J Happiness Stud
DOI 10.1007/s10902-011-9254-x

The Interaction Between Culture, Health and Psychological Well-Being: Data Mining from the Italian Culture and Well-Being Project

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Abstract The purpose of this study is to understand the impact of health status and cultural participation upon psychological well-being, with special attention to the interaction between patterns of cultural access and other factors known to affect psychological well-being. Data for this report were collected from a sample of 1,500 Italian citizens. A multi-step random sampling method was adopted to draw a large representative sample from the Italian population. Subjects underwent a standard questionnaire for psychological well-being [the Italian short form of the Psychological General Well Being Index (PGWBI)], and a questionnaire related to the frequency of participation to 15 different kinds of cultural activities during the previous year. The results show that, among the various potential factors considered, cultural access unexpectedly rankes as the second most important determinant of psychological well-being, immediately after the absence or presence of diseases, and outperforming factors such as job, age, income, civil status, education, place of living and other important factors. According to a semantic map generated by a powerful data mining algorithm, it turns out that different factors (among which cultural access and health status in particular) may be viewed as concurrent elements of a complex multi-causal scheme that seems to play a primary role in determining psychological distress or well-being. In particular, distress seems to be tightly connected with: living in the Southern part of Italy, average income level, living in semi-urban and urban areas, age group 46–60, presence of more than two concomitant diseases and a low level of cultural access. Well being, on the other hand, is tightly connected with: male gender, high

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Published online: 02 March 2011

cultural access, and absence of diseases. Some of these associations are confirmed by Principal Component Analysis.

Keywords Health · Well-being · Disease prevention · Culture

1 Introduction

In the past 20 years, a few studies have focused upon the relation between cultural access and physical and psychological health through cross sectional or longitudinal surveys. The existing evidence seems to confirm the relevance of cultural experiences in terms of health and well-being indicators, and in the literature a number of studies seem to provide clear and solid evidence that participation in cultural activities is beneficial for health. For example, there is evidence on the relationship between cultural attendance and life expectation, showing that cultural access clearly improves chances of survival in longitudinal samples. A 14-year longitudinal study by Koonlaan et al. (2000) investigated the possible influence of attending various kinds of cultural events, or visiting cultural institutions as a determinant of survival. The study found a higher mortality risk for those people who rarely went to cinema, concerts, museums, or art exhibitions, as compared to those visiting them most often. Less beneficial effects were found for attendance to theatre, church service or sport events as a spectator, and no effect at all from reading or music playing. Furthermore, Hyppa et al. (2006) undertook a study concerning cultural participation as a predictor of survival on a sample of 8.000 Finnish, observing a lower risk of mortality among frequent attendees. In a similar way, Bygren et al. (2009) have examined the relationship between attendance to cultural events and cancer-related mortality. The results of their longitudinal study on more than 9,000 participants show that those who were rare or moderate attendees were, respectively, 3.23 and 2.92 times more likely to die of cancer during the follow-up period than frequent attendees. However, this effect was observed only among residents of urban areas.

As to the relationship between culture and individual psychological well-being, recent studies have provided some interesting insight. Daykin et al. (2008) have carried out a literature review to explore the evidence for the impact of performing arts on the health and well-being of young people in non-clinical settings. They found evidence of positive effects of performing arts practice, including positive changes in reported behavior and improvements in social skills and interaction among young people at risk. Evaluating the impact of participatory art projects for people with mental health problems, Hacking et al. (2008) found that participation led to significant improvements in empowerment, as well as in mental health indicators and social inclusion. However, the actual relationship is likely to be more complex and multi-faceted than one could infer from these preliminary pieces of evidence.

Zheng et al. (2004) show that, among Chinese students in Australia, the level of acculturation has a quite noticeable impact on subjective well-being. Rosengren et al. (2009) find evidence of clinical implications, showing, on the basis of a large sample from 52 different nations covering very different cultural contexts (in the socio-environmental sense), that, in high income countries, high levels of education and other elements of socio-economic status imply a substantially lower risk of acute myocardial infarction. The effect is considerably weaker in low and medium-income countries. One can rationalize this relatively strong relationship between instrumentally acquired cultural traits and well-being and health indicators in terms of the capabilities and functioning approach described

by Sen (1999). Higher levels of education and acculturation allow individuals to make better informed and self-conscious choices, which have a positive impact in terms of self-determination and health-serving habits and practices.

And what about subjective psychological well-being and physical health? It is quite clear that health status is one the major determinants of a subjective sense of well-being. In a survey carried out in Italy in 2000, health status (expressed as the number of concomitant diseases) actually emerged as the top determinant of perceived well-being, followed by income and age (Grossi et al. 2006). In fact, considering that the average PGWBI index in a general population sits around a score of 78, it turns out that people without any disease show average values around 82, whereas to subgroups with 1, 2, 3, 4 or 5 or more diseases correspond decreasing average scores (79, 78, 77, 73, 66, 56 respectively).

Since well-being is a complex multi-factorial phenomenon which is the effect of the interaction of many, mutually influencing variables, it is very difficult to understand the net impact of a specific factor in such a tangled interplay. For this reason, new statistical models able to deal with several interacting factors and to sort out their specific roles and characteristics are needed.

The Italian Culture and Well-being study is a population-based cross-sectional study, focused upon a homogeneous population from Italy. The principal aim of this investigation is to explore environmental, social, demographic and cultural factors for well-being determination in a sample of 1,500 Italian residents. Well-being status has been measured with the Psychological General Well-Being Index—PGWBI, a tool that has been validated through accurate research (Grossi et al. 2006), while patterns of cultural access have been investigated by inquiring about the subjects' frequency of access to 15 distinct types of culturally related activities. A descriptive preliminary analysis has suggested that culture has a relevant role in determining individual psychological well-being (Sacco et al. 2009).

Data mining is generally referred to as an analytical process designed to search a data base for consistent patterns and/or systematic relationships between variables, and its ultimate goal is to discover hidden, subtle trends and associations among variables. In this vein, we have applied a novel data mining technique, based on a novel kind of Artificial Neural Network (Auto Contractive Map), to explore the many-to-many (rather than dyadic) possible associations among 32 different variables with the sample subjects' patterns of psychological distress or well-being.

As we will see, our analysis strongly confirms that the concurrent action of health status and cultural access is a primary factor that explains psychological well-being, and this relationship clearly emerges from both our sophisticated and detailed Auto-contractive Map (AutoCM)-based data mining, and from the coarse-grained representation provided by standard Principal Components Analysis. These results, in turn, by establishing such a strong link between culture and psychological well-being, provide a further stimulus to inquire about the relationship with *physical* well-being. We tackle this further, most relevant issue in the final discussion, that places our results in a wider framework of possible directions for future research.

2 Materials and Methods

Our cross-sectional survey assessing the modes and intensity of access to cultural experiences, and its relation with psychological well-being, has been conducted on a relatively large sample ($n = 1{,}500$) of Italian residents living in non-isolated areas, i.e. being exposed to some degree of continuing community life. The survey has been conducted with

the assistance of Doxa, an Italian pollster company, through telephone interviews, according to the Computer Aided Telephone Interview (CATI) system. The sampling universe is that of the National Statistical Survey, carried out on year 2001 by ISTAT the Italian National Statistical Institute that covered 57 millions of Italians from all regions, stratified according to region and size of the town or city of residence. A multi-step random sampling method was adopted to draw a large representative sample from the Italian population.

Our sampling universe, as a subset of the aforementioned National Survey, consisted of 49.2 million Italians from all regions, aged 15 years or more, and stratified according to region and population size of the place of residence. The sampling units were chosen as follows: In the first stage, the choice regarded the municipalities where the interviews took place; in the second stage, in each selected municipality, an adequate number of electoral wards were extracted at random so that various types of urban areas were represented (e.g., central, suburban, outskirts and isolated houses); finally, names and addresses of the persons to be contacted were extracted at random from the electoral lists of the areas selected in the second stage. Mean scores for all items, as well as the global summary measures, were calculated according to the chosen algorithm (see below), and weighted by gender, age and size of the municipality with reference to the sampling universe.

Our survey collected information covering socio-demographic and health-related data, that are widely recognized as relevant determinants of well-being: Geography (North, Center, South quadrants of the country), environment (urban, semi urban, rural environment), gender, age, schooling (no school, primary, secondary, high school, college), civil status (single, married, widow, divorced/separated), monthly income level (<1.000 Euro, 1.000–1.500 Euro, 1.500–2.500 Euro, >2.500 Euro, no data) presence/absence of a given list of diseases (see Table 1 for more details).

In addition, 15 different variables related to cultural access have been added, after a scrutiny of the relevant literature in the cultural field; such variables are to be jointly meant as a proxy of individual levels of 'cultural access' (Table 1).

Each subject being surveyed in the study had to go through a structured questionnaire asking about the daily frequency of access to all of the activities listed in Table 1 during

Table 1 Cultural activities considered in the survey

Jazz music concerts
Classic music concerts
Opera/ballet
Theatre
Museums
Rock concerts
Disco dance
Paintings exhibition
Social activity
Watching sport
Sport practice
Book reading
Poetry reading
Cinema
Local community development

the previous year. The intensity of access to a specific cultural activity could thus be measured on a quantitative scale ranging theoretically from 0 to 365.

2.1 The Psychological General Well Being Index (PGWBI)

The level of subjective psychological well-being has been measured by means of an index that has been validated by decades of clinical practice: The Psychological General Well Being Index (PGWBI). The PGWBI has been 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. The original PGWBI consists of 22 self-administered items, rated on a 6-points scale, which assess psychological and general well-being of respondents in six Health Related Quality of Life (HRQoL) domains: Anxiety, depressed mood, positive well-being, self-control, general health and vitality. Each item has six possible scores (from 0 to 5), referred to the last 4 weeks of the subject's lifetime. Each domain is defined by a minimum of 3 to a maximum of 5 items. The scores for all domains can be summarized into a global summary score, which reaches a theoretical maximum of 110 points, representing the best achievable level of well-being a sort of 'state of bliss' (Dupuy 1990).

In this survey, we have adopted the short form of PGWBI, consisting of six items that generally explain more than 92% of the global variance of the questionnaire. The full PGWBI (the 22 items version) has been adopted in two previous waves of research about well-being of Italian population (2000 and 2004). This short version has been validated in a long-term project carried out from 2000 to 2006 in Italy (Grossi et al. 2006).

The six items of the PGWBI short form correspond to the items no. 5, 6, 7, 18, 20, 21 of the original 22 item scale, and are the following:

- Have you been bothered by nervousness or by your "nerves" during the past month?
- How much energy, pep, or vitality did you have or feel during the past month?
- I felt downhearted and blue during the past month.
- I was emotionally stable and sure of myself during the past month.
- I felt cheerful, lighthearted during the past month.
- I felt tired, worn out, used up, or exhausted during the past month.

We have added reporting upon cultural access data in a specific section of the questionnaire, and information collected through the interviews has been phrased in quantitative terms (i.e. answers elicited quantities such as the number of times per year that the respondent participated to any given activities). In principle, we could have also worked upon qualitative data, by suitably restating them in quantitative terms (e.g. as self-reported levels of satisfaction for a given item on a 10-point scale). In the present research, however, only quantitative elements—frequency of participation to culture-related activities—have been considered.

2.2 Data Analysis

As already remarked, the sample selected for the analysis (Italy, $n = 1{,}500$) is relatively large, as it is required by the nature of the research question, to allow enough variability to make meaningful inferences as to the predictive capacity of the single variables. Univariate analysis has been carried out on the PGWBI mean values as related to different levels of cultural access and different levels of co-morbidity. Means have been compared with unpaired T tests.

The Italian Culture and Well-being data base has the aim of increasing our understanding of the complex pathway leading to well-being or distress. This goal has been achieved through a new data mining method, based on a particular artificial adaptive system, the Auto Contractive Map (AutoCM), that is able to compute the association strength of each variable with all the others in any dataset (i.e. in terms of many-to-many rather than dyadic associations). The architecture and mathematics of AutoCM is described elsewhere (Buscema and Grossi 2008; Buscema et al. 2008; Licastro et al. 2010).

In non-technical terms, AutoCM is a new data mining tool based on an Artificial Neural Network developed at Semeion Research Center (Buscema 2007), that is especially effective at highlighting any kind of consistent patterns and/or systematic relationships and hidden trends and associations among variables. Quite uncommonly, the weights determined by AutoCM after the training phase admit a direct interpretation: Specifically, they are proportional to the strength of many-to-many associations across all variables. This allows a further, useful processing: Association strengths may be easily visualized by transforming weights into physical distances. Such a 'translation' proceeds in an intuitive way: Couples of variables whose connection weights are higher get relatively nearer, and vice versa. By applying a simple mathematical filter such as the minimum spanning tree to the matrix of distances, a graph is generated, whose use has been already tested in the medical field (Buscema and Grossi 2008; Buscema et al. 2008), and that is termed connectivity map. This representation then allows a very intuitive visual mapping of the complex web of connection schemes among variables, and greatly eases the detection of the variables that play a key role in the schemes, i.e. that turn out to be "hubs" of the graph.

The AutoCM matrix of connections preserves non linear associations among variables, while at the same time capturing elusive connection schemes among clusters that are often overlooked by traditional cluster analyses, and highlighting complex similarities among variables on various dimensions role, connectivity, essentiality, and so on. The AutoCM algorithms used for all the computations presented in this paper are implemented only by a Semeion proprietary research software, which is exclusively available for academic purposes. A Principal Component Analysis has been applied to the same data set as a linear benchmarking, using the Matlab package.

3 Results

3.1 Sample Description

The sample consists of 779 females and 721 males. The mean age of the sample was 46.54 years (17.24 SD); the range was 15–92 years. The values of the short version of the PGWBI were rescaled in the 0–110 range according to an algorithm described in Grossi et al. (2006), in order to allow historical comparison with studies employing the 22 items version. The average value of PGWBI in the overall population resulted to be 77.76 (17.73 SD) (range 4–110). The average value is almost identical to those recorded in previous surveys carried out in 2000 and 2004 (78.0). As expected, the average PGWBI value resulted higher in males as compared with females (80.95 vs. 74.81 respectively). Table 2 shows the characteristics of the sample of our study, as compared to the general Italian population structure as resulting from the national survey of 2001.

Table 2 Sample characteristics with reference to main ISTAT parameters

	N	%	Italian population ISTAT %
Gender			
Male	726	48	48
Female	779	52	52
Age groups			
15–17	53	3.5	3.5
18–34	397	26.4	24.2
35–54	507	33.7	35.0
55+	548	36.4	37.3
Degree			
Primary/junior school	909	60.4	56.6
High school	469	31.2	32.7
College	126	8.4	10.7
Geographical area			
North	690	45.8	45.8
Center	295	19.6	19.8
South	520	34.6	34.4

3.2 Univariate Analyses

The univariate analysis shows the influence of descriptive variables considered in the survey on PGWBI (Table 3).

As expected, an inverse linear relation between age and PGWBI value is present in our sample. However, despite this clear trend in absolute mean values, score differences don't reach statistically significant levels easily. In fact, differences become statistically significant starting from age 40 versus age 15–17, and age 50 versus 18–20 years. So age is important for PGWBI changes but big overlaps take place.

What about gender? Male subjects feel on average better than females, with a six points spread in mean PGWBI. This male-favoring gender gap is statistically significant despite the absolute score gap is smaller here than for age values. The same is true for income: People with less than 1.000 euro per month of income show PGWBI values statistically lower than for all other levels of income, but any further income differences do not turn out to be statistically significant. Thus, income level beyond a certain threshold does not seem to play a major role in the perception of well-being.

Job categories are associated with a wide range of well-being values, with average PGWBI going from around 70 in case of farmers or unemployed people to 84 for managers. Also in this case, score variability is so large that no statistically significant difference emerges. The same is true for civil status and schooling and education, always due to the extent of score variability, thereby messing up expected absolute differences—for instance, among primary and high school.

The health status is clearly more specific in determining substantial differences in well-being values. We already observe statistically significant differences by comparing the 'no disease' versus 'just one disease' classes, and at each increase in the number of diseases, groups are statistically well separated, with the exception of the '1 disease' versus '2 diseases' classes.

Table 3 Descriptive features in study population

Feature	No.	PGWBI		
		Average	S.D	C.I
Gender				
Female	779	74.82	18.23	73.53–76.1
Male	721	80.96	16.62	79.74–82.17
Age (years)				
15–17	48	85.1	12.97	81.33–88.86
18–20	93	78.81	15.86	75.55–82.08
21–24	79	78.49	15.44	75.03–81.94
25–29	62	79.72	12.79	76.47–82.97
30–34	150	79.49	18.33	76.54–82.45
35–39	102	79.73	15.64	76.66–82.8
40–44	142	77.65	17.32	74.77–80.52
45–49	128	77.69	17.18	74.68–80.69
50–54	138	76.81	18.23	73.75–79.88
55–64	318	76.5	18.76	74.43–78.57
65–74	167	76.82	17.74	74.11–79.53
75–100	73	72.73	24.02	67.13–78.34
Income				
≤1.000 €	193	71.13	21.95	68.01–74.25
1.001–1.500 €	299	77.7	17.17	75.74–79.65
1.501–2.500 €	361	78.71	16.77	76.97–80.44
>2.500 €	265	80.03	4.03	78.33–81.73
Doesn't state	382	78.72	18.28	76.88–80.56
Job				
Entrepreneur	100	80.96	16.14	77.76–84.16
Manager	22	84.45	17.46	69.76–88.36
Teacher	74	77.99	16.56	74.15–81.83
Employee	261	78.32	15.65	76.41–80.23
Artisan	29	78.26	18.39	71.27–85.26
Blue collar	191	79.2	18.68	76.27–84.69
Farmer	9	69.67	27.44	26.01–113.33
Housekeeping woman	192	74.8	18.78	72.13–77.48
Retired	362	77.32	19.28	75.33–79.32
Unemployed	61	70.27	21.12	64.86–75.68
Student	189	79.41	14.98	77.26–81.55
Missing	10	87.27	20.8	72.39–102.15
Civil status				
Single	429	79.48	16.18	77.94–81.01
Married	938	77.54	18.08	76.38–78.7
Widow	90	72.44	20.35	68.18–76.7
Divorced	43	76.83	17.12	71.56–82.1
Schooling and education				
University degree	195	78.35	15.66	76.01–80.69

Table 3 continued

Feature	No.	PGWBI		
		Average	S.D	C.I
High school	1,240	78.92	15.29	76.2–81.64
Primary school/junior school	165	72.23	18.47	63.59–80.88
Diseases				
No disease	489	83.17	15.23	81.82–84.52
1 disease	360	79.94	16.01	78.28–81.60
2 diseases	264	77.03	18.43	74.79–79.26
3–5 diseases	342	70.90	17.57	69.03–72.77
>5 diseases	45	58.18	22.45	51.43–64.92
Geography				
North	696	79.34	17.71	78.02–80.66
Centre	293	78.04	17.12	76.07–80.00
South	511	75.47	17.91	73.92–77.03
Culture				
No consumption at all	93	65.4	22.42	60.75–70.04
From 1 to 25 per year	448	74.2	17.72	72.55–75.85
From 26 to 103 per year	467	80.14	15.88	78.70–81.59
Over 100 per year	380	81.61	16.18	79.97–83.24

SD Standard deviation, *CI* Confidence intervals

Also, cultural access levels are associated with statistically significant differences in well-being scores. In fact, people with no access at all to cultural activities show average PGWBI values statistically lower than people with 1–25 activities/year, a category which in turn results statistically less well-being than the 26–103/year category. Beyond this point, further increases in cultural access do not reflect into statistically significant increases in well-being any further. From this univariate analysis already, it is quite clear that health status and cultural access dominate the scenario of factors potentially influencing well-being. This evidence is further corroborated by the comparison among the absolute score size effects for each variable.

Figure 1 shows the impact of each variable on average PGWBI scores in term of absolute effect size for different subgroups as described in Table 2. For example, for the diseases variable, the value of 25 reported in the figure results from the difference between the average PGWBI of 83.17 for the 'No disease' class, and the average PGWBI of 58.18 for the '5+ diseases' class.

It is apparent that cultural access clearly stands out as the second variable in terms of absolute effect size on perceived well-being, right after health condition. On the basis of these results, it seems quite natural to dig deeper into the relationship between the cultural and health realms in determining well-being, and trying to capture some possibly elusive but important deeper relationship, if any. This has been thus our next step.

Figure 2 shows the relation between the intensity of cultural access, expressed in classes of cumulative frequency of attendance to all cultural activities examined, and the average score of PGWBI according to the number of concomitant diseases. It is evident that there is a linear increase of the average well-being score with the increase of cultural activities, either in subjects with no disease, or in subjects with just 1 or two diseases, or even in

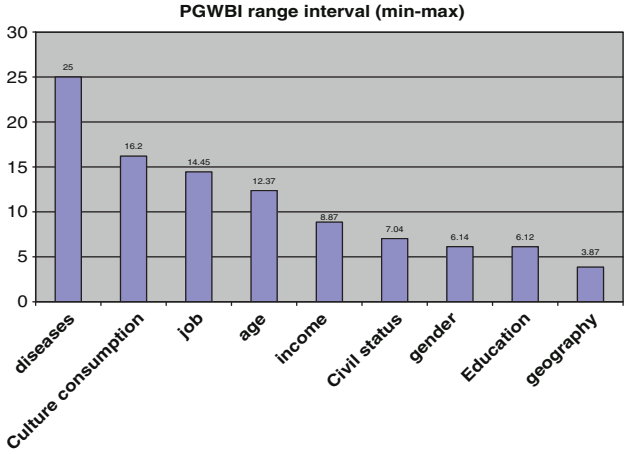

Fig. 1 Impact of main descriptive variables on average PGWBI values. The *bar* refer to the interval range of PGWBI registered in each feature span. (See text for explanation)

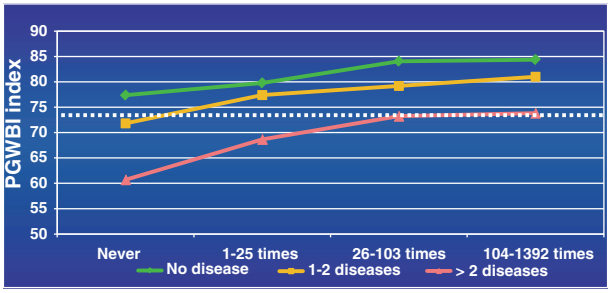

Fig. 2 Relation among wellbeing ad participation to cultural activities according to disease burden

subjects with more than 2 diseases. Surprisingly enough, however, the effect size of PGWBI increase is the greatest in subjects with many diseases ($p < 0.001$), as shown in Fig. 3, which compares the spread in PGWBI average values for weak and strong cultural attendees according to the number of concomitant diseases. The explanation of this phenomenon could be that cultural access acts as a sort of modulator of the disease-associated psychological burden of the perceived loss of well-being.

At this point, we asked ourselves whether, apart from the frequency of access to cultural activities, the degree of heterogeneity of the cultural activities being accessed would play a role as well in the perception of well-being. In other words, we asked whether "culturally omnivorous" behaviour was associated to higher levels of well-being. The data shown in Table 4 seem to deny this possibility. In fact, excluding the switch-on step (i.e. moving from 'no cultural activity at all' to 'at least one cultural activity'), the variation in average levels of PGWBI are not particularly affected by the number of concurrent cultural activities accessed by the same subject, with a flattening of the curve once the (very low) threshold of 3 cultural activities is crossed.

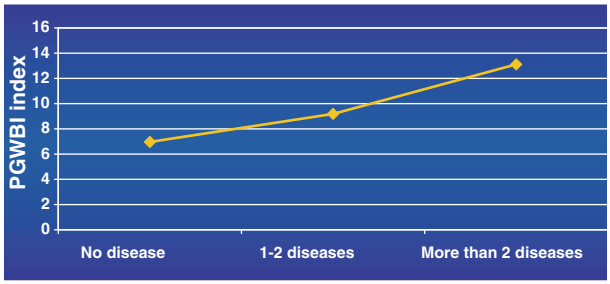

Fig. 3 PGWBI min—max range in high and low cultural activities attendance according to diseases status

Table 4 Relation between number of concomitant cultural activities irrespectively of intensity and PGWBI

Number of concomitant cultural activities	Mean PGWBI	No. subjects
0	65.4	92
1	74.49	129
2	72.14	136
3	78.9	129
4	79.27	137
5	79.7	133
6	79.2	143
7	80.9	136
8	81.3	111
9	81.3	104
10	79	64
11	77.38	38
12	77.87	21
13	93.5	6

3.3 Multivariate Analyses

At this point, the AutoCM tool allows us to introduce a further level of analysis, in order to construct a semantic connectivity map. As explained in the Sect. 2, this is a powerful technique to assess the interaction of multiple concurrent factors in complex systems. To capture their impact on the well-being dimension more easily, we will conduct this part of the analysis by cutting away from the study sample those subjects who present intermediate scores for PGWBI, and codifying well-being as a condition characterized by a PGWBI score above 85, and accordingly, distress as a condition characterized by a PGWBI score below 70. Such cut-off values have been derived from previous surveys carried out in Italy with the same methodology employed for this study (Sacco et al. 2009). After this round of pruning, the sample boils down to 956 subjects.

In the map shown in Fig. 4, distress and well-being are well-defined hubs, i.e. variables with a very high level of connectivity with other variables. Distress is directly connected with South geography, average income, semi-urban and urban area, age 46–60, presence of diseases (2–3 and >3) and low level of cultural access (1–25 per year). Well-being, on the

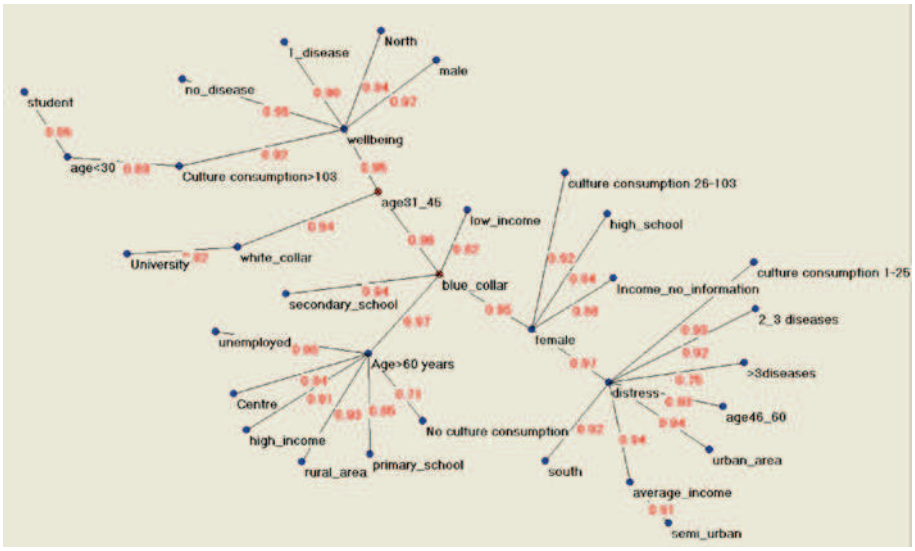

Fig. 4 Semantic Connectivity Map of the variables under study in the study group with Auto-CM system. The values on the arcs of the graph indicate the strength of the connection, measured on a scale ranging from zero to 1

other hand, is directly connected with male gender, cultural access over 103 per year, absence of diseases and 'income no information' (a variable that is a likely signal of very high income). The transition from well-being to distress is mediated by female gender—which in turn is directly connected with high school, 'just 1 disease' and cultural access between 26 and 103. 'No cultural access' seems to be a marginal variable, not interacting with either distress or well-being, but just with advanced age. From these data, it is quite clear that the interaction of culture and health status is quite powerful and relevant both on the positive and on the negative side: Low cultural access together with the presence of diseases are connected with psychological distress, and vice versa.

The AutoCM diagnostics also allows to define the association strength among variables. As one can see in Fig. 4, the association strengths among the six variables directly connected to well-being are all very high (all above 0.9).The same is true for the eight variables directly linked to distress, with the exception of '3+ diseases'. Cultural access is relatively more strongly associated on the distress side rather than on the well-being side in comparison with other variables. In other words, low cultural access has a stronger marginal role in the arousal of distress than high cultural access has in the arousal of well-being.

To benchmark AutoCM against the standard linear statistical approach, Principal Component analysis (PCA) has been employed. The corresponding maps for the first–second and third-fourth components, respectively, are reported in Figs. 5 and 6. PCA is mathematically defined as an orthogonal linear transformation that re-maps possibly correlated data into a new coordinate system of uncorrelated variables, such that the largest possible amount of variance is mapped onto the first (uncorrelated) variable (called the first principal component), the second largest amount of (residual) variance is mapped onto the second coordinate, and so on. In this way, by discarding lower-order principal components, the information loss is relatively small, as most of the variance of the phenomenon is

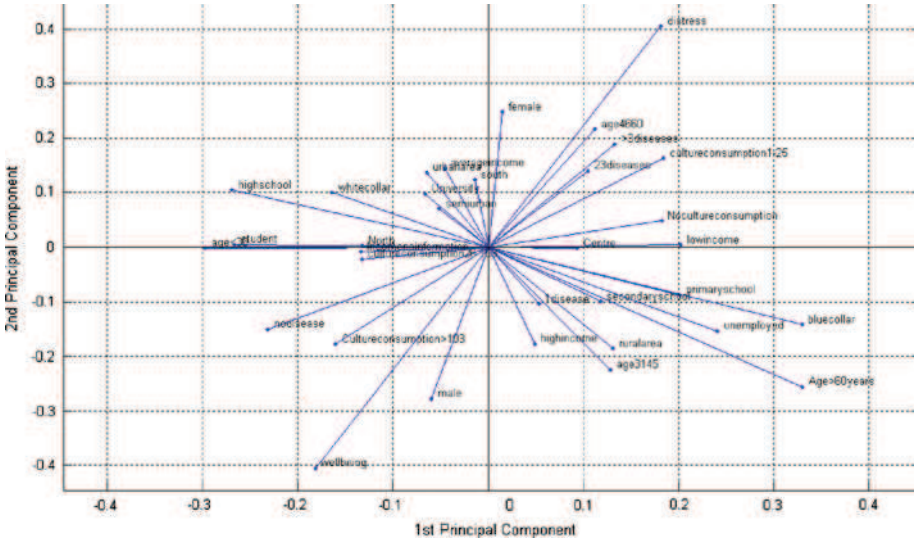

Fig. 5 Principal component analysis: first and second component

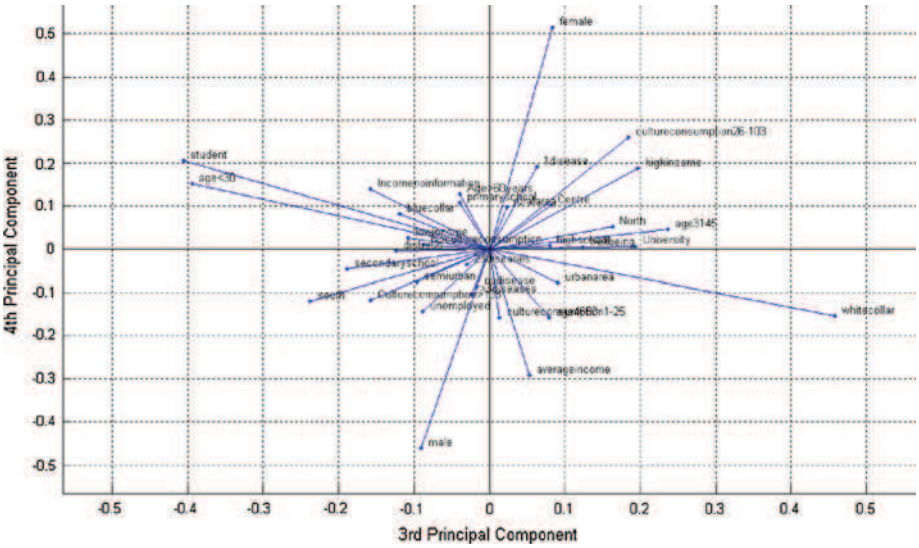

Fig. 6 Principal component analysis: third and fourth component

gathered in the higher-order components: Under certain conditions, then (essentially, the jointly normal distribution of the data generating process that guarantees the mutual independence of the principal components), PCA is a conceptually simple and computationally undemanding technique for capturing the essential features of a certain phenomenon. Figures 5 and 6 show the PCA projection of the descriptive variables in the components space. The first and second principal component graph is, accordingly, the one with the largest informational content. More explicative variables (i.e. those accounting for

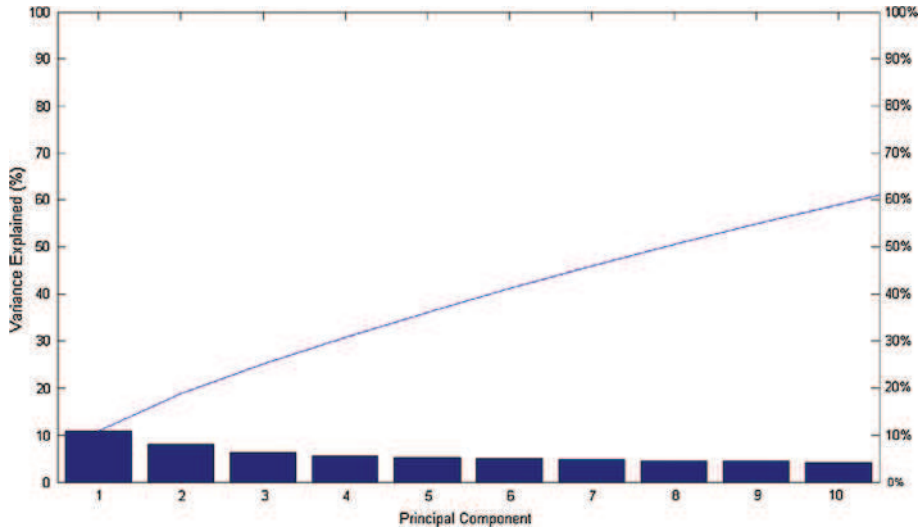

Fig. 7 Variance explained by the first 10 components of PCA

a larger share of the variance) are the ones that lie far away from the origin. When close to each other, variables are significantly positively correlated (r close to 1), whereas, if orthogonal, variables are not correlated (r close to 0). Finally, when they are on opposite sides with respect to the origin, they are negatively correlated (r close to -1). As one can see in Fig. 5, well-being, distress and advanced age here explain a good deal of the variance of the data set. Well-being is associated with high cultural access and male gender, whereas distress is associated with age 46–60, female gender and 3+ diseases. These associations are not fully confirmed in Fig. 6, however, where in the lower-order components well-being is associated with University degree, North and age 31–45, whereas distress is associated with low income, low cultural access and secondary school. This is a typical problem with PCA: the associations among variables change according to the different components, and it becomes difficult to construct a globally coherent picture from these chunks of information.

Overall, the variance explained by the first ten components of the PCA for our data set is about 60% (Fig. 7): there is, thus, a non-negligible informational loss, whereas the AutoCM technique basically captures all of the available information. Moreover, not even the higher-order components account for relatively large amounts of the total variance: suffice it to say that the first component makes for slightly more than 10% of the total. It is interesting to stress, however, that even from the relatively coarse-grained approximation provided by PCA, the strong joint action of health status and cultural access in determining well-being already emerges quite clearly. A further sign that a deep structural link is actually at work.

4 Discussion

Our findings that the joint action of health status and cultural access are a powerful determinant of psychological well-being naturally lead us to the next step: As they seem to

interact so powerfully as far as 'feeling good' is concerned, what is, then, the relationship between health status and cultural access in the first place? To provide some tentative answer, we cannot in turn but consider the relationship between physical and psychological well-being—and to understand why, we start from an intriguing quotation from the classics.

That psychological well-being is strongly linked to physical health is a truth even for common sense, and it is therefore not surprising to remark that the idea of physical health being a major determinant of psychological health is well established in Western civilization. "*Sit mens sana in corpore sano*" ("A sound mind in a sound body"): This famous Latin quotation is taken from Satire X of the Roman poet Juvenal. Put into context, the sentence is part of the author's answer to the question of what people should desire in life, the answer consisting in an articulate discussion of some subtle aspects of human nature:

> It is to be prayed that the mind be sound in a sound body.
> Ask for a brave soul that lacks the fear of death,
> which places the length of life last among nature's blessings,
> which is able to bear whatever kind of sufferings,
> does not know anger, lusts for nothing and believes
> the hardships and savage labors of Hercules better than
> the satisfactions, feasts, and feather bed of an Eastern king.
> I will reveal what you are able to give yourself;
> For certain, the one footpath of a tranquil life lies through virtue.

In his discussion, Juvenal clearly points out that psychological health is a very multifaceted condition, which is deeply connected with a craving for physical exercise and sobriety rather than for laziness and luxury. Among the many quotes one might have chosen to illustrate this concept, Juvenal's is particularly intriguing, in that it establishes a contraposition between "the hardships and savage labours of Hercules" and "the satisfactions, feasts, and feather bed of an Eastern king" as, respectively, a positive and a negative iconic representation of the determinants of physical well-being and *therefore* of psychological well-being.

By establishing such a strong link between health status and cultural access and psychological well-being, we consequently cannot but ask ourselves how culture would fit into Juvenal's conception. Intuitively, one could argue that certain forms of cultural access, like for instance listening to musical performances, would more easily fit into the category of satisfactions and feasts than into that of hardships and savage labours—and then, is Juvenal saying that, contrary to our findings, culture is bad for physical well-being and *then* for psychological well-being? And more generally, what are the possible implications of our results in terms of the possible impact of cultural access on physical well-being? This is admittedly a far less obvious connection than that with psychological well-being. But if we were able to establish it on firm grounds, this would pave the way to a deep rethinking of some aspects of welfare economics, and would consequently bring about far-reaching implications in the design and implementation of state-of-the-art welfare policies. In this final discussion, in sketching some possible promising directions for future research stemming from our results, we thus feel that this is by far our primary concern.

It must be said from the beginning that the issues raised here are far from being straightforward at the bottom level already. As the number of epidemiological studies available is limited, quite surprisingly, it is not precisely known to what extent physical well-being is related to psychological well-being. Most of the papers dealing with the impact of co-morbidity on quality of life have focused upon subjects belonging to specific

contexts, or upon patients affected by specific diseases, rather than upon the general population. Associations among gender, overweight and obesity, medical co morbidity, and health-related quality of life (HRQoL) were examined in a general population sample of 4,181 women and men aged 18–65 years by Mond and Baune (2009): The main findings are consistent with the hypothesis that women suffer a disproportionately large share of the disease burden of overweight and obesity that is not due solely to differences in medical co morbidity. A similar study was carried out by Kalaydjian and Merikangas (2008) on patients suffering from chronic headache, to investigate the contribution of co morbidity to health utilization and negative health perception in a large-scale population-based study, combining 6-year data from the 1999 to 2004 National Health Examination and Nutrition Survey ($n = 31{,}126$ adults), i.e. nationally representative datasets of the US population. The results point out that adults with headache are more likely to evaluate their health as "fair or poor" (17.9% vs. 6.1%), to ask for medical treatment four or more times in a year (43.3% vs. 22.7%), and to report physical and mental limitations. Health utilization and negative health perception are more strongly influenced by co morbid mental rather than physical disorders. Another national health survey was conducted on 2,192 randomly selected adults in Spain by Loza et al. (2009). Multi morbidity was defined as the co-occurrence of at least 2 chronic diseases, as defined by self-report. All subjects completed the 12-item short form (SF-12) health survey, and the Health Assessment Questionnaire (HAQ). Estimates at 95% confidence intervals (CI) of the prevalence of multi morbidity were obtained. The estimated prevalence of multi morbidity was 30% (95% CI, 25–34), and was associated with impaired daily functioning and lower physical and mental HRQoL dimension, bringing the authors to the conclusion that multi morbidity is frequent in the general population and can considerably impair daily functioning and HRQoL. Having a rheumatic disease worsens these outcomes.

That age, sex, and comorbidities must always be considered when comparing HRQoL data from the general population is suggested by a Korean study (Yun et al. 2007). The purpose of this study was to provide reference data for HRQoL in a sample of 1,000 persons from the general Korean population, so that the data could be compared with those of cancer patients. Men reported better functioning and existential well-being, whereas women reported more physical symptoms, anxiety, and depression. Most scores of functioning and well-being scales decreased and most physical symptoms, anxiety, and depression increased with increasing age. Increasing the number of comorbidities had a negative effect on all functions and most symptom scales.

Saarni et al. (2006) have addressed the impact of 29 chronic conditions on health-related quality of life in a general population survey in Finland, investigating the impact of major chronic conditions on HRQoL. Adjusted for other conditions and socio-demographic variables, Parkinson's disease had the largest negative impact on HRQoL at the individual level, followed by anxiety disorders, depressive disorders and osteoarthritis of the hip and knee. Based on prevalence, osteoarthritis of the hip or knee, depression, back problems and urinary incontinence caused the greatest loss of HRQoL at the population level.

From this brief examination of some of the relevant studies in the literature, we then conclude that the relationship between physical and psychological well-being tends to be supported, although mainly on the *negative* side and for one-sided causation: Physical diseases cause a worsening of the perception of well-being at the psychological level—which is by far the less surprising and the conceptually more straightforward aspect of the issue. There is therefore an urgent need to explore this field in a more systematic way. But then, even though discounting for the shaky ground we stand upon, what kind of evidence do we have about the links between cultural access and health status?

Apparently, the important dimension here has to do with the social dimension of cultural access and with its impact upon community health. White (2009) explores the role played by the arts in community health settings, through interviews with leading practitioners and case studies of examples of arts in community health practice from Ireland, Western Australia, South Africa and Northern England. He considers the development of the use of participatory arts to promote community health, the characteristics of its practice and the challenges it poses for evaluation. The author focuses on a holistic approach to arts and public health, taking into account personal development instead of merely a person's illness. Alongside with the therapeutic benefits to patients, the book also considers environmental improvements to support staff, and the use of the arts to produce more creative kinds of health information. Worthy of mention are also the results from a longitudinal study about the influence of music participation on the elderly. Cohen et al. (2006) measures the impact of participation in a professionally conducted chorale upon the physical health, mental health, and social activities of adults over 64 years old. The study concludes that this activity had important effects on health promotion and prevention, and contributed to reducing the risk factors driving the need for long-term care. Cohen (2009) reviews the latest theories about the underlying mechanisms that explain the positive effects of music and arts on health and ageing, and discusses the latest findings demonstrating these effects. The study also summarizes the full findings from the first study about the intriguing relationship between creativity and ageing. An older longitudinal study by Silverstein and Parker (2002) has examined the relation between changes in leisure activities and (retrospectively assessed) change in quality of life among elderly people in Sweden. The analysis revealed that those increasing their participation in multiple domains activities tended to perceive an improvement in their life conditions. This effect was particularly strong among elderly adults who became widowed, developed functional impairments, and had relatively rare contact with their background family. The results suggest that maximizing activity participation is an adaptive strategy undertaken by elderly adults to compensate for social and physical deficits in later stages of life. Lally (2009) reports on a qualitative evaluation of a singing-based participatory arts initiative. Qualitative evidence of the outcomes of the program suggest that it had a positive impact on participants' physical and social well-being, as well as upon their creative activity. The author argues that accounts of personal experience of the program's participants provide the most powerful evidence of its impact. Taking into account current debates about evidence-based policy approaches, the author concludes that it is necessary to understand the complexities of evidence in cultural policy and to develop new language to talk about evidence without unnecessarily privileging quantitative or statistical forms at the expense of qualitative evidence.

None of the above studies has tried to assess the multiple interactions among variables under evaluation. This is not surprising since, considering the complexity of the interplay among various components of well-being, only very sophisticated mathematical tools are able to tackle the inherent nonlinearity of the interactions among multiple concurrent factors. This is why we expect that a systematic application of tools such as AutoCM-based data mining can help us to take a leap forward in the understanding of such conceptually challenging issues.

The relationship among the many intervening factors that cause both physical and psychological well-being is indeed very complicated, and more research is needed to unscramble it to some extent. What the evidence reviewed so far seems to suggest is that what is really needed for the promotion of *both* physical and psychological well-being is a continued exercise, *both* physical and mental: By keeping people engaged into meaningful

activities, and by putting at work the whole range of human faculties, conducing an active life seems to be the best way to well-being in its full-fledged sense (not incidentally, and coherently with this pro-active rather than passive view of culture, we have included sport practice in the list of the 'cultural' activities of our database). This explains by the way the role of the social dimension of cultural activity in promoting the physical health of the elderly: It is the social incentive behind collective participation that motivates people to engage in activities that they would likely to turn down if they had to practice them on their own. This, in turn, explains how our findings not only can be reconciled with Juvenal's quotation, but nicely fit into it: it is not cultural access per se that is beneficial, but cultural access as a way of maintaining and developing one's capabilities working in terms of well-being. Therefore, meant in this way, culture is more akin to the "labor of Hercules" than to the "feasts and the feather bed of an Eastern king"—which brings us back on the same side as Juvenal.

To proceed further along this direction, we have to understand what we have achieved so far. The interaction among psychological well-being and health status emerging from our data mining analysis seems to be very complex, since many factors jointly concur to affect the perception of well-being. The AutoCM and PCA analyses have been carried out for a large subset of subjects of our sample, broadly covering the two extreme tertiles of the PGWBI scores distribution. In this way, we have 'forced' the key variables to choose their association with respect to the distress versus well-being status. Once this is made, it emerges that gender assumes a fundamental role, being differentially linked to well-being versus distress. The AutoCM connection map shows that male gender is directly connected to well-being, whereas female gender is connected to distress. Surprisingly, age doesn't seem to be too important, as neither advanced age or young age are directly connected to distress or well-being respectively, as one could have expected—a finding that seems to confirm the idea that socially and individually established lifestyle habits matter more than one could expect. The presence or absence of diseases, geographical location and cultural access play vice versa an important role, as they are always directly connected to either well-being or distress. But again, income doesn't play a major role and neither job type does—and this seems to tell us that the social dimension is playing a more important role than the economic dimension when it comes to well-being. Observed through the Auto-CM filter, the ranking of relevance of the variables with regard to psychological well-being is actually rather different from that emerging from univariate analysis, where job, age and income were respectively the third, fourth and fifth in order of importance, and gender was one of the least important factors: This is, again, the value added of making use of tools that allow us to capture the deep nonlinear interactions among variables and to bring to attention elusive effects that would otherwise be entirely overlooked, while at the same time singling out spurious one-sided, apparent causations.

Our study has certainly a number of limitations: First of all, the incidence of a particular disease is based on self-reporting from a check list, rather than on spontaneous reporting or, better, on objective medical check. We cannot exclude that in a certain percentage of cases people have not noticed diseases they actually carry, or have erroneously reported the presence of disease. However, it is reasonable to think that the general trend should not be seriously biased, since overrating and underrating should compensate in the different subgroups.

By the same token, also cultural access data potentially suffer from some bias due to self reporting rather than objective registration by a third party of a particular activity carried out by the subject. We cannot rule out, for instance, a certain degree of overstatement in certain particular subgroups, such as, e.g., people with lower socio-economic conditions

willing to compensate their status by exaggerating their cultural access patterns. But it is remarkable that the incidence of cultural inertia across the sample resulted to be much higher that expected: 16% of the sample admitted to skip completely or almost completely (at most one activity per year) any opportunity of cultural access—and this frank admission can be seen as a consequence of the low relevance that cultural access seem to have in determining social stigma in today's Italy. This fact in our view supports the idea that, as to cultural habits, self-reporting might have been fairly consistent with reality after all, or at least less biased than one could think.

The present study is, to our knowledge, one of the first attempts to evaluate the well-being implications of cultural activities conducted on a relatively large sample at a national level, and in this respect it has the prerequisites to deliver a few empirically founded results, and thus provide a preliminary evaluation of the relevance of cultural access for public health theory and policy issues. In particular, we believe that acknowledging cultural access as a major determinant of subjective well-being can be conducive to novel, challenging approaches to the design and implementation of public health strategies.

The relationship between cultural access and subjective well-being, however, is likely to be quite subtle and elusive, at least when investigated by means of conventional univariate, bivariate or multivariate statistical analysis. Cultural habits are manifold, and are rarely reducible to single-channel patterns: people with cultural interests tend to allocate their time, attention and energy among several different activities. Therefore, if one wants to trace how cultural access contributes to psychological well-being, there is a strong necessity to rely upon tools that allow the researcher to take into account this inextricable multi-dimensional association between variables that translate the typical behavioral patterns of (cultural) choice. To this purpose, we have to dismiss models where only a few variables are selected through linear correlations, for the result would be a model that is unable to consider in full the dynamic interaction of variables, in order to assess their joint predictive potential. The advanced ANNs techniques adopted in this paper, however, allow us to do precisely this, and consequently to evaluate what is the best bundle of variables that explains the variability of the target, and the internal ranking of such variables in terms of relative predictive power. Once we put the culture/well-being link under the right set of analytical lenses, it turns out quite clearly that 'culture counts', namely, that there is clear evidence that cultural access has a definite impact on individual psychological well being (and particularly so if cultural access occurs in a well-balanced mind–body perspective), and moreover that culture provides for some of the most effective predictors of well-being.

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