A comparative study of the structure of attitudes toward the computer, science, and technology was carried out with 320 university students evenly distributed by country (Italy and the United States), by field of study (humanities, psychology, science, and engineering), and by gender. The instrument used was a Likert-type scale of 56 statements. First, individual items were analyzed for cross-national differences. Then items showing a range of values within both national groups were analyzed by factor analysis to reveal the latent dimensions underlying the set of items. We extracted three factors that, together, accounted for 39% of the variance: attribution to the computer of negative effects, both at an individual psychological level (Factor 1) and at a social psychological level (Factor 2); and the attribution to science, to technology, and to the computer of positive effects at an instrumental and organizational level (Factor 3). Attitudes toward computers, science, and technology were generally more positive than negative in both countries. Nevertheless, against this background of cross-national similarity, sociocultural factors produced attitudinal differences. In particular, the nationality of the subjects made the greatest difference, whereas gender showed a less important influence than did field of study.

ATTITUDES TOWARD COMPUTERS, SCIENCE, AND TECHNOLOGY

A Cross-Cultural Comparison Between Students in Rome and Los Angeles

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It has become a commonplace that we are living in a period of epochal change made possible by technological innovations involving computers. It is thus especially interesting to know what people—particularly young

AUTHORS' NOTE: This research was carried out by Gilda Sensales during the final year of her Ph.D. in psychology (Universities of Rome, Bologna, Padua, and Turin), thanks to a grant raise authorized for that purpose by the doctorate staff and by a grant from the Centro Nazionale delle Ricerche (Project CTB CNR 87.00942.08). We would like to thank Eraldo De Grada and Anna Paola Ercolani for their invaluable advice during all stages of this research; Alessandra Areni for consultation generously granted during the statistical processing; and Patrizie Regolo for help with the early stage and Alessandro Duranti for help with the final stages of the American translation of the questionnaire. Finally, a special thanks to Laura Weiss for her collaboration in gathering data at UCLA. Manuscript preparation was supported by the Gold Shield Faculty Prize to Patricia Greenfield. Requests for reprints should be sent to Gilda Sensales, Dipartimento di Psicologia dei Processi di Sviluppo e Socializzazione, Via dei Marsi 78, 00185 Rome, Italy or to Patricia Greenfield, Department of Psychology, University of California, Los Angeles, CA 90095.

JOURNAL OF CROSS-CULTURAL PSYCHOLOGY, Vol. 26 No. 3, May 1995 229-242

people—really think of, expect from, fear, and know about these new technologies.

Research in the United States tends to show the general existence of positive attitudes toward the best-established functions of the computer (such as mathematical and statistical calculation, and criminal record checks) and the presence of critical and ambivalent attitudes toward more innovative applications (such as the use of computers in medical diagnosis, and consulting) (e.g., Lee, 1970; Wagman, 1983). Moreover, some research reveals significant gender differences in attitudes, differences attributed to the traditional division between male and female roles (cf. Campbell, 1990; Dambrot, Watkins-Malek, Silling, Marshall, & Garver, 1985; Popovich, Hyde, Zakrajesek, & Blumer, 1987; Meier, 1988; Temple & Lips, 1989; Wilder, Mackie, & Cooper, 1985). In general, the attitudes of female subjects, more open to "expressive-social" factors, turn out to be less positive or more negative than those of male subjects, who are more open to "technical-instrumental" factors.

Research on Italian populations carried out by Sensales and colleagues (Ercolani & Sensales, 1985; De Grada, Ercolani, Areni, & Sensales, 1987; De Grada, Sensales, & Areni, 1990; Sensales, 1994; Sensales & Bonatuto, 1993) substantially confirms the U.S. results, though these studies do show a greater emphasis on negative attitudes. However, specific positive attitudes were also revealed: above all, those toward the use of computers to create a more rational organization of society and work, and as aids to knowledge and mental activity.

The gender differences that emerged from the U.S. studies were also confirmed. However, the type of secondary school attended exerted an even greater influence: Students with a humanities education, when compared to those with a scientific background, showed less positive or more negative attitudes; those with a technical education clustered somewhere in between. These results prompted us to study cross-culturally the consistency of the differences between these population categories, the consistency of the latent dimensions identified, and similarities/differences attributable to cultural factors. The countries chosen for this study were Italy and the United States, both having a similar economic structure but different levels of development of cultural traditions, and, of even more importance, different degrees of computer diffusion.

METHOD

SUBJECTS

In Italy, the subjects of the research were second- and third-year students at the University of Rome *La Sapienza*; in the United States, they consisted

of juniors and seniors at the University of California, Los Angeles (UCLA). Because students begin their university studies one year later in Italy than in the United States, the samples were matched for age. In each country the subsample was subdivided according to academic field of specialization: (1) humanities (literature, philosophy, history); (2) psychology; (3) sciences (physics, chemistry, mathematics); and (4) engineering. Each group consisted of 20 males and 20 females. Consequently, there were 160 subjects from each country, and 320 subjects in all.

INSTRUMENTS

We expanded an Italian questionnaire developed by De Grada and Sensales (De Grada et al., 1987). For students in the United States, the questionnaire was first translated into English by the Italian-dominant author (G.S.), then checked by the English-dominant author (P.M.G.). Next it was back-translated from English to Italian by an Italian graduate student studying psychology in the United States. The Italian and English versions were checked against each other by an Italian-born bilingual social scientist living and working in both the United States and Italy (and engaged in research on computer communication). Finally, the English questionnaire was pretested on a group of 30 introductory psychology students at UCLA. At each stage of the checking process, appropriate corrections were made. We tried to make the English translation faithful to the Italian concepts, rather than making it more familiar or colloquial for an audience in the United States.

The present analysis will focus on a Likert-type scale of 56 items (part of the larger questionnaire) that explored Attitudes toward Computers, Computer Science, and Technology (SACCST). Items were balanced between positive and negative (28 of each), and represent attitudes toward the following 12 aspects of computers and technology: (1) mathematical and statistical calculation, (2) social control, (3) organization of society and work, (4) creative activities, (5) mental work and cognitive processes, (6) education and training, (7) play activities, (8) science and technology, (9) sociality and socialization, (10) public administration and management, (11) similarity between humans and computers, and (12) financing of computer science. The scale had six points ranging from 1, "disagree very much," to 6, "agree very much."

PROCEDURE

The questionnaire was administered individually or in small groups by one of two research assistants from the United States, assisted by the Italian author (G.S.). The humanities, science, and engineering students were paid subjects recruited through announcements printed in the student newspaper, posted on bulletin boards, and made in class. The psychology students signed up to fulfill an introductory psychology course requirement. For the Italian subjects, the survey was conducted at the University of Rome, *La Sapienza*, using a similar procedure to the one adopted for subjects in the United States. However, announcements were made during classes or by asking students individually to participate (there is no student newspaper). Students were not paid because this would not be considered normal practice in Rome.

RESULTS

CROSS-CULTURAL COMPARISON OF ITEM SCORES

The most comprehensive vehicle for assessing cultural similarities and differences was a comparison of mean item scores in Rome and Los Angeles. This analysis considered every item in the scale, even those that were later discarded from the factor analysis for statistical reasons. Table 1 provides an overview of attitudes toward computers, science, and technology in the two cultures, as well as the results of the factor analysis, to be discussed below.

First of all, average attitudes toward computers, science, and technology are often neutral: almost half the items failed to elicit strong agreement or disagreement in each country (means between three and four). Secondly, in the case of items where a cultural group deviated from neutrality, many more items elicited positive than negative opinions concerning computers, science, and technology.

In terms of the role of culture, differences must be seen against a background of similarity and cross-cultural agreement. For about one fourth of the items, opinions were homogeneous and extreme (mean = < 3 or > 4) in both countries. In all cases, the direction of the attitude was the same in both countries. The greatest agreement across subjects and nationalities was that "No machine will ever approach the perfection of human mind and body" (Item 44). Students in both cultures also strongly agreed that "Science is in itself a source of social and material progress" (Item 26) and that "The introduction of computers in industry spares human beings from the more monotonous and dangerous duties" (Item 8). Students in both countries seem generally to want computers in schools and public offices (Item 42), but to be negative about video games (Items 3 and 5).

Against this background of basic cross-cultural agreement the strength of these views sometimes differed in the two countries. Students in Rome were significantly more negative about video games (Item 5), whereas students in

TABLE 1
Items of SACCST: Student *t* Test on Mean Scores of Each National Group and Indication of the Items Discarded for Ill Distribution of Frequencies

				Factor Loading		
	$\bar{X}$ *United States*	$\bar{X}$ *Italy*	p	*1*	*2*	*3*
1. Technological motivation is what really propels social and civic progress.	4	4.2				.54
2. By eliminating the monotony and repetition of mental work, computers make work easier and more pleasant.[a]	4.4	3.5	**			
3. Video games are one of the best means for people to exercise their intelligence while enjoying themselves.[ab]	2.7	2.4				
4. Computer storage of personal information represents a serious threat to the privacy of citizens.	3.5	3.2			.59	
5. Only those who are devoid of imagination fail to appreciate video games.[ab]	2.1	1.8	*			
6. Computers permit the organization of knowledge in new and more effective ways.[ab]	5.1	4.6	**			
7. Given their speed and efficiency, it would be very desirable for computers to be used even for simple and routine mathematical operations.	4.1	4.2				
8. The introduction of computers in industry spares human beings from the more monotonous and dangerous duties.[ab]	4.5	4.4				
9. An honest citizen cannot be hurt in any way by the widespread use of computers in the administration of justice.	2.9	3.7	**	–.63		
10. The computer is a very good playmate for a young person.[b]	3	2.5	*			
11. The national government should be concerned with the better financing of social services rather than throwing away money for so-called scientific and technological development.	3	3.3				
12. Nothing is more monotonous and banal than a video game.	2.9	3.5	**	.42		
13. The computer is an ideal tool for education and training.	4.2	3.5	**	–.52		.51
14. By taking away duties for which people are qualified, the computer emphasizes the more negative aspects of lower-level occupations.	3.2	3			.40	

(continued)

TABLE 1 continued

	X̄ United States	X̄ Italy	p	Factor Loading 1	2	3
15. Working with computers gets people out of the habit of remembering and thinking for themselves.	3.6	3.7		.70		
16. Too often, technological development has resulted in severe damage to nature and humanity.	3.8	3.9			.49	
17. Only the widespread introduction of computers can reduce the slowness and inefficiency of bureaucracy.[b]	3.6	4.4	**			
18. The ever greater dissemination of computers will take away from people the capacity to do operations as simple as calculation.	3.5	3.9	*	.67		
19. Good sense and personal intuition are worth more than cold scientific knowledge.[a]	4.3	4				
20. To spend the community's money for the development of computers is an excellent investment for the future.	4.1	4.1				.47
21. Computer use promotes alienation and the tendency toward isolation.	3.6	4		.60		
22. Without technological progress there is no social progress.	3.6	3.5				.56
23. In the evaluation of school performance, computers are certainly more precise and impartial than humans.	3.7	3	**			.47
24. In banking operations, computers are certainly more discreet and trustworthy than any employee.[b]	4	4.5	**			
25. People, thanks to the calculating power of computers, can solve even complex problems without understanding the mathematical principles that are involved.[a]	4.4	3.8	**			
26. Science is in itself a source of social and material progress.[ab]	4.6	4.4				
27. The human mind is but a very complex computer.	3.8	3.1	**			.45
28. The computer transforms learning into a mechanical exercise, devoid of any critical examination.	3.6	4.1	*	.67		
29. Many complex calculations are now within everyone's reach thanks to computers.[a]	4.6	4.2	*			

(continued)

TABLE 1 continued

	X̄ United States	X̄ Italy	p	Factor Loading 1	2	3
30. Computers tend to immerse their users in an abstract and artificial world, cutting them off from the real world outside.	3.5	3.1		.51	.48	
31. Computers' high-speed combinatory and permutational capacity insure results that are comparable, if not superior to human imagination.[b]	2.9	2.2	**			
32. Financing the development of scientific and technical knowledge represents a clear duty of the community.[b]	3.9	4.4	**			
33. Computers, especially in their graphic applications, are a powerful stimulus for personal creativity.	4.1	3.6	*	–.42		.42
34. The introduction of computers in social and work-related organizations complicates life rather than simplifying it.[ab]	2.7	2.4	*			
35. The highest educational goal is the training of scientific thinking.[b]	3.0	2.6	*			
36. The spread of computers permits a more rational organization of society and thereby improves everybody's quality of life.	3.5	3.3				.56
37. The storage of personal data in computers is essential for adequately planning many social services.	3.9	4				.49
38. The one and only form of sure knowledge is scientific knowledge.[a]	2.6	3.1	*			
39. Playing games on a computer at most trains reaction time, certainly not intelligence.[b]	3.7	4.3	**			
40. In the supposed conflict between science and morality, reason is usually on the side of science.	3.7	3.3	*			.45
41. In administrative procedures, computers also make mistakes but it is easier to become aware of them.	3.1	3.5	*			
42. To spend public money filling schools and public administration with useless computers represents an inadmissible waste.[ab]	2.5	2.7				
43. To utilize computers means to lose one's very autonomy of thinking and to let oneself be conditioned by a machine.[a]	2.4	2.9	*			

(continued)

TABLE 1 continued

	$\bar{X}$ United States	$\bar{X}$ Italy	p	Factor Loading 1	2	3
44. No machine will ever approach the perfection of human mind and body.[ab]	5	5.1				
45. Computers' large capacity for information is matched by a small potential for education and training.	3.2	3.7	*	.60		
46. Computers operate on a strictly logical level and therefore do not leave room for personal creativity.	3.2	3.9	**	.72		
47. Science and technology are destructive and dangerous without sure moral guidance.[b]	3.9	4.7	**			
48. It is a common error to mistake the combinational speed of computers for creativity.[b]	4	4.7	**			
49. Having access to a computer often ends up uselessly complicating bureaucratic procedures.[b]	2.9	2.6				
50. Astrology often gives answers that are more sensible than those given by behavioral scientists.[ab]	1.9	1.6	*			
51. Technological development is not necessarily equivalent to social and civic progress.[b]	4.1	4.3				
52. The so-called scientific attitude frequently masks dogmatic positions.	3.6	3.6				.48
53. With the automated management of banking it is relatively easy to steal by getting into the computer.	3.1	3.4				
54. Computers permit access to a complex network of relations with other people and their diverse ideas.[a]	4.6	3.3	**			
55. The computer is in any case a powerful and dangerous tool for social control.	3.4	3.6		.69		
56. Whenever administrative needs are simple and repetitious, computer use represents a useless complication.[a]	2.3	3	**			

a. Items discarded for ill distribution of frequencies in United States.
b. Items discarded for ill distribution of frequencies in Italy.
*$p < .01$; **$p < .001$.

Los Angeles were significantly more positive about using computers to organize knowledge in new and more effective ways (Item 6). Indeed, although the majority of items (32 out of 56) produced statistically significant cultural

differences between Italy and the United States, the polarity of the attitude was usually the same in both countries. The attitude was simply more extreme in one place or the other. For example, in terms of positive attitudes toward computers, students in Rome and Los Angeles tended to agree that "in banking operations, computers are certainly more discreet and trustworthy than an employee" (Item 24); however, students in Rome held this view more strongly. On the negative side, students in both Rome and Los Angeles tended to disagree with the statement that "computers' high speed combinatory and permutational capacity insure results that are comparable, if not superior to human imagination" (Item 31); students in Rome simply disagreed more strongly.

Most important from the perspective of cultural differences were seven items on which the affective polarity of the attitude differed significantly in the two cultures; that is, an attitude was negative in one culture, positive in the other. The most interesting differences related to differing views of human nature, with the Italians having a more humanistic view, the U.S. sample possessing a more materialistic one (Items 27, 40, 45, 46). This difference was best exemplified by Item 27: Subjects in the United States typically agreed whereas subjects in Italy typically disagreed with the statement, "The human mind is but a very complex computer."

The other three significant polarity differences relate to areas in which computers are much more used in the United States than in Italy—educational/testing (Item 23), computer networks (Item 54), and the administration of justice (Item 9). In the first two areas, students in the United States were generally positive, students in Italy generally negative; in the administration of justice, however, it was students in the United States who expressed negative opinions.

THE STRUCTURE OF ATTITUDES: FACTOR ANALYSIS

Moving from between-culture variability to within-culture variability in attitudes, we wondered if the structure of this variation would be the same or different in Italy and the United States. Factor analysis was used to answer this question. For this analysis, we therefore discarded those items that showed, in either sample, frequencies clustered too near the extremes of the scale. The remaining 28 items had means between 2.75 and 4.25 (Table 1).

A factor analysis (method of Principal Components) was carried out for each national group on the remaining 28 items. The Scree test yielded, for each sample, two significant factors that account for 32.2% of the total variance in Rome, and 30.3% in Los Angeles. In both cases the first factor explained more than 21% of the total variance (25% in the Italian sample). To verify the homogeneity of the factorial structure in the two samples, the saturation matrices of the first two factors were compared using a correlation technique (McDonald, 1985). The correlations between the two samples for the first and second factors were .9667 ($p = .001$) and .5172 ($p = .01$), respectively.

The factor structures in the two groups were therefore considered similar and the two samples were combined. On this unified sample a second factor analysis was performed, again using Principal Component Analysis. This time the Scree test yielded three factors that were rotated by the Varimax method; only the items with saturations .40 or higher were retained (see Table 1 for the items and factor loadings of the final scale). The first three rotated factors of the final 24-item scale account for 39.4% of the total variance. Factors 1 and 2 were the same as the two-factor solutions for each national sample considered separately.

Rotated Factor 1 (accounting for 24.4% of the total variance) is defined by items attributing negative effects to the computer, prevalently in *psychological-cognitive* terms, in the areas of education, creativity, play, and sociability-socialization. This factor mostly refers to the possibility of psychological damage or limitation deriving from the use and spread of computers (e.g., Items 15 and 46 in Table 1).

Rotated Factor 2 (accounting for 8.3% of the total variance) is defined by items attributing negative effects to the computer—but also to science and technology—chiefly in *social* terms. See, for example, item 16 in which technological development is equated with "severe damage to nature and to humanity." The negative effects are often seen in the areas of social control and social organization (e.g., Items 4, 55, and 14).

Rotated Factor 3 (accounting for 6.7% of the variance) is defined by items concerning a positive attitude toward technology in general, and positive influences of the computer, on both the psychological level (e.g., Item 33) and the social level (e.g., Items 22 and 36).

GROUP COMPARISONS OF FACTOR SCORES

In the analysis of variance model used, the factor scores, calculated for each subject for each of the three rotated factors, were treated as dependent variables; whereas the sociocultural features—country (United States and Italy), field of study (humanities, psychology, science, and engineering), and gender—were treated as independent variables. The level of significance of the differences was chosen with p equal to or less than 0.01. The analysis of variance showed that country ($F(1, 304) = 24.32, p = .000$), gender ($F(1, 304) = 13.07, p = .000$), and field of study ($F(3, 304) = 4.62, p = .004$) produced significant effects on Factor 1, negative attitudes toward the effects of the computer prevalently in psychological-cognitive terms. There were no significant interactions. In order of increasing effect, students in psychology and the humanities, females, and Italians are significantly more negative about the computer's psychological and cognitive effects than are students in the sciences and engineering ($p < .01$, Duncan's post hoc test), males, and Americans.

Country ($F(1, 304) = 27.78, p = .000$) and field of study ($F(3, 304) = 6.26, p = .000$) (but not gender) are the variables that produced the main effects on Factor 2, negative attitudes toward social effects of computers. Americans and students of psychology and the humanities fear the computer's social effects significantly more than do Italians or students of science and technology ($p < .05$, Duncan's post hoc test).

Like Factor 2, analysis of variance on Factor 3, positive attitudes toward technology and computers, shows significant main effects for the variables of nationality ($F(1, 304) = 11.16, p = .001$) and field of study ($F(3, 304) = 4.27, p = .006$) (but not gender). Students in Los Angeles are more positive than those in Rome, whereas students in the humanities are distinctly less positive ($p < .05$, Duncan's post hoc test) in comparison to students of all other fields about the role of science, technology, and computers.

DISCUSSION

For all three factors, culture generally made a bigger difference to attitudes than did gender or field of study. Nevertheless, students in both countries were overall more positive than negative about computers. An exception to generally positive attitudes occurred in the negative evaluation of video games (where Italians were also more extreme). In this case, the presence of negative opinions about video games (all but one of the items concerning these are evaluated negatively) is an example of negative stereotyping toward the computer that contrasts with a whole series of experimental proofs of the stimulation of different intellectual abilities by video games (cf. Greenfield, 1993; Greenfield & Cocking, 1994).

In terms of cultural differences, Italians are less fearful of the social uses of computers than are Americans. This may reflect both the greater emphasis on the social group (versus the individual) in Italy and the greater problems of highly bureaucratized social institutions in Italy. Another explanation of this greater fear is that it may be the result of a more widespread use for this purpose in the United States, from computerized expert systems used by government agencies for tax audits and crime control to databases available to politicians preparing electoral campaigns, all of which has caused much controversy. In Italy, the lack of application of computers in these sectors makes such clearly defined attitudes less probable. Americans, in contrast, are less fearful of problems with applications of computers that develop the individual. Finally, the more positive attitudes toward both kinds of items in Factor 3 by students in the United States may simply reflect a more optimistic, less critical cultural outlook in the United States. It is interesting that the greater diffusion of computers in the United States did not lead to more positive attitudes across the board. Instead, the computer as tool was assimilated to preexisting cultural attitudes, yielding different patterns of positive and negative attitudes within each culture.

The overall results are congruent with the previous data of De Grada et al. (1987) in which attitudes clustered around three parallel factors. The consistency of the latent dimensions of attitudes to computers, to technology and to science in general, and of the influence of sociocultural features on the orientation of those attitudes was confirmed. In the present study, the first dimension relates to potential negative effects of the computer on cognitive/educational processes and on the individual's intercourse with the world. People who view the computer as having a negative cognitive and educational effect also view it as having an isolating effect on the individual. In essence, subjects tended to hold consistent attitudes concerning the computer's potential negative effect on the individual.

The second dimension relates to the possible negative effect of the computer on social institutions (work, social control, justice) and socially sanctioned rights (privacy). It also includes negative attitudes toward science and technology more generally. A subject who agrees that the computer has a negative effect on one social institution will tend to see negative effects on other social institutions, as well as negative effects of science and technology more generally.

The third factor consists mainly of positively worded items about computers and science. It includes the effect of the computer at both the individual and societal levels. Given that the content is somewhat similar to the other two factors, one wonders if this factor may indicate the extent to which an individual will accept positive (as opposed to rejecting negative) images of the computer and science more generally.

The sociocultural trends distinguished by De Grada et al. (1987) are confirmed. Gender makes less attitudinal difference than does field of study. Within field of study, humanities and psychology students have more negative and less positive attitudes than do their peers in science and technology toward the individual and social impact of computers, science, and technology. The humanists, in particular, are very distinctly less positive toward the role of computers, technology, and science. Science students, by contrast, along with their engineering peers, show a more positive and less negative attitude toward various social applications of computers, science, and technology; they also show a greater reluctance than any other subsample to agree with the supposed negative impact of computers in the individual psychological sphere.

In terms of gender differences, the results show a distinction between male and female students only with respect to the negative effects on the individual: females agree with statements concerning these negative effects significantly more than males do. This finding confirms a persistent division of sexual roles, but it is of reduced importance in comparison to more consistent occupational differences and even larger cultural differences.

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