Personality and Individual Differences 74 (2015) 133–138

Contents lists available at ScienceDirect

Personality and Individual Differences

journal homepage: www.elsevier.com/locate/paid

Personality related traits as predictors of music practice: Underlying environmental and genetic influences

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ARTICLE INFO

Article history:
Received 11 July 2014
Accepted 1 October 2014

Keywords:
Music practice
Personality
Big 5
Motivation
Openness
Flow
Music flow

ABSTRACT

Little is known about reasons for individual differences in practice behavior – why do some individuals practice more than others? Here we explore personality related traits such as openness, motivation and flow proneness as well as IQ as potential predictors of music practice. Using a large Swedish twin cohort of more than 10,500 individuals we also estimated genetic and environmental influences underlying such associations. Significant associations with music practice were found for IQ, intrinsic motivation, music flow, and openness. With all predictors in the same model (including sex and age) we could explain about 25% of variance in music practice. However, IQ and intrinsic motivation became non-significant in the full model, with music specific flow being the strongest predictor of music practice. Multivariate genetic modeling with the two remaining significant predictors (openness and music flow) and music practice suggested that the associations between the variables were largely due to shared genetic influences with some additional non-shared environmental influences. Our findings suggest that common genes may influence both music practicing behavior and traits related to artistic interests and musical enjoyment (flow).

1. Introduction

It is generally accepted that music practice is the best predictor of expertise in music (Ackerman, 2014; Hambrick et al., 2014; Lehmann & Ericcson, 1997). However, little is known about why some people continue to practice and persist in an activity, such as playing a musical instrument, while others do not. It appears likely that one source of individual differences in practicing is personality and related traits such as cognitive ability, motivation, and flow.

Individual differences in personality have rather been neglected in relation to music practice. However, several studies have explored personality differences between musicians and non-musicians or between different types of musicians cross-sectionally. Kemp (1996) reported that musicians are relatively more introverted, independent, sensitive, and anxious compared to non-musicians. Compared to population norms, musicians have been shown to be higher on neuroticism and openness and some aspects of extraversion (Dyce & O'Connor, 1994; Gillespie & Myors, 2000), while differences in conscientiousness have been found between different types of musicians (Bell & Cresswell, 1984). A recent study showed that, in children, conscientiousness and openness was correlated with music practice; however, in hierarchical regression with cognitive variables included, only openness was significant (Corrigall, Schellenberg, & Misura, 2013). In undergraduates, only openness was correlated with music practice, and openness and IQ both predicted practicing in the regression analysis (Corrigall et al., 2013).

Individual differences in cognitive abilities have extensively been investigated in relation to music practice, and associations have been found with spatial–temporal reasoning (Rauscher et al., 1997), verbal memory (Chan, Ho, & Cheung, 1998; Franklin et al., 2008; Ho, Cheung, & Chan, 2003; Jakobson, Lewycky, Kilgour, & Stoesz, 2008), auditory memory (Cohen, Evans, Horowitz, & Wolfe, 2011; Degé, Wehrum, Stark, & Schwarzer, 2011), visual memory (Degé et al., 2011; Jakobson et al., 2008), and general IQ (Jakobson et al., 2008; Mosing et al., submitted for publication; Schellenberg, 2006, 2011). Further, studies investigating the relationship between motivation and music practice suggest that intrinsic motivation, the desire to engage in a task because it is inherently interesting or enjoyable (Ryan & Deci, 2000), may also predict practicing behavior. Yoon (1997) showed that frequency of practice in children can be predicted by positive

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http://dx.doi.org/10.1016/j.paid.2014.10.006
0191-8869/

self-schemas and perceived parental pressure. Renwick (2008) found that internal motivation best accounted for variance in several types of practising behavior in children and teens, and McPherson and McCormick (1999) reported, that among piano students those with greater amounts of practice tended to express more intrinsic interest in learning an instrument. Task orientation goals, which indicate intrinsic motivation, have also been shown to be positively related to practice strategies (Smith, 2005) and to metacognitive and social learning strategies among music undergraduates (Graabraek Nielsen, 2008).

Another potential predictor of practice, related to intrinsic motivation, may be individual differences in the proneness to experience psychological flow – a state of effortless concentration so focused that it amounts to absolute absorption in an activity (Nakamura & Csikszentmihalyi, 2002). Flow may lead to longer commitment, especially as it has been described as a pleasurable state which may also serve as an intrinsic motivator. However, individuals who frequently engage in a specific activity, as a result, may also be more likely to experience flow in that domain. Several studies have confirmed that experiencing flow is associated with music practice. Austin and Berg (2006) investigated practice motivation and regulation among children who played an instrument and reported that practice motivation (the item with highest loading was "Time passes quickly when practicing") was related to practice. Marin and Bhattacharya (2013) found that flow proneness was significantly related to daily amount of practice in hours among piano students, but not to their overall duration of piano training in years. However, flow does not seem to be experienced more often among professional musicians compared to amateur musicians (Sinnamon, Moran, & O'Connell, 2012), or among music students at higher year level (Wrigley & Emmerson, 2011). One explanation for that could be that, in order to experience flow, the difficulty level of an activity has to match the skills of an individual. In line with that, O'Neill (1999) found a difference in reported frequency of flow experience among teenage musicians of different abilities, with high achievers experiencing flow more often than moderate achievers. However, differences in flow proneness are also partly due to genetic factors, with a heritability of 41% for general flow (Mosing, Pedersen, et al., 2012), and heritability estimates of 29%, 35% and 33% for flow during leisure, maintenance and work, respectively (Mosing, Magnusson, et al., 2012).

To summarize, the past literature has shown that openness, intrinsic motivation, and flow proneness may all be important predictors of music practice while other personality traits seem to be less important. However, to our knowledge no study to date has explored how much specific variance is explained by each of these traits when all included in the same analysis. Further, music practice (Mosing, Madison, Pedersen, Kuja-Halkola, & Ullén, 2014), personality (Johnson, Vernon, & Feiler, 2008), as well as flow proneness (Mosing, Magnusson, et al., 2012) have all been shown to be moderately heritable traits, but no study to date has explored the genetic and environmental overlap between these variables. The same genes which predispose individuals to be of a specific personality type may also predispose them to be more likely to engage in practice. Here, a large genetically informative sample (more than 10,500 adult twins) was used in order to explore (i) potential predictors of music practice including IQ, openness, motivation, and flow (general and specific to music) and (ii) genetic and environmental contributions to these associations.

2. Method

2.1. Participants

Data were collected online from a cohort of twins born between 1959 and 1985 – the STAGE cohort (Lichtenstein et al., 2006) – part of the Swedish Twin Registry (STR) (Lichtenstein et al., 2006, 2002). The full sample consisted of 10,699 twins aged between 27 and 54 (M = 40.7, SD = 7.75) with a score for at least one of the studied variables, comprising 2570 full twin pairs (1211 monozygotic (MZ) and 1359 dizygotic (DZ) pairs) and 5389 single twins without the co-twin participating. Single twin-individuals were retained for analysis as they contribute to the estimation of means, variances, and covariate effects. In the STR, zygosity is determined based on questions about intra-pair similarities; these zygosity classifications have subsequently been confirmed in 27% of the twins using genotyping, showing that the questionnaire based zygosity determination was correct for more than 98% of twins. For further details on the STAGE cohort and zygosity determination in the STR see Lichtenstein et al. (2002, 2006). The study was approved by the Regional Ethics Review Board in Stockholm (Dnr 2011/570-31/5, 2011/1425-31, and 2012/1107/32).

2.2. Measures

2.2.1. Music practice

Participants were first asked to indicate whether they play an instrument or sing. Those who responded positively were asked to indicate how many years during four age-intervals (age 0–5, 6–11, 12–17, and 18 till now) and how many hours a week during each of those intervals they practiced. From these estimates a sum-score of the total hours played throughout lifetime was calculated, with non-players receiving a score of zero. Retrospective self-reported practice assessments have been shown to have an acceptable reliability with estimates ranging between 0.6 and 0.9 (de Bruin, Smits, Rikers, & Schmidt, 2008; Ericsson, Krampe, & Tesch-Römer, 1993). Music practice was positively skewed with many individuals having none or little practice, but since previous analysis of the data has shown that results were very similar for transformed and untransformed practice estimates (Mosing et al., 2014) and given the large sample size, untransformed data were used here.

2.2.2. Intelligence

Intelligence was measured using the Wiener Matrizen Test (WMT; Formann & Piswanger, 1979) – a non-verbal matrix reasoning test similar to Raven's matrices. The WMT consists of 24 multiple choice questions, listed in order of difficulty, measuring the test-takers' reasoning ability, which is often referred to as general intelligence. The WMT has good psychometric properties as shown in previous online administrations (Ullén et al., 2012).

2.2.3. Openness

Personality was measured using the 44-item Big Five Inventory (John, Naumann, & Soto, 2008) in Swedish translation (Zakrisson, 2010). Responses were given on a five-point Likert scale, ranging from 'do not agree at all' to 'agree completely'. Reliability and validity of the Swedish version has been found to be similar to estimates previously reported for personality (Zakrisson, 2010). Only the Openness sub-scale was included here.

2.2.4. Motivation

Motivation was measured using the General Motivation Scale (GMS; Guay, Mageau, & Vallerand, 2003; Pelletier et al., in preparation), adapted and translated into Swedish. The GMS consists of 18 items tapping into six different dimensions of motivation: Intrinsic, Integrated, Identified, Introjected, External and Amotivation. Each item was rated on a seven-point Likert-type scale, ranging from *'Don't agree at all'* to *'Completely agree'*. In this study only results of the Intrinsic subscale were used which showed satisfactory reliability (Table 1).

Table 1
Descriptive statistics.

	N (*including pairs*)	*M* (*SD*)	Cronbach alpha	*t* (df) sex	*t* (df) age
Music practice	10,699	2471.98 (3553.49)[a]	–	4.63 (7723)[*,a]	13.85 (10758)[*]
IQ	8419	12.78 (5.24)	–	10.94 (8479)[*]	−16.71 (8479)[*]
Openness	9760	3.26 (.67)	.82	1.98 (9829)	−.96 (9829)
Motivation	10,309	16.22 (3.38)	.71	−6.85 (10,380)[*]	3.42 (10,380)
Music flow	7251	22.47 (5.55)	.82	−3.52 (7304)[*]	4.89 (7304)[*]
General flow	10,187	26.01 (3.21)	.82	−7.61 (10258)[*]	10.33 (10,258)[*]

[*] $p < .001$.
[a] Among the players.

2.2.5. Flow

Flow proneness was measured with the Swedish Flow Proneness Questionnaire (SFPQ; Ullén et al., 2012), which consists of three subscales: work (if participant worked), leisure, and maintenance with seven items each responded to on a five-point Likert scale ('Never' to 'Every, or almost every day'). Here, an additional subscale was added (music flow) consisting of seven items specifically assessing flow in the music domain, while flow proneness in leisure was measured specifically excluding playing an instrument or singing. In the present analyses, the music flow sub-scale and general flow, which was the mean score of the other three subscales (leisure without music, work, and maintenance), were used. Both scores had satisfactory reliability as shown in Table 1.

2.3. Statistical analyses and genetic modeling

For non-genetic analyses, a sample consisting of all single twins and one randomly selected twin of each full pair was used, in order to account for the relatedness in the sample. Pearson correlations were calculated between all variables and hierarchical regression analysis was applied to explore which predictors explained independent variance in music practice. For genetic analyses, all variables were converted to *z*-scores. The classical twin design utilizes the differences in genetic sharing between MZ and DZ twins, with the former sharing 100% of their segregating genes while the latter only share 50% on average (like normal siblings), to partition trait variance into that due to *additive genes* (*A*) and environment (*common* (*C*) – all influences shared between the twins and making the pair more alike to each other, *and unique* (*E*) – all influences not shared between the twins and making them more different including measurement error). With the use of structural equation modeling the combination of ACE influences that best explains the population variance in a trait or the covariance between two or more traits can be estimated. Using maximum likelihood (ML) modeling procedures parameter estimates for the saturated model can be derived (through optimization) and subsequently specific hypotheses regarding the significance of particular parameters can be tested statistically. This is done by comparing the goodness-of-fit to the observed data (distributed as χ^2) of various models using the minus two times log-likelihood (-2LL) statistic. If the change in χ^2 ($\Delta\chi^2$) is not significant, the more parsimonious model can be regarded the one of choice.

Genetic analyses were done in the statistical program Mx (Neale, Boker, Xie, & Maes, 2006; Neale & Maes, 2004). After assumption testing, univariate models were fitted to the data in order to estimate A, C, and E influences for each variable. Based on the results of the univariate analyses, a trivariate common sex-limitation ACE Cholesky decomposition was fitted to explore genetic and environmental influences on the covariation between the traits. To simplify modeling, only same-sex twin pairs were included for the multivariate analyses. Note that the exclusion of DZ opposite-sex pairs as well as the increase in power using multivariate modeling can result in slight differences in the estimates between univariate and multivariate analyses. Nested reduced univariate and multivariate models were compared to the full models in order to test which parameters were significant.

3. Results

Descriptive statistics for all variables as well as covariate effects (age and sex) are presented in Table 1. As females were more likely to play an instrument (80% as opposed to 62% of men) we also tested for sex differences in music practice among the participants who had played an instrument. There were significant sex differences in hours of music practice with men scoring higher than women, as well as in motivation, music flow and general flow with women scoring higher than men. Significant age effects on the means were found for music practice, music flow and general flow with all variables increasing with age. Therefore, sex and age were included as covariates in subsequent twin modeling.

Phenotypic correlations between variables in the study are presented in Table 2. Music practice was correlated with openness, intrinsic motivation, IQ and music flow. Music practice was not correlated with general flow, and therefore, only music flow was included in further analyses. Results of the regression analysis are presented in Table 3. First, sex, age and IQ were entered in order to control for these variables. In the second step openness, intrinsic motivation and music flow were added to the model. The full model explained 25% of the variance in music practice with music flow ($\beta = .41$, $p < 0.001$) and openness ($\beta = .19$, $p < 0.001$) as

Table 2
Phenotypic correlations ($N = 4671–7806$).

	IQ	Openness	Motivation	Music flow	General flow
Music practice	.07[*]	.31[*]	.13[*]	.46[*]	.01
IQ		.12[*]	.05[*]	.00	.04[*]
Openness			.27[*]	.29[*]	.13[*]
Motivation				.21[*]	.32[*]
Music flow					.24[*]

[*] $p < 0.01$.

Table 3
Hierarchical multiple regression results.

Predictor	Partial correlation	*p*-Value
*Step 1: $R = .21$, $F(3,4659) = 70.63$, *$p < 0.001$*		
Age	.20	<0.001*
Sex	−.05	<0.001*
IQ	.06	<0.001*
Step 2: $R = .53$, $F(3,4656) = 497.07$, $p < 0.001$		
Age	.20	<0.001*
Sex	−.06	<0.001*
IQ	.04	0.005
Openness	.19	<0.001*
Motivation	−.02	0.19
Music flow	.41	<0.001*

Table 4
Twin correlations with 95% confidence intervals.

Zygosity	Openness	N pairs	Music flow	N pairs	Music practice	N pairs
MZ	.57 (.53–.60)	1069	.41 (.35–.47)	743	.63 (.60–.66)	1211
DZ	.24 (.19–.29)	1177	.19 (.12–.25)	761	.40 (.36–.44)	1359
MZF	.60 (.55–.64)	695	.39 (.32–.46)	538	.59 (.55–.63)	781
MZM	.50 (.43–.57)	374	.44 (.33–.54)	205	.69 (.65–.73)	430
DZF	.29 (.21–.37)	392	.25 (.14–.34)	288	.44 (.36–.51)	439
DZM	.23 (.10–.34)	248	.11 (−.06–.27)	131	.44 (.34–.52)	280
DZOS	.19 (.11–.27)	537	.17 (.07–.27)	342	.36 (.29–.42)	640

Note. MZ = monozygotic; DZ = dizygotic; DZOS = DZ opposite-sex; F = female; M = male.

Table 5
Test statistics for the trivariate sex-limitation Cholesky decomposition with openness, music flow, and music practice.

Model	−2LL	*df*	$\chi^2(df)$	*p*
Full Cholesky ACE	49,452.89	18,543		
Equate ACE between sexes for O and music flow[a]	49,464.07	18,558	11.19(15)	.74
Drop C for O and music flow	49,470.334	18,563	17.45 (20)	.62

[a] Music practice in this sample could not be equated across sexes (Mosing et al., 2014).

significant predictors. Based on this analysis openness and music flow were selected for genetic analyses with music practice.

Based on the pattern of twin correlations, presented in Table 4, univariate ACE models were run first. As previously shown, genetic influences explained between 41% and 69% of the variance in music practice in the present sample, with some additional contributions of shared environment (Mosing et al., 2014). Genetic influences explained 55% and 40% of the variance in openness and music flow, respectively, and did not differ across sexes. Shared environmental effects were non-significant.

Results of the multivariate twin analyses are presented in Table 5. The best-fitting Cholesky decomposition with unstandardized parameter estimates is presented in Fig. 1. All genetic and non-shared environmental paths between openness, music flow and music practice were significant indicating that both genetic and environmental influences contribute to phenotypic associations between those traits. Overlap between genetic influences was stronger than overlap between non-shared environmental influences. Highest genetic overlap was found between music flow and music practice, accounting, in both men and women, for approximately 76% of the phenotypic association between music flow and music practice. Also, genetic overlap accounted for approximately 75% of the phenotypic association between openness and music practice, and 61% of the phenotypic association between openness and music flow.

4. Discussion

To our knowledge, this is the first study to explore the relationship between music practice and a broad set of relevant individual difference variables, i.e. openness, intelligence, motivation, and the proneness to experience psychological flow. As a large twin sample was used, genetic and environmental contributions to the associations could be estimated.

In line with previous studies we found that music practice was significantly associated with openness, intrinsic motivation, IQ, and musical flow proneness, but not with general flow (as

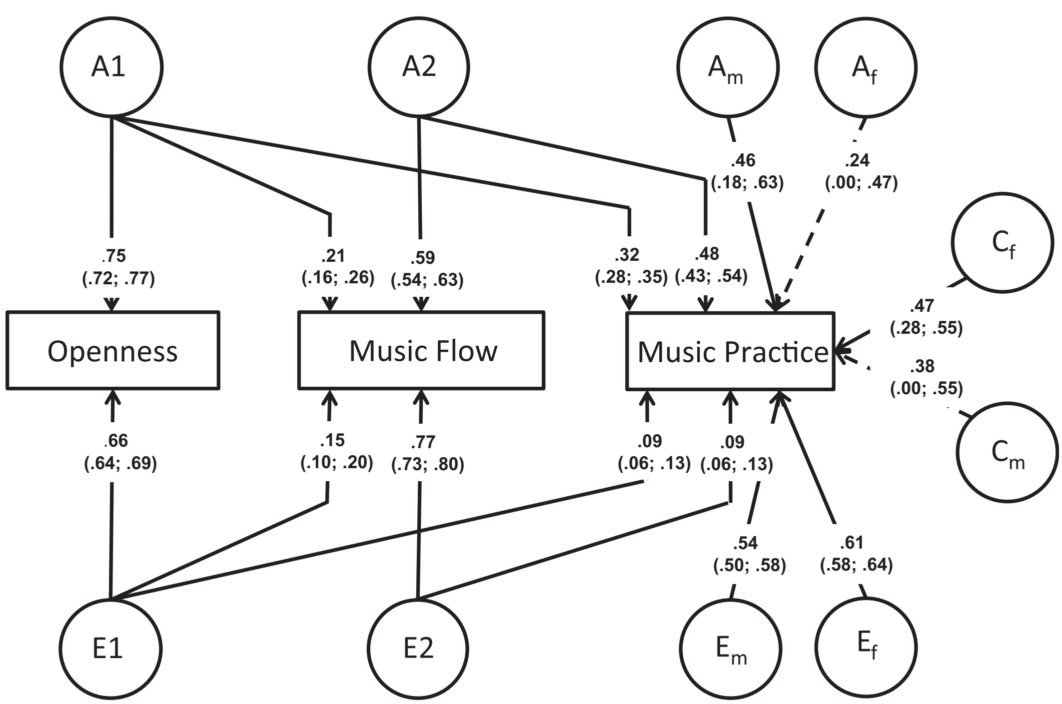

Fig. 1. The best-fitting Cholesky decomposition. *Note.* A = additive genetic; C = shared environmental; E = non-shared environmental influences.

measured here). Interestingly, musical flow proneness was by far the most significant predictor of music practice in this sample. Once all variables had been included in the model, intrinsic motivation and IQ became non-significant. This indicates that subjective experiences of absorption and enjoyment within a specific domain are important predictors of long-term engagement, and much more so than domain-general variables related to motivation, e.g. trait intrinsic motivation and general flow proneness. Openness was also an important predictor of music practice in adult age, in line with what has previously been shown in children and undergraduates (Corrigall et al., 2013). The present model, which included music flow explained more variance (25%) than the model of Corrigall et al. (2013) (15.6% in undergraduates and 21.9% in children), which included demographic variables, cognitive ability and personality.

Univariate genetic analyses showed that heritability estimates for openness, music flow, and music practice were moderate. In line with estimates previously reported for personality traits (Johnson et al., 2008), genetic influences explained about 55% of variance in openness with the remainder being due to non-shared environmental influences. Similarly, genetic influences explained about 40% of variance in music flow, which is in line with heritability of general flow proneness, ranging from 29% to 35% (Mosing, Magnusson, et al., 2012). Heritability estimates for music practice ranged between 41% and 69%, as previously shown in this sample (Mosing et al., 2014). Phenotypic associations between openness, music flow and music practice were largely due to shared genetic influences, with some additional covariance due to non-shared environmental influences. Shared environmental influences were non-significant. Common genetic influences accounted for approximately 75% of the phenotypic associations with music practice, and for 61% of the association between openness and music flow.

What does this mean in the context of individual differences in music practice? First, with all the variables included in this study only 25% of variance in music practice was explained, suggesting that other factors (not included here) are of importance. Further, the associations between openness, music flow and music practice were largely due to shared genes, indicating that genetic influences predisposing an individual to higher openness also predispose to more music flow and more music practice. A smaller part of the relationship was due to non-shared environmental influences, nevertheless supporting that environmental factors also play a role for the observed associations. However, such non-shared environmental associations may also be due to correlated measurement error. Although our study design does not allow for any causal inferences, a reasonable explanation for our findings could be that individuals higher in openness are more likely to try out a new musical instrument (or singing) if they have the opportunity. Further, the flow experience is enjoyable in itself and may act as an intrinsic motivator to continue practising. However, clearly those who play more hours may also have a higher chance to experience flow (if they are prone to have music flow experiences).

Studies exploring why people cease to play an instrument provide some information about other factors potentially important for individual differences in music practice. Such studies have indicated that lower motivation and achievement may play an important role (Costa-Giomi, 2005). Children who cease to play an instrument seem to have unrealistically high expectations about how much they should practice, and tend to practice less before stopping (McPherson & Davidson, 2002). Decisions to terminate practicing were also associated with feelings of low competence, relatedness, and autonomy (Evans, McPherson, & Davidson, 2013). Musical aptitude in itself may be an important predictor (and potentially a motivational factor) of how much an individual practices (Mosing et al., 2014).

Engagement and achievement in a domain depends on a multitude of individual difference variables in different modalities, such as cognitive abilities, personality, interests, and motivation. Ackerman and Heggestad (1997) have used the term *trait complex* for the constellation of traits characterizing individuals which engage successfully in a particular field. They also identified artistic interests as a part of one specific trait complex that also includes openness, absorption, ideational fluency and high typical intellectual engagement. The present work indicates that the components of a trait complex may be driven by common set of genes, and that the same genes may also be associated with the tendency to invest time in active practicing within the field. Expert performance may thus depend on genetic factors with broad effects on specific interests, motivation, and abilities, as well as the tendency to develop specialized skills relevant for the particular domain of expertise through long-term deliberate practice.

The present study showed that openness and music flow are important predictors of music practice, and their associations are largely due to shared genes. However, we only explained about a quarter of the variance in music practice, showing that our knowledge of why some people practice and others do not is still limited. As music practice is a dynamic process, different predictors may not be equally important for different age-groups or for different degrees of expertise. Therefore, longitudinal studies could improve our understanding of individual differences in music practice throughout different periods in life and genetic contributions to practice behavior over time.

Acknowledgments

The present work was supported by the Bank of Sweden Tercentenary Foundation (M11-0451:1), the Swedish Scientific Council (521-2010-3195) and the Sven and Dagmar Salén Foundation. We thank the twins for their participation.

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