. 2015). Table 6 below lists the variables taken into account in the auto-CM analysis.

By wellbeing responders versus non-responders, as above, we meant a percentage increase of the post-test VAS values by at least 33% of the baseline value, and for cortisol responders versus non-responders, likewise, a reduction of at least 33% of post-test salivary cortisol values with respect to the baseline. The choice of this cut-off value splits the sample into two sub-samples of similar size.

The distress, no distress and wellbeing state variables are determined on the basis of the PGWBI scores. There is distress for PGWBI values below 60, no distress for PGWBI values between 60 and 80, and wellbeing for PGWBI values above 80,

Table 6 Variables used in auto-CM analysis

Wellbeing responder	High school
Wellbeing non responder	Primary/secondary school
Morning	Blue collar
Afternoon	White collar
Cortisol responder	Retired
Cortisol non responder	No diseases
< 40 years of age	1–2 diseases
41–65 years	> 2 diseases
> 65 years of age	Low cultural index
Male	Average cultural index
Female	High cultural index
Married	Religiosity index
Single	Distress as general state
Divorced/widowed	No distress as general state
University degree	Wellbeing as general state

respectively. Figure 5 shows the MST generated by the auto-CM analysis of the variables in Table 6.

The first interesting aspect to notice in the map is the relative position of the variables "cortisol responders" and "cortisol non-responders", and of "wellbeing responders" and "wellbeing non-responders". Cortisol response is strongly associated to white collar and high cultural participation. It seems therefore that

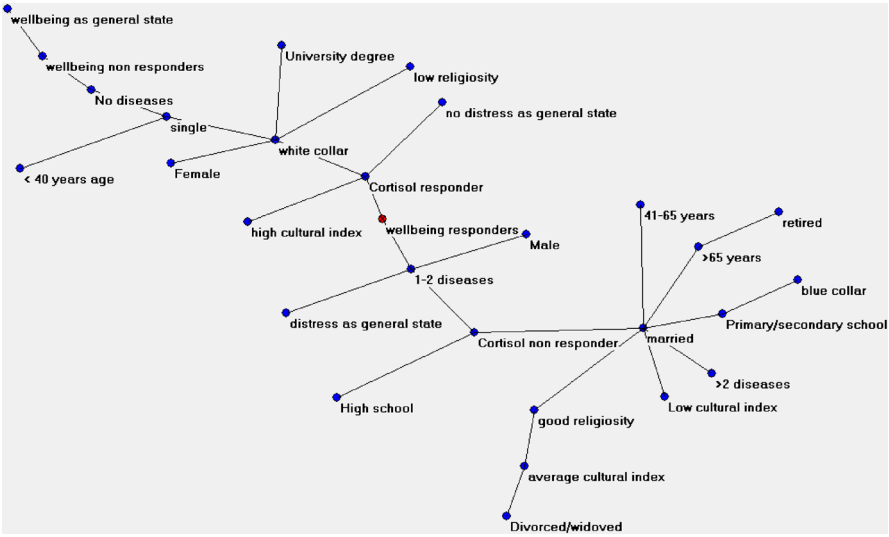

Fig. 5 Semantic connectivity map (MST) generated by the auto-CM ANN. Direct links denote strong association among variables. The red node denotes the center of the graph

intense cultural participation 'trains' the body to a favorable neurobiological response to cultural stimuli. This is a very interesting result, which is intuitive and possibly even expected, but that deserves further scrutiny in future work. Moreover, cortisol responders are strongly associated also to no distress and even wellbeing response, and to a lesser extent to lack of religiosity. Whereas in the above analysis based upon traditional statistical tools cortisol and wellbeing responses were weakly correlated, it turns out that once considering the *n*-to-*n* association among *all* variables at the same time, the two phenomena become strongly related. Wellbeing responders, in turn, are strongly associated not only to cortisol responders, but also to the presence of 1–2 diseases and distress. Subjects with relatively moderate health problems tend to have the highest wellbeing gains from the aesthetic experience. On the other hand, female gender is more associated to cortisol response, whereas male gender to wellbeing response.

Cortisol non-respondents tend to have diseases, are married, have a medium–low level of education and are relatively religious, middle-age or old, and male. Wellbeing non-respondents, on the other hand, are clearly identified as single, without diseases, young and with a high baseline wellbeing. They are, as a tendency, female and well educated. Auto-CM analysis therefore provides us with a relatively clear profiling of the main characteristics behind both cortisol and wellbeing response, and, in turn, with an equally clear profiling of the characteristics that drive effective versus failed response in both domains.

Discussion

The aim of the present study was investigating the effect of a highly connoted visual aesthetical experience in terms of certain types of biological (stress reduction) and psychological (wellbeing enhancement) responses. We have found that the chosen experience has significant impacts on both wellbeing and cortisol levels, and that such impacts are modulated by specific sets of variables in ways that are consistent with other, although still partial and fragmentary, results from related literature. In particular, we find that levels of cultural participation modulate cortisol response, and also, although less directly, wellbeing response. On the other hand, being religious is more strongly associated to cortisol *non*-response, thus suggesting that religion and aesthetic experience could be, at least in some subjects, competing rather than synergetic factors of stress reduction, in the light on the evidence that suggests that religious experience may be an effective anti-stressor (Ellison et al. 2001).

Another interesting finding is the preferential association between cortisol response and women versus wellbeing response and men. To our knowledge, this result does not reflect previous findings in the literature and is worth a closer examination in future research. Likewise, although this result is more intuitive, for the relationship between wellbeing response and the presence of a moderate pathological state, with absence of pathologies (and more generally a high baseline wellbeing level) as a strong factor of wellbeing *non*-response—a result that makes a powerful case for a 'cultural welfare' twist in future cultural policies aimed at

improving citizens' cultural participation, by suitably designing specific programs in cultural institutions that target specific physical and mental health issues (McKeown et al. 2016). As a matter of fact, the theme of beauty as a healing force is a deeply ingrained one in human cultures (Vaillancourt et al. 2007), and such an approach would then basically revive a long-standing tradition. We even have examples of medical institutions of the past where aesthetically conspicuous environments for care-giving were maintained as an essential component of the healing concept (Gates 2008).

The low correlation between cortisol and wellbeing response, moreover, makes it clear that the reduction of cortisol is not due, as a first instance, to a concurrent improvement in wellbeing. The two channels are relatively independent even if, as we have seen from the auto-CM analysis, they are in fact synergetic to some extent. This implies, among other things, that even people for whom we hardly can expect an increase of well-being as a result of aesthetic experiences due to high baseline values, can nevertheless benefit from it in terms of stress reduction. The effects of aesthetic experiences on brain function are in fact still largely unexplored despite the rapid development of neuro-aesthetics. (Cela-Conde et al. 2004) elucidate the role of the selective activation of the prefrontal area in humans during the perception of objects that have been rated as 'beautiful' by subjects. Aesthetic perception could therefore have a specific neural correlate. This intuition is corroborated by more recent research (Van Dongen, Van Strien, and Dijkstra 2016) which, investigating the role of aesthetic experience in emotion regulation, shows how aesthetic experience is characterized by specific perception modes and brain activation patterns. Therefore, aesthetics can be hypothetically considered as an attribute perceived by means of a particular brain processing system, in which the prefrontal cortex seems to play a key role. If the glucocorticoid hormone, which is excreted by the adrenal cortex spontaneously or according to a circadian rhythm, will be also produced (or reduced) in response to psycho-social stimuli, this body of results makes a plausible case for the reduction in cortisol as a pertinent specific response to aesthetic stimuli, as observed in our study. An especially promising avenue of research in this vein is the investigation of the reward systems associated to aesthetic experience, which have been so far mainly studied with reference to music listening (Menon and Levitin 2005). However, recent research has found analogous mechanisms associated to visual stimuli, and in particular to the joint activation of the dorsolateral prefrontal cortex and the striatum as markers of wellbeing enhancement and lower cortisol (Heller et al. 2016). This seems to suggest that the results presented in our study might be backed by specific neuroendocrine pathways—an aspect that needs further scrutiny, but opens up exciting prospects for future research.

Investigating whether there are specific gender differences in terms of access to different types of cultural activities, and to what extent they influence well-being and cortisol response, or, more generally, whether there is a differential impact of different types of cultural activities on well-being and cortisol response is beyond the scope of the present paper. Obtaining statistically significant results on these finer-grained aspects would require a larger sample than the one available for this study, and is therefore a promising topic for future research. Likewise, it would be

interesting to analyze the potential role of personality traits as a further key mediator for well-being and cortisol response, as the literature suggests that personality traits may actually play such a role in the relationship between cultural participation and well-being (Weziak-Bialowolska, Bialowolski, and Sacco 2018).

A potential limitation of our study is the high average educational level of our sample. On the basis of our findings, it could be that less educated samples could experience a less significant cortisol reduction or wellbeing improvement from aesthetic experiences. On the other hand, the fact that educational levels may be such a powerful modulator of stress reduction from aesthetic experiences could provide a very interesting basis for the strategic integration of health, cultural and educational policies as a more comprehensive approach to future welfare policies. Currently, the social benefits of cultural participation are still generally largely under-recognized, as they are typically associated to leisure and entertainment (which however, as noted above, may have equally important effects on human health). If the arts and culture would gain enough credit as key factors of promotion of health and wellbeing, and therefore as a new major field of public health research and policy design, that would make a significant difference. The more we manage to successfully involve individuals in regular forms of cultural participation, and to embed such participation in stable social networks providing the right social incentives (Tavano Blessi et al. 2016), the larger the likely long-term societal impact in public health terms. Therefore, cultural participation should be regarded as a key structural factor in evaluating the individual and social effects of arts-and-culture-focused health policies.

Funding The economic support for this study was provided by Kalatà Foundation (Mondovì, Italy).

Compliance with Ethical Standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Specifically, an ethical approval for the study was obtained from the ethical committee of Santa Croce Hospital (Cuneo, Italy).

Informed Consent Informed consent was obtained from all individual participants included in the study.

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