
The Dynamic Adjustment of Physical Self in Adults

Grégory Ninot*, Marina Fortes, Didier Delignières, & Christophe Maïano

University of Montpellier I, France

ABSTRACT - This study examined the dynamics of global self-esteem and physical self-perception in eight sedentary adults. Each participant completed the shortened version of the Physical Self Inventory, which measured global self-esteem (GSE), physical self-worth, and four physical sub-domains, everyday between 7:00 and 9:00 a.m. and 7:00 and 9:00 p.m. over the year 2001. Two weeks later, they completed the same inventory in an isolated room every 5 minutes for 4 hours and 15 minutes. The auto-regressive integrated moving average (ARIMA) procedures showed that the dynamics of GSE and physical self dimensions were non-stationary over two consecutive semesters or one year. The ARIMA indicated that all the perceived dimensions functioned as a moving average model (0, 1, 1) without significant constant. Inversely, the time series obtained in an isolated room showed 88% random oscillations around a local value, which indicated a (0,0,0) model.

Global self-esteem represents one's general or typical feelings of self-worth and self-liking (Greenier, Nicolson, Berkhof, & de Vries, 1999). The term physical self, on the other hand, has a more specific meaning. It reflects the domain of perceptions of one's body, and the corresponding feelings of physical self-worth, with these perceptions particularly focused on sub-domains such as physical condition, sport competence, physical strength, and attractive body (Fox & Corbin, 1989; Sonstroem, Speliotis, & Fava, 1992; Sonstroem, Harlow, & Josephs, 1994). Classic works in social psychology using questionnaires with Likert-type response scales and a few reports presenting longitudinal data have shown that the mean group level of global self-esteem and physical self does not significantly differ over time in adults (Burke, Kraut, & Dworkin, 1984; Cheek & Hogan, 1983; Costa & McCrae, 1988; Demo, 1992; McCrae & Costa, 1994; Mortimer, Finch, & Kumka, 1982), suggesting good stability across situations for these two concepts. This stability in self-perception may reflect self-consistency with the development of feelings of unity, independence, predictability, and control (Epstein, 1979). The notions of *self-schemata* (Markus, 1977) and the *primary basis of security* (Rogers, 1959) were advanced as explanations of this stability such that, if an individual were to experience no critical life events, and if measurement error could be eliminated by directly assessing the content of the person's mind, global self-esteem would be characterized as a single point on an appropriately labeled scale. The purpose of this study was to examine how global self-

*Grégory Ninot, Université Montpellier I, Faculté des Sciences du Sport et de l'Éducation Physique; UFR STAPS; 700 avenue du Pic St-Loup, 34090, Montpellier, France; gregory.ninot@univ-montpl.fr (email).

esteem and the physical self dimension function over time at an intra-individual level using a brief questionnaire, daily assessment and time series analyses.

According to dynamical psychology, the declarative perception of the self is a highly complex process (Nowak, Vallacher, Tesser & Borkowski, 2000). Global self-esteem and physical self can be considered as phenomena emerging from several interactions in brain activity. The mind cannot be reduced to separate mechanisms, but instead mutual influences and coordination must be taken into account. Specific brain structures carry out cognitive and emotional functions in parallel but also interact to produce higher order structures with emergent properties. Behavior, for example, can be conceived of as a property emerging from the interplay of the many elements included in a system. Recent examples of behavior viewed from this perspective can be found in the literature on interpersonal relationships (Felmlee & Greenberg, 1999; Guastello & Guastello, 1998). According to this conception, however, researchers need to assess not only the level of self-perception (mean score), but also the variability (standard deviation) and intra-individual dynamics over time. Intra-individual study has become particularly interesting because it provides a formal framework for investigating the collective properties of the self (Amorose, 2001). Within this framework, it is possible to capture basic and robust features of self-concept organization and to investigate its processes (Nowak et al., 2000). The hierarchical model of global self-esteem and physical self developed by Fox and Corbin (1989) could be considered as a complex system subjected to several constraints over time.

A number of mathematical procedures are available to model the dynamics of time series according to an iterative equation: $y_t = f(y_{t-1})$, where y_t corresponds to an observation at t time. The Auto-Regressive Integrated Moving Average (ARIMA) procedures are used to analyze the internal dynamics of time series (Box & Jenkins, 1976). Recent experiments using these procedures have focused on motivation (Guastello, Johnson & Rieke, 1999), chronic fatigue syndrome (Jason, Tryon, Taylor, King, Frankenberry & Jordan, 1999), and quality of life (Barge-Schaapveld, Nicolson, Berkhof & de Vries, 1999). The procedures are based on auto-correlation and partial auto-correlation functions which provide information on time dependence in the series. Modeling is accomplished by the potential association of three kinds of mathematical processes: auto-regressive, integrated and moving average (MA). The model takes the form (p,d,q) , where p indicates the number of auto-regressive parameters, d the number of differencing parameters, and q the number of MA parameters. If we assimilate self-esteem and physical self functioning as an iterative equation, then three categories of the ARIMA model are exhibited: fixed equilibrium, dynamic equilibrium, and exogenous dependence.

Fixed equilibrium functions as random oscillations (corresponding to a systematic measurement error) around a reference value (the mean of the time series). The subject actively resists change and thus demonstrates impressive stability in her or his self-image, as a personality *trait* (Burke, Kraut, & Dworkin, 1984; Coopersmith, 1967; Epstein, 1979; McCrae & Costa, 1994; Mortimer et al., 1982). The fluctuations that may be noted across multiple assessments of daily self-esteem are considered to reflect unreliable responding rather than meaningful psychological processes. Major importance is given to maintaining the stability of self (Duval & Wicklund, 1972; Markus & Wurf, 1987; Sedikides & Skowronski, 1997; Swann, 1990; Tesser, 1988). According to the ARIMA procedures, this iterative equation, referred to as $(0,0,0)$, functions like this: $y_t = \mu + \epsilon_t$ (1) where y_t is the value observed at time t , μ is the mean of the time series, and ϵ_t is a random measurement error demonstrating white noise. This equation characterizes a stable reference value associated with weak and random measurement error fluctuations.

Dynamic equilibrium is also based on several oscillations around a reference point, though it denotes a tendency to return to a fixed-point attractor on a longer time scale (Nowak et al., 2000). Over time, the dynamics of any system tend to cohere into reliable patterns, referred to as attractors. In this particular case, the subject maintains a relatively stable and positive self-evaluation despite a high number of negative elements in his or her self-system (Nowak et al., 2000). She or he concentrates on the positive regions and disregards the negative regions (Pelham & Swann, 1989; Showers, Abramson & Hogan, 1998). Compared to *fixed equilibrium* functioning, the time needed to return to the reference value can be much longer, and the magnitude of oscillations can be higher. The system may react to endogenous or exogenous influences. The influences tend to be short-lived, however, so that the system quickly returns to its attractor. Occasionally, the reference value will change because of an event judged to be important by the person. At that point, the self-system is pushed to a new equilibrium level, making it difficult to return to its initial state (Nowak et al., 2000). Although this process needs more time to recover the reference value, the resulting ARIMA model is the same as the preceding (0,0,0).

The *exogenous dependence* model of perceived self-esteem and physical self characterizes extremely reactive functioning, with high dependence on environmental change. Both major and minor life events and experiences cause self-perceptions to change: Self-esteem varies as a function of daily events (Butler, Hokanson & Flynn, 1994; Nezelek & Plesko, 2001). The system thus evolves without any reference point, as a *personality state* (Butler et al., 1994; Cattell, 1973; Leary, 1990). Self-esteem or physical self becomes situation-specific and, as a consequence, unstable. It functions as a systematic assimilation of endogenous or exogenous influence. An auto-regressive model (1,0,0) supposes that each point is explained by a constant (μ), plus the weighted mean (ϕ) of the preceding measure, plus the random error. This model is related to short-term adaptation: $y_t = \phi y_{(t-1)} + \varepsilon_t$ (2).

The fourth possibility is the *dynamic adjustment* of self-esteem and physical self. This system functions as an iterative model based on MA (0,1,1), without a significant constant, which is defined by terms of y_{t-1} , a differencing parameter; $-\theta\varepsilon_{(t-1)}$, a fraction of previous measurement error; and ε_t the random measurement error. The MA model suggests that the time series is based on a local reference value that evolves slowly with time. Individuals tend to experience slight variations rather than dramatic shifts in their self-evaluations (Kernis, Grannemann & Barclay, 1989; Kernis, Grannemann & Mathis, 1991; Demo, 1992). The MA (0,1,1) model without significant constant characterizes a dynamic association of adaptive and conservative functioning over time: $y_t = y_{(t-1)} - \theta\varepsilon_{(t-1)} + \varepsilon_t$ (3).

The present study assessed the intra-individual dynamics of global self-esteem and physical self in eight sedentary adults over periods of four hours and 15 minutes, six months, and one year to determine the effects of time period and ecological conditions. The first hypothesis was that the means but not the standard deviations of global self-esteem and physical self measured twice a day would be similar over two consecutive periods of six months. The second hypothesis was that any fluctuations over different periods, i.e., six months and one year, would conform to an MA (0,1,1) model without significant constant and not to a (0,0,0) model. The third hypothesis, however, supposed that a (0,0,0) model would operate in conditions of isolation in an empty room for a period of several hours.

Method

Participants

The participants were eight healthy adults, four men (A: 25 years old; B: 28; C: 42; D: 31) and four women (E: 24 years old; F: 24; G: 29; H: 24). They were all employed (five were also students). The participants came from middle-class backgrounds. None had pharmacologically treated psychiatric disorders or severe medical illness and none had recently undergone major negative life events that would have affected psychological function over the one-year period. All gave informed written consent to participate.

Measures

The Physical Self Inventory (PSI-6), which has been validated in French (Ninot et al., 2001), was used to assess global self-esteem and physical self components (Fox & Corbin, 1989). This instrument measures six dimensions: global self-esteem, physical self-worth, physical condition, sport competence, physical strength, and attractive body (Table 1) using a visual analog scale. This scale was chosen, rather than a traditional Likert scale, to prevent learning effects with repeated measurements. The questionnaire was completed on personal computer using dedicated software, a procedure that helped to avoid biases such as social desirability. The six items were always presented in random order to reduce the likelihood of systematic responses. The participants had to move the cursor along a line anchored by "not at all" at the left extremity and "absolutely" at the right. The software then determined the cursor's distance from the left extremity and converted the response to a score ranging from 0.0 to 10.0. The participants were also asked to move the cursor to the center of a 10-cm horizontal visual analog scale. This additive item was designated to estimate the measurement error corresponding to the difference between the true value (5 cm, center of the 10-cm line) and the response mark. Participants were not informed of these numerical scores and were not allowed to consult their previous responses.

Table 1
Items of the Physical Self Inventory – Short Version
(Ninot, Fortes, & Delignières, 2001)

Category	Item
Global self-esteem	Globally, you have a good opinion of yourself
Physical self-worth	Physically, you are proud of who you are and what you can do
Physical condition	You would be good in an endurance test
Sport competence	You manage well in all sports
Attractive body	You think that you have a pleasant body to look at
Physical strength	When you come to situations requiring strength, you are among the first to step forward

Procedure

For the first experiment, which tested the first two hypotheses, each participant completed an inventory on personal computer twice a day between 7 and 9 a.m. and 7 and 9 p.m. over a one-year period (from January to December 2001). The participants completed the PSI-6 as they went about their everyday activities, and they based their responses on how they felt at the moment they were completing each form. The participants assessed their immediate, contextually based feelings of self-perception. The individual time series presented 728 observations per dimension over a period of one year, and 364 over a six-month period.

For the second experiment, which tested the third hypothesis, each participant

completed the PSI-6 on personal computer every five minutes over four hours and 15 minutes. The participants remained in an empty room without interruption over this period. The inventory items, including the item to measure error, were presented in random order for each session. The individual time series presented 51 observations per dimension.

Statistical analyses

Statistical analysis focused on the individual time series. For the first hypothesis, the means and standard deviations of the 364 observations from the two consecutive six-month periods were compared for the six perceived dimensions and the measurement error using a paired *t*-test.

For the second and third hypotheses, the ARIMA procedures were applied to determine the underlying iterative functioning of the time series and to infer the subjacent psychological processes (Spray & Newell, 1986; Guastello et al., 1999). ARIMA procedures are mainly based on analysis of auto-correlation and partial auto-correlation functions, which are essential diagnostic instruments to identify the dependence structure of the series (Box & Jenkins, 1976). The auto-correlation is the correlation of the series with itself, lagged by a particular number of observations. The partial auto-correlation is the partial correlation of a series with itself, lagged by a particular number of observations and controlling for all correlations for lags of lower order. For example, the partial auto-correlation for a lag of 2 represents the unique correlation of the series with itself at that lag, after controlling for the correlation at lag 1.

A particular case is encountered when such auto-correlations appear to be near zero for any time-lag separation ($p > .05$). This function characterizes a random or white noise process obeying Equation 1, which characterizes random oscillations around a reference value over time and thus constitutes an ARIMA (0,0,0) model. This process is termed stationary since the mean of the series is constant and does not depend on time. Mathematically, the stationarity of a time series refers to the time invariance of the data-generating process, revealed by the stability of the mean and variance over time. Stationarity with respect to the mean implies that time series fluctuate around a constant value over time. Thus, the auto-correlation plot of a stationary variable will usually decay into noise and/or hit negative values within three or four lags. The psychological interpretation of such a stationary model is that subjects develop a stable reference around which responses randomly fluctuate (*fixed equilibrium* or *dynamic equilibrium* model).

For the *exogenous dependence* and *dynamic adjustment* models, time series of global self-esteem and physical self should display time-dependent behavior, revealed by significant peaks in the auto-correlation function, and in this case the modeling will have recourse to the combination of the auto-regressive, integrated and MA processes. In such cases, it is necessary to determine which processes need to be included and how many parameters are sufficient to fit the data and then to establish the value of each parameter ϕ and θ for the respective auto-regressive and MA processes.

The typical signature of an auto-regressive process is a slow decay in the auto-correlation function and a sharp cut-off in the partial auto-correlation function, which presents a limited number of significant peaks. The number of significant correlations in the partial auto-correlation indicates the number of auto-regressive parameters to include in the model. An auto-regressive process suggests that the current value is determined by a weighted sum of the preceding values. For example, an auto-regressive process of order 1 obeys Equation 2.

As the ARIMA procedures consist of building models on time series that are stationary by nature, the series have to be rendered truly stationary by transformation. The presence

of positive and persistent auto-correlations in the auto-correlation function (up to 10 lags, for example) implies the need to introduce at least one differencing parameter (I) into the model. Differencing operates by subtracting the previous value from the current one. For first-order differencing, the current value is thus considered, on average, as equal to the preceding value, plus a constant. This differencing eliminates the trend and stationarizes the series. To determine whether stationarity has been achieved, one may examine the auto-correlation function of the differenced series, which should converge quite rapidly to zero as the value of the lag increases. Moreover, to determine whether the differencing is appropriate, one may confer on the *portemanteau* test, based on the examination of the Box-Ljung statistics (Q). If Q remains significant, it means that differencing only removes the trend and that the MA or auto-regressive parameters need to be included. More complex trends may be modeled by second-order differencing when the auto-correlation function of the differenced series presents the persistence of significant auto-correlation for more than 10 lags. Conversely, the appearance of one significant negative auto-correlation at lag 1 (above -0.5) tends to arise in series which are slightly overdifferenced. Finally, if the variance of the series increases over time, a log transformation of the data set can be performed to correct the variance nonstationarity.

The second step is to identify the MA parameters to include in the model through examination of the auto-correlation and partial auto-correlation functions of the (stationarized) series. The typical MA signature corresponds to a slow decrease in the partial auto-correlation function while the auto-correlation function displays a sharp cut-off presenting significant spikes only for the very first lags. The number of significant correlations in the auto-correlation function indicates the number of MA parameters to include in the model. Obtaining inverse patterns for these two functions means that auto-regressive processes can more relevantly model the series. One should note that an MA signature is commonly associated with negative auto-correlation at lag 1, often introduced by differencing.

An MA process implies that the current value is determined by the weighted average of the preceding values. Since the series is stationary, this process is defined as the sum of the mean of the series plus the weighted sum of the errors associated with the preceding values. Thus an MA process of order 1 obeys Equation 3. This model (also called the *simple exponential smoothing model*) is typical of times series that exhibit noisy fluctuations around a slowly varying mean.

The obtained models are submitted to a multi-criteria evaluation: (i) each coefficient in the model should be statistically significant, (ii) the residuals should represent a white noise process without any time dependence, and (iii) the standard deviation of the residuals should be lower than the standard deviation of the original series (Box & Jenkins, 1976).

For the second hypothesis, since self-esteem and physical self are assumed to be sensitive to environmental changes with a slow change, MA models with one differencing without significant constant (0, 1, 1) were expected over the two periods (Equation 3). For the third hypothesis, we expected to find a (0,0,0) process for perceived dimensions characterizing random oscillations around a reference value over four hours and 15 minutes (Equation 1).

Results

Mean Score and Standard Deviation Over Two Consecutive Periods of Six Months

Table 2 presents the descriptive results over the two consecutive periods of six months. The paired *t*-test revealed no differences in the mean score of any auto-evaluative dimension between the two semesters. The paired *t*-test revealed only one standard

deviation of global self-esteem significantly higher for semester 1 compared to semester 2 ($p < .05$). The other comparisons for standard deviation showed no significant differences.

Table 2
Descriptive Values of Global Self-Esteem and Physical Self over Two Consecutive Semesters

			A(M)	B(M)	C(M)	D(M)	E(W)	F(W)	G(W)	H(W)	<i>p</i>
ME	Sem 1	M	0.08	0.07	0.07	0.08	0.10	0.08	0.08	0.08	
		SD	0.12	0.12	0.16	0.12	0.13	0.12	0.13	0.12	
	Sem 2	M	0.04	0.04	0.01	0.06	0.05	0.04	0.09	0.04	0.50 ($t = 0.70$)
		SD	0.11	0.11	0.16	0.11	0.11	0.10	0.12	0.11	0.11 ($t = 1.77$)
GSE	Sem 1	M	9.11	8.36	7.24	7.43	5.18	7.49	6.67	6.25	
		SD	0.47	0.84	0.60	0.53	1.08	0.54	0.66	0.85	
	Sem 2	M	9.37	8.66	7.10	7.49	5.37	7.10	7.13	5.58	0.95 ($t = -0.06$)
		SD	0.29	0.75	0.59	0.54	0.69	0.44	0.28	0.25	0.03 ($t = 2.84$)
PSW	Sem 1	M	8.53	7.71	6.91	6.46	4.90	7.31	6.58	7.40	
		SD	0.41	1.11	0.58	0.81	1.29	0.57	0.84	0.33	
	Sem 2	M	8.79	8.04	6.83	6.64	2.69	6.90	7.22	7.33	0.94 ($w = 2.0$)
		SD	0.27	1.11	0.56	0.96	0.59	0.49	0.27	0.35	0.16 ($t = 1.57$)
PC	Sem 1	M	8.52	6.69	6.37	6.06	4.73	6.76	6.68	6.66	
		SD	0.42	1.21	0.52	1.01	1.19	0.76	0.68	0.42	
	Sem 2	M	8.81	6.86	6.26	6.36	2.48	6.23	7.24	6.46	0.50 ($t = 0.70$)
		SD	0.26	1.30	0.49	1.23	0.63	0.67	0.27	0.34	0.19 ($t = 1.42$)
SC	Sem 1	M	8.53	7.15	6.49	6.15	5.51	7.10	6.60	7.01	
		SD	0.41	1.12	0.48	0.79	1.36	0.69	0.76	0.35	
	Sem 2	M	8.81	7.28	6.41	6.31	6.54	6.57	7.25	6.82	0.33 ($t = -1.05$)
		SD	0.25	1.08	0.50	0.95	0.78	0.55	0.28	0.31	0.11 ($t = 1.77$)
AB	Sem 1	M	9.17	6.70	7.20	6.43	5.33	7.37	6.62	7.07	
		SD	0.41	1.50	0.50	0.68	1.00	0.55	0.61	0.34	
	Sem 2	M	9.40	6.88	7.11	6.58	6.12	7.03	7.04	6.97	0.25 ($t = -1.26$)
		SD	0.26	1.69	0.47	0.82	0.64	0.54	0.27	0.29	0.31 ($t = 1.08$)
PS	Sem 1	M	8.10	6.69	6.27	5.97	4.63	6.78	6.84	6.12	
		SD	0.28	1.41	0.50	0.91	1.26	0.62	0.63	0.36	
	Sem 2	M	8.17	6.91	6.34	6.22	2.43	6.37	7.31	5.98	0.50 ($t = 0.70$)
		SD	0.27	1.58	0.39	1.05	0.56	0.50	0.29	0.31	0.24 ($t = 1.28$)

Note. Minimum and maximum scores with a 10-centimeter visual analog scale, respectively 0 and 10; ME = measurement error (each participant drew a mark in the middle of the horizontal visual analog scale corresponding to 5 centimeters, the data are shown in terms of difference from 5); GSE = global self-esteem; PSW = physical self-worth; PC = physical condition; SC = sport competence; AB = attractive body; PS = physical strength; Sem = semester.

Table 3
Coefficient Value θ of the MA Model (0,1,1) Without Significant Constant on Global Self-Esteem, Physical Self-Worth and Sub-Domains in Eight Adults Over a One-Year Period ($p < .001$)

		A(M)	B(M)	C(M)	D(M)	E(W)	F(W)	G(W)	H(W)	p
	Sem 1	0.79	0.65	0.70	0.41	0.64	0.90	0.29	0.72	0.42 ($t = 0.86$)
GSE	Sem 2	0.47	0.72	0.39	0.39	0.66	0.64	0.48	0.85	
	Year	0.68	0.67	0.55	0.40	0.65	0.71	0.37	0.76	
	Sem 1	0.86	0.53	0.72	0.55	0.54	0.74	0.51	0.62	0.53 ($t = 0.66$)
PSW	Sem 2	0.55	0.60	0.57	0.38	0.68	0.62	0.38	0.92	
	Year	0.75	0.56	0.64	0.49	0.56	0.64	0.47	0.77	
	Sem 1	0.79	0.52	0.77	0.49	0.57	0.65	0.46	0.54	0.94 ($t = -0.07$)
PC	Sem 2	0.63	0.52	0.65	0.40	0.76	0.74	0.34	0.78	
	Year	0.73	0.52	0.72	0.45	0.61	0.71	0.40	0.62	
	Sem 1	0.83	0.58	0.74	0.56	0.62	0.72	0.28	0.71	0.24 ($t = 1.27$)
SC	Sem 2	0.57	0.57	0.55	0.49	0.52	0.65	0.30	0.90	
	Year	0.73	0.58	0.66	0.52	0.60	0.67	0.29	0.82	
	Sem 1	0.82	0.56	0.64	0.42	0.65	0.62	0.43	0.74	0.16 ($t = 1.55$)
AB	Sem 2	0.43	0.55	0.62	0.39	0.56	0.51	0.30	0.87	
	Year	0.67	0.56	0.63	0.40	0.62	0.55	0.38	0.80	
	Sem 1	0.86	0.52	0.65	0.35	0.48	0.70	0.65	0.64	0.74 ($W = 6.00$)
PS	Sem 2	0.54	0.56	0.68	0.52	0.74	0.73	0.19	0.85	
	Year	0.77	0.53	0.66	0.43	0.52	0.72	0.53	0.74	

Dynamics of Self-Esteem and Physical Self Over Six Months and One Year

All time series of self-perception (144) presented long-trend auto-correlation functions. Each of them exhibited significant and progressive decline in auto-correlation coefficients from lag 1 to a high number of lags ($p < .05$). This assumes that the time series are non-stationary and have a constant average trend. Moreover, the best and significant auto-correlation coefficient was always found at lag 1. Conversely, no significant auto-correlation or partial correlation coefficients were observed for any time series for the measurement error item. Thus, the best ARIMA model for the measurement error time series was systematically (0,0,0), corresponding to Equation 1.

The lag 1 auto-correlation of the self-perception time series led to a negative value, thus the series did not need further differencing. After fitting an ARIMA (0,1,0) model without constant, the standard deviation was reduced, indicating that the trend had been completely eliminated. The auto-correlation function displayed a sharp cut-off while the partial auto-correlation function decayed slightly (i.e., had significant spikes at higher lags), thus suggesting an MA signature. MA models (0,1,1) without significant constant were noted in all time series ($p < .001$). Table 3 shows the θ coefficient of the MA model. Global self-esteem and physical self presented the same MA dynamics over the three periods: the first semester of 2001, the second semester of 2001, and the entire year. No

significant differences were found between the coefficients of semesters 1 and 2. Figures 1 and 2 illustrate, respectively, the dynamics of global self-esteem and the measurement error for participants C and G over 2001. Figure 3 illustrates the dynamics of physical self-worth and the measurement error for participant F over 2001.

Figure 1
Change in Global Self-Esteem (Upper Curve) and Measurement Error (Lower Curve) in Participant C(M) Over the Year 2001 (Two Measures Per Day, Minimum and Maximum Scores, Respectively, 0 and 10)

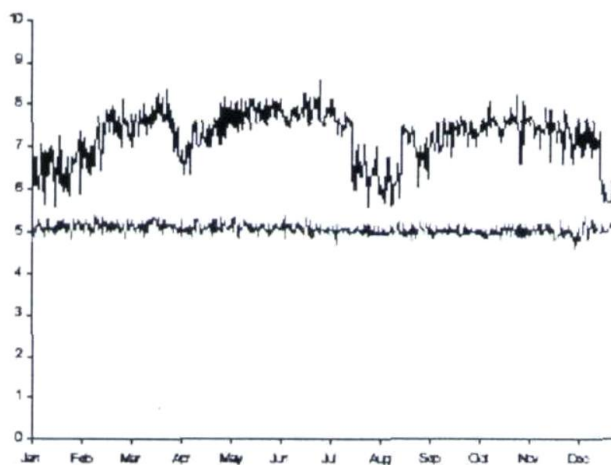


Figure 2
Change in Global Self-Esteem (Upper Curve) and Measurement Error (Lower Curve) in Participant G(W) Over the Year 2001 (Two Measures Per Day, Minimum and Maximum Scores, Respectively, 0 and 10)

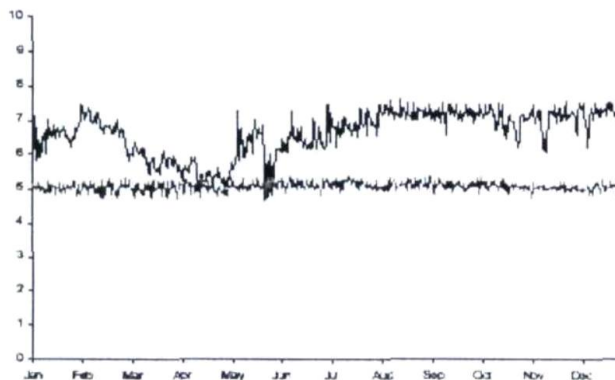


Figure 3

Change in Physical Self-Worth (Upper Curve) and Measurement Error (Lower Curve) in Participant F(W) Over the Year 2001 (Two Measures Per Day, Minimum and Maximum Scores, Respectively, 0 and 10)

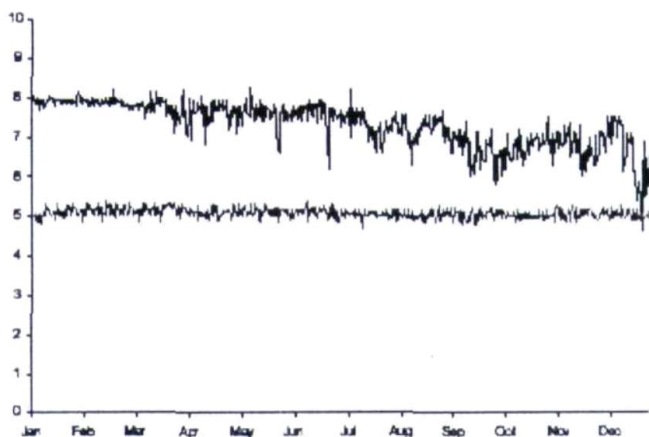
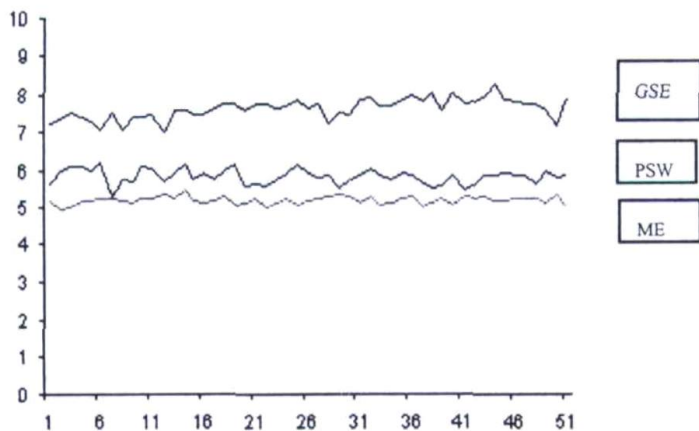


Figure 4

Change in Global Self-Esteem (GSE), Physical Self-Worth (PSW) and Measurement Error (ME) in Participant D(M) Over Four Hours and 15 Minutes (One Measure Every Five Minutes; Minimum and Maximum Scores, Respectively, 0 and 10)



Dynamics of Self-Esteem and Physical Self Over Four Hours and Fifteen Minutes

Most of the time series did not present a long-trend auto-correlation function and thus did not need to be differentiated following a first-order procedure. This assumes that the time series were stationary. The observations reflected white noise with small variability. ARIMA models (0,0,0) were noted for 49 of the 56 time series, or 88% of the models. Figure 4 shows the dynamics of global self-esteem, physical self-worth and measurement error for participant D. The other models were MA without significant constant (0,1,1): global self-esteem ($\theta = 0.43$), physical self worth ($\theta = 0.67$), and physical strength ($\theta = 0.67$) for participant C; physical self worth ($\theta = 0.69$) for participant D; sport competence ($\theta = 0.65$) for participant E; physical self worth ($\theta = 0.93$), and sport competence ($\theta = 0.88$) for participant H.

Discussion

The results supported the first hypothesis that the adults would present stable mean scores of global self-esteem, physical self-worth, and the physical sub-domains between two consecutive periods of six months. The individual systems of self-perception maintained their scores of self-perceptions over a period of one year. However, the significant difference in the standard deviation of global self-esteem scores indicated that these adults reduced their fluctuations during the second semester. This intra-individual result supports the assumption of several authors that global self-concept scales referring to no particular domain are more subject to short-term mood, situational, and context effects that disrupt stability than are the scales specific to a particular domain (Amorose, 2001; Marsh & Byrne, 1993; Marsh & Yeung, 1998). The results presented in Figures 1, 2 and 3, however, indicate that the variability in self-perceptions was different from the variability in the measurement error item. Consequently, the descriptive indicators of variability were insufficient to determine the psychological process that produces global self-esteem and physical-self perception.

The second hypothesis was that global self-esteem and physical self dynamics would not be related only to measurement error over a period of six months or one year, suggesting that individuals actively resist changing in response to life events and return quickly and systematically to a reference value in cases of impact. The results showed clearly that the 144 auto-evaluative dimensions fluctuated over two consecutive periods of six months or over a one-year period more than the 24 time series resulting from the measurement error item. The global self-esteem and physical self (i.e., physical self-worth and sub-domains) time series were neither stationary nor random. The significant auto-correlation, including a progressive decrease from lag 1, indicated that the perceived process of global self-esteem and physical self functioned with short-term history for each participant.

The ARIMA procedures showed 100% of the MA (0,1,1) model associated with one differencing and a non-significant constant, also called the simple exponential smoothing model. The results showed that the θ coefficient was quite similar for global self-esteem and the perceived physical dimensions over the same period. This indicates that the dynamics of global self-esteem and physical self in an adult confronted with several constraints tend to show the same pattern of change. In detail, the first part of the MA (0,1,1) equation ($y_t = y_{(t-1)} + \dots$) proposes an adaptive function, as an individual iterative functioning based on historicity over a short period that generates self-esteem maintenance and resistance to incoming information (Markus & Wurf, 1987; Sedikides & Skowronski, 1997; Tesser, 1988). The second part of the MA (0,1,1) equation is related to a conservative function, $-\theta \epsilon_{(t-1)}$, corresponding to a fraction of the random shock emerging from the previous auto-evaluation (a sort of correction of previous adaptations).

The third part of the MA (0,1,1) equation, $+\epsilon_t$, is a reaction to the random shocks of daily events (perceptible and/or imperceptible impact). Thus, neither global self-esteem nor physical self is an attractor that functions as a stable principle (McCrae & Costa, 1994) or *dynamic equilibrium* (Headey & Wearing, 1989; Nowak et al., 2000) over time. The system did not oscillate around one reference value (μ) and/or it did not tend to come back to this reference after a perturbation. The system exhibited noisy fluctuations around a slowly varying mean. However, global self-esteem and physical self measured over time did not function as an exogenous dependent model either (Markus & Wurf, 1987). The combined effects of the three processes led to a slow evolution of the local value of the series under the influence of life events. The results thus indicated that a *dynamic adjustment* governed the changes in global self-esteem and physical self. This moving average model suggests that the dynamics of the time series were based on a local reference value that evolved slowly over time. From a clinical point of view, Equation 3 indicates that the closer the θ coefficient was to 0, the less conservative the system was and the less it resisted to environmental stimuli. The low θ coefficient reflected low historical consistency, which can be interpreted as unstable self-esteem, fragile and vulnerable self-worth, an over-dependence on the love and approval of significant others, a heightened tendency to be ego-involved in every day activities, excessive dependency needs, over-reliance on the evaluations of others, and an impoverished self-concept (Butler et al., 1994; Kernis et al., 1989; Rosenberg, 1986; Tennen & Affleck, 1993; Greenier et al., 1999).

Biological systems are often characterized by spontaneous behaviors having a high level of stability and reproducibility (Kelso, 1995). Our study indicates that the same may be said of psychological systems. The similar patterns of the participants (model with one MA parameter, one differencing parameter and a non-significant constant) suggest that the intra-individual dynamics of self-perception were stable over time with slow change. The θ coefficient reflected a tendency to conserve a local value of self perception. This tendency may reveal the presence of an attractor linked to the dynamic of self. Further research is needed to explore this hypothesis over a longer period and in function of specific impacts.

The third hypothesis was that global self-esteem and physical self dynamics were only related to white noise fluctuations around a defined value over a period of four hours and 15 minutes in a closed room without stimulation. The results showed that 88% of the auto-evaluative dimensions did not significantly fluctuate over this period—no more than the measurement error item. This suggests that individuals actively resist change and return to a local reference value under conditions of a confined environment with no interruption. Thus, self perception seems to function linearly in this particular condition. However, the fact that 12% of the time series functioned as an MA (0,1,1) model suggests that certain auto-evaluative dimensions oscillate during short periods lacking internal or environmental constraints.

To conclude, this study showed the same dynamics of global self-esteem and physical self scores over two consecutive periods of six months in eight sedentary adults living in their own ecological environment. The individuals exhibited noisy fluctuations around a slowly varying mean. When the environmental impact was restrained to a minimum for several hours, the dynamics showed massively only white noise fluctuations around a stable value. The ARIMA procedures provided a quite reasonable model of the psychological processes underlying the dynamics of self-esteem and physical self.

References

- Amorose, A. J. (2001) Intraindividual variability of self-evaluations in the physical domain: prevalence, consequences, and antecedents. *Journal of Sport and Exercise Psychology*, 23, 222-244.
- Barge-Schaapveld, D. Q., Nicolson, N. A., Berkhof, J., & de Vries, M. W. (1999). Quality of life in depression: daily life determinants and variability. *Psychiatry Research*, 88, 173-189.
- Box, G. E., & Jenkins, G. M. (1976). *Time series analysis: forecasting and control*. Oakland: Holden-Day.
- Brown, J. D. (1998). *The Self*. Boston: McGraw-Hill.
- Butler, A. C., Hokason, J. E., & Flynn, H. A. (1994). A comparison of self-esteem liability and low trait self-esteem as vulnerability factors for depression. *Journal of Personality and Social Psychology*, 66, 166-177.
- Burke, P. A., Kraut, R. E., & Dworkin, R. H. (1984). Traits, consistency, and self-schemata: what do our methods measure. *Journal of Personality and Social Psychology*, 47, 568-579.
- Cattell, R. B. (1973). *Personality and mood by questionnaire*. San Francisco: Jossey-Bass.
- Cheek, J.M. & Hogan, R. (1983). Self-concepts, self presentation, and moral judgment. In I.J. Suls & A.G. Greenwald (Eds.), *Psychological perspectives on the self* (vol. 2, pp. 9-73). Hillsdale, NJ: Erlbaum.
- Coopersmith, S. (1967). *The antecedents of self-esteem*. San Francisco: Freeman.
- Costa, P. T., & McCrae, R. R. (1988). Personality in adulthood: a six-year longitudinal study of self-reports and spouse ratings on the NEO Personality Inventory. *Journal of Personality and Social Psychology*, 54, 853-863.
- Demo, D.H. (1992). The self-concept over time: research issues and directions. *Annual Review of Sociology*, 18, 303-326.
- Dutton, K. A., & Brown, J. D. (1997). Global self-esteem and specific self-views as determinants of people's reactions to success and failure. *Journal of Personality and Social Psychology*, 73, 139-148.
- Duval, S., & Wicklund, R.A. (1972). *A theory of objective self-awareness*. New York: Academic Press.
- Epstein, S. (1979). The stability of behavior: on predicting most of the people much of the time. *Journal of Personality and Social Psychology*, 37, 1097-1126.
- Felmlee, D. H. & Greenberg, D. F. (1999). A dynamical systems model of dyadic interaction. *Journal of Mathematical Sociology*, 23, 155-180.
- Fox, K. R., & Corbin, C. B. (1989). The Physical Self Perception Profile: Development and preliminary validation. *Journal of Sport and Exercise Psychology*, 11, 408-430.
- Greenier, K. D., Kernis, M. H., McNamara, C. W., Waschull, S. B., Berry, A. J., Herlocker, C. E., & Abend, T. A. (1999). Individual differences in reactivity to daily events: examining the roles of stability and level of self-esteem. *Journal of Personality*, 67, 185-208.
- Guastello, S. J., & Guastello, D. D. (1998). Origins of coordination and team effectiveness: a perspective from game theory and nonlinear dynamics. *Journal of Applied Psychology*, 83, 423-437.
- Guastello, S. J., Johnson, E. A., & Rieke, M. L. (1999). Non-linear dynamics of motivational flow. *Non-Linear Psychology and Life Science*, 3, 259-274.
- Headey, B., & Wearing, A. (1989). Personality, life events, and subjective well-being: toward a dynamic equilibrium model. *Journal of Personality and Social Psychology*, 57, 731-739.

- Jason, L. A., Tryon, W. W., Taylor, R. R., King, C., Frankenberry, E. L., & Jordan K. M. (1999). Monitoring and assessing symptoms of chronic fatigue syndrome: use of time series regression. *Psychological Reports, 85*, 121-130.
- Kelso, J. A. (1995). *Dynamic patterns: the self-organization of brain and behavior*. Cambridge: MIT Press.
- Kernis, M. H., Grannemann, B. D., & Barclay, L. C. (1989). Stability and level of self-esteem as predictors of anger arousal and hostility. *Journal of Personality and Social Psychology, 56*, 1013-1022.
- Kernis, M. H., Grannemann, B. D., & Mathis, L. C. (1991). Stability of self-esteem as a moderator of the relation between level of self-esteem and depression. *Journal of Personality and Social Psychology, 61*, 80-84.
- Leary, M. R. (1990). Response to social exclusion: social anxiety, jealousy, loneliness, depression, and low self-esteem. *Journal of Social and Clinical Psychology, 9*, 221-229.
- Markus, H. (1977). Self-schemata and processing information about the self. *Journal of Personality and Social Psychology, 81*, 207-215.
- Markus, J. B., & Wurf, E. (1987). The dynamic of self-concept: A social psychological perspective. *Annual Review of Psychology, 38*, 299-337.
- Marsh, H. W., & Byrne, B. M. (1993). Do we see ourselves as others infer: a comparison of self-other agreement on multiple dimensions of self-concept from two continents. *Australian Journal of Psychology, 45*, 49-58.
- Marsh, H. W., & Yeung, A. S. (1998). Top-down, bottom-up, and horizontal models: the direction of causality in multidimensional, hierarchical self-concept models. *Journal of Personality and Social Psychology, 75*, 509-527.
- McCrae, R. R., & Costa, P. T., Jr. (1994). The stability of personality: Observations and evaluations. *Current Directions in Psychological Science, 3*, 173-175.
- Mortimer, J. T., Finch, M. D., & Kumka, D. (1982). Persistence and change in development: The multidimensional self-concept. In P. B. Baltes & O. G. Brim, Jr. (Eds.), *Life span development and behavior* (Vol. 4, pp. 263-313). New York, NY: Academic Press.
- Nezlek, J. B., & Plesko, R. M. (2001). Day-to-day relationships among self-concept clarity, self-esteem, daily events, and moods. *Personality and Social Psychology Bulletin, 27*, 201-211.
- Ninot, G., Fortes, M., & Delignières, D. (2001). A psychometric tool for the assessment of the dynamics of the physical self. *European Journal of Applied Psychology, 51*, 205-216.
- Nowak, A., Vallacher, R. R., Tesser, A., & Borkowski, W. (2000). Society of self: the emergence of collective properties in self-structure. *Psychological Review, 107*, 39-61.
- Pelham, B. W., & Swann, W. B. (1989). From self-conceptions to self-worth: On the sources and structure of global self-esteem. *Journal of Personality and Social Psychology, 69*, 825-838.
- Robins, R. W., Hendin, H. M., & Trzesniewski, K. H. (2001). Measuring global self-esteem: construct validation of a single-item measure and the Rosenberg self-esteem scale. *Personality and Social Psychology Bulletin, 27*, 151-161.
- Rogers, C. R. (1959). A theory of therapy, personality, and interpersonal relationships, as developed in the client centered-framework. In S. Koch (Ed.). *Psychology: A study of science* (Vol. 3, pp. 184-256). New York: McGraw-Hill.
- Rosenberg, M. (1986). Self-concept from middle childhood through adolescence. In J. Suls & A. Greenwald (Eds.). *Psychology perspectives of the self* (pp. 107-135). Hillsdale, NJ: Erlbaum.

- Sedikides, C., & Skowronski, J. J. (1997). The symbolic self in evolutionary context. *Personality and Social Psychology Review*, 1, 80-102.
- Showers, C.J., Abramson, L.Y., & Hogan, M.E. (1998). The dynamic self: how the content and structure of the self-concept change with mood. *Journal of Personality and Social Psychology*, 75, 2, 478-493.
- Sonstroem, R. J., Speliotis, E. D., & Fava, J. L. (1992). Perceived Physical Competence in Adults: An examination of the Physical Perception Profile. *Journal of Sport and Exercise Psychology*, 14, 207-221.
- Sonstroem, R.J., Harlow, L.L., & Josephs, L. (1994). Exercise and self-esteem: validity of model expansion and exercise associations. *Journal of Sport and Exercise Psychology*, 14, 207-221.
- Spray, J. A., & Newell, K. M. (1986). Times series analysis of motor learning: KR versus no-KR. *Human Movement Science*, 5, 59-74.
- Swann, W.B., Jr. (1990). To be adored or to be known? The interplay of self-enhancement and self-verification. In R.M. Sorrentino & E.T. Higgins (Eds.), *Motivation and cognition* (Vol. 2, pp. 408-448). New York: Guilford Press.
- Tennen, H., & Affleck, G. (1993). The puzzles of self-esteem, a clinical perspective. In R. F. Baumeister (Ed.), *Self-esteem: The puzzle of low self-regard*. New York: Plenum Press.
- Tesser, A. (1988). Toward a self-evaluation maintenance model of social behavior. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 21, pp. 181-227). New York: Academic Press.

Received 08/05/2003; Accepted 09/10/2003