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Studies examining age-related changes typically report findings as age-based generalizations that neglect the phenomenon of variability in gerontological research. This paper examines the degree of attention given in 185 studies to individual differences and the empirical patterns of variability reported in those studies that present measures of dispersion. Measures of dispersion were reported in 43% of the gerontological studies reviewed and in 24% of the developmental studies. Overall, a majority of all gerontological studies presenting data reported increases in variability with increasing age (65%). This pattern was more pronounced in longitudinal studies than in cross-sectional ones.

Key Words: Individual differences, Variability, Dispersion statistics

Aged Heterogeneity: Fact or Fiction? The Fate of Diversity in Gerontological Research¹

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Studies examining age-related changes or differences typically focus upon mean-level differences or other measures of central tendency and give little attention to dispersion within each age category. This focus on the average allows for age-based generalizations, which contribute to a portrait of the life course in terms of age-specific stages or periods. Such generalizations are useful for many purposes and influence both professional and popular images of aging. However, in focusing upon mean-level differences, researchers often overlook individual differences. Mean-level differences may misrepresent the character of age differences if intracohort variability systematically changes over the life course: the measure of central tendency becomes less typical, and less meaningful, as the amount of intersubject variation increases. To the extent that this is the case, normative patterns present an oversimplified picture of the changes that occur as individuals age.

The issue of age-based generalization is especially problematic when studying older subjects (Dannefer & Sell, 1988). Gerontologists and others contend that the aged are highly diverse, perhaps the most heterogeneous of any age strata in regard to psychological and physiological characteristics, material security, and life-style (Baltes, 1979; Bengtson, Kasschau, & Ragan, 1977; Elder, 1969; Maddox & Douglas, 1974; Neugarten, 1982), presumably as a result of increasing differentiation over the life course (e.g., Dannefer, 1987; Neugarten, 1983). A number of scholars

have begun to emphasize the need to complement the emphasis on normative age patterns with an examination of diversity among age peers (Adelman, 1985; Dannefer, 1984a, 1984b, 1988; Dannefer & Sell, 1988; Hogan, 1985; Krauss, 1980; Lazarus & DeLongis, 1983; Maddox, 1987; Marini, 1984; Neugarten, 1982; Perlmutter, 1985; Rowe & Kahn, 1987).

However, the phenomenon of the heterogeneity of the aged itself is not well documented. Bornstein and Smircana's (1982) review of 56 research articles examining age differences that were published in the *Journal of Gerontology* 1979-1980 found that only 42% reported statistical measures of variability within age categories and that very few studies (4 of the 56 studies surveyed) made any reference to changes in variability in their textual discussion.

From our perspective, that the reporting of variability occurs less than half of the time and that the changes in individual differences are discussed much more rarely point to an important yet largely ignored contradiction in gerontological scholarship: a popular emphasis on diversity in gerontological rhetoric on one hand, but a neglect of it in analyzing and interpreting research findings on the other.

This issue of aged heterogeneity has been acknowledged as being relevant for theory, policy, and practice (Dannefer, 1987; Dannefer & Sell, 1988; Maddox, 1987). For example, aged heterogeneity has been invoked to argue against stereotyping the aged (Butler, 1974), and to caution against social policies that target the elderly as an undifferentiated group (Bielby, 1986; Neugarten, 1982; Riley, 1983). In many cases, diversity takes the clear form of inequality. Recent demographic analyses have shown that, in cohort after cohort, inequality in family income tends to increase systematically with age (Dannefer & Sell, 1988; Phillipson & Walker, 1987; Treas, 1986). The same has been found for occupational status. Case studies of the career development of entire cohorts

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of employees in large-scale organizations have similarly indicated movement toward increasingly differentiated (and unequal) positions over time (Howard & Bray, 1988; Rosenbaum, 1984). Documented health differences among the aged have led some to advance strong cautions about overgeneralization (e.g., Rowe & Kahn, 1987), and a recent volume of *The Annual Review of Gerontology and Geriatrics* was subjected in its entirety to a review and exploration of diversity.

While Bornstein and Smircana's 1982 study suggests that this interest is not reflected in gerontological research, this requires further documentation. Bornstein and Smircana surveyed only 2 years of one journal, and their findings are now a decade old. Especially in view of the recent expansion of theoretical interest in the topic, one may ask whether any parallel increase in interest in empirical research can be discerned over the past few years.

Along with their analysis of the reporting of variability, Bornstein and Smircana also analyzed the patterning of variability across age groups. They found, at best, mixed evidence for increasing diversity. In addition to the rather narrow sampling base of their study, there are several other limitations in their analysis of patterns of variability. Bornstein and Smircana did not differentiate between longitudinal and cross-sectional studies in their analysis, and they did not distinguish types of characteristics in their discussion of findings regarding variability. This is important because some writers have suggested that, for example, variability may increase more for psychosocial characteristics than for physical ones (e.g., Hickey, 1980). However, the principal significance of Bornstein and Smircana's analysis is not their findings regarding the reported empirical patterning of diversity with age, but the indication that evidence for within-age differentiation in the research literature is sparse.

In view of these limitations on what is known, our intentions were to document the degree of attention given to the topic of variability in the gerontological literature and, where evidence is available, to report the empirical patterning of variability with age. In analyzing patterns of variability, the present paper: (1) distinguishes longitudinal from cross-sectional data; (2) considers the types of characteristics in which differences in the amount of variance between age groups are found; (3) reports statistical tests conducted to determine significance of difference, where possible; and (4) considers the age groups or ranges for which comparisons are made.

Perhaps even more than in gerontology, developmental studies of the earlier years of life focus on the identification of normative age patterns. Yet here, too, at least some research has suggested that variability increases or changes systematically. For example, Rosenbaum's (1976) analysis of IQ trends among high school students shows a systematic intracohort divergence across the high school years, with lower-scoring students in the 9th grade suffering a net loss by the time they reach the 12th grade and top-scoring students posting gains. It is of interest, therefore, to

consider systematically how intra-age variability is reported and discussed—and the nature of the observed patterns—in developmental as well as gerontological studies. To our knowledge, no systematic study of the extent of attention to within-age variability in the developmental literature on early life has been undertaken. An additional objective of this study thus was to compare gerontological treatment of variability with that in studies of development in the early years.

Method

Six journals focused on aging and development were chosen for study. Four (*Journal of Gerontology*, *Developmental Psychology*, *Human Development*, and *Developmental Review*) are well-established journals; the other two (*Psychology and Aging* and *Research on Aging*) were included because they are significant new journals publishing empirical research on aging. The volumes sampled from each of these journals were the following: *Journal of Gerontology*, 1982, 1984, 1985; *Psychology and Aging*, 1986, 1987; *Developmental Review*, 1983, 1986; *Human Development*, 1983, 1984; *Developmental Psychology*, 1983, 1984, 1985; and *Research on Aging*, 1985, 1986.

In each of these volumes, all articles that presented an empirical analysis of data and used age as an independent variable were reviewed ($N = 185$). For each article meeting these two criteria, we recorded every discussion or presentation of data on within-age variability. When such data were present, we noted the type of variability measures reported, the description of age-related patterns of variability reported, and the textual discussion of within-age variability (independent of the presentation of data). In addition, we collected basic information regarding the sample size, nature of design (i.e., longitudinal or cross-sectional), age groups or ranges, and the characteristics being studied.

Studies were classified as indicating increasing variability or decreasing variability based on any consistent pattern shift in absolute magnitude. Cases in which the shift in magnitude of variability between age groups or over time was inconsistent or fluctuated were categorized "no pattern"; studies were classified as stable when there was no meaningful change in magnitude. Studies that presented multiple analyses reporting variability across age groups were coded as increasing, decreasing, or stable if more than 75% of the reported analyses described uniform patterns. Those that did not conform to this constraint were coded as having no pattern.

It would have been possible to use the analysis(es) of the study rather than the study itself as the unit of analysis. While such an approach would provide a more detailed treatment of all published analyses, we decided against it because it would weight some studies much more heavily than others, and because generally there was a high degree of consistency within studies in the age-related trends of variability. Where increases and decreases were observed, most

of the differences in magnitude were relatively large. Where possible, reported differences in variability between age groups were tested for statistical significance, and the results of these tests are reported below.

Of the 185 articles, 127 were from gerontological journals, and 58 were from developmental journals. Overall, 22 of the studies were longitudinal—10 gerontological and 12 developmental studies. Since child and adult studies included are drawn from different literatures, findings for each are presented separately.

Results: Gerontological Studies

Report of Variability

Of the 127 gerontological studies, 43% (54) actually report dispersion measures. Thirty-six studies report standard deviation, three report variance, and three report the range. Four report both the standard deviation and the range, and the remaining eight report variability of the results through other measures of dispersion (e.g., standard error, standard error of the mean). It is noteworthy that the proportion of studies reporting some measure of dispersion is virtually the same as that reported in Bornstein and Smircana's review. In view of the growing emphasis given to the issue of variability in the recent gerontological literature (Dannefer, 1984b; Bornstein & Smircana, 1982; Maddox, 1987; Rowe & Kahn, 1987), a trend analysis over the study period (1982–1987) was conducted, but it revealed no trend toward increasing attention to variability over this period.

Dispersion measures are reported in six of the ten longitudinal studies and in 48 (41%) of 117 cross-sectional studies. Each of these six longitudinal studies includes a textual discussion of the findings. In addition, another of the longitudinal studies discusses variability observed by the researcher but not reported in the quantitative analyses. In all, then, seven (70%) of the longitudinal studies discuss within-age variability found in the data. Thirty-two (27%) of the cross-sectional studies at least once discuss within-age variability reported in the data, and about two-thirds of these (22) discuss the issue of variability (see Table 1).

In the majority of the studies that discuss dispersion statistics, remarks were made as an aside—"older adults had slightly greater response variability

in range of responses" (Burke & Peters, 1986, p. 287), "older people as a group have highly variable thresholds" (Moore, Neilson, & Mistretta, 1982, p. 69), "other background variables were relatively important predictors of individual differences" (Arbuckle, Gold, & Andres, 1986, p. 60)—with no other discussion. This was the case in all of the longitudinal studies.

While most of the cross-sectional studies also discussed variability in an offhand manner, several commented on it more directly. One study suggested that the lack of a normative finding was *due to variability*: "The lack of a significant rhythm in the remaining men indicates considerable individual variation" (Prinz et al., 1984, p. 566). Four studies attempted to explain dispersion statistics. Two of these studies contended that the increased variability found in their older-aged groups was attributable to ontogenetic causes. In the first of these studies the authors suggest that the variability in memory retrieval was due to older individuals having deficits in semantic memory processing, and in the second study "any increase in ability occurring in an old person is *not* normal but is due to some pathological cause" (Gabbell & Nayak, 1984, p. 666). The authors of the third study suggest that cohort effects might have something to do with the increasing variability they found in their results. The final study stated that "with advanced age this variability was enhanced somewhat, perhaps reflecting the wide variation often observed in cognitive function of elderly adults" (Polich, Howard, & Starr, 1985, p. 725).

Patterns of Variability

Direction. — Of the 54 aging studies that present measures of dispersion, nearly two-thirds (65%) report a pattern of increasing diversity among age peers with advancing age. The rest of the studies report patterns fairly evenly spread over the remaining three categories (see Table 2). This pattern of increase was more prominent among longitudinal studies than cross-sectional ones (83% vs 63%, respectively).

Significance. — It was possible to perform Bartlett's test for homogeneity of variance on measures of variability for ten gerontological studies. All ten of these studies were among those reporting

Table 1. Reporting of Variability in Gerontological Studies Reviewed

Studies	Report measures of variability in data	Discuss variability found in data	Discuss variability in concluding remarks
All ^a	43%	31%	20%
Longitudinal ^b	60%	70%	30%
Cross-sectional ^c	41%	27%	19%

^a*n* = 127.

^b*n* = 10.

^c*n* = 117.

Table 2. Overall Patterns of Variability Reported in Gerontological Studies Reviewed

Pattern	All studies ^a	Longitudinal studies ^b	Cross-sectional studies ^c
Increasing	65%	83%	63%
Decreasing	16%	17%	17%
No pattern	15%	0	17%
Stable	4%	0	4%

^a*n* = 54.

^b*n* = 6.

^c*n* = 48.

increasing patterns of variability. In half of these (50%), the differences in within-age variability between age groups were significant ($p \leq .02$).

In discussing the significance of diversity, it is important to consider the age groups or range of age in the studies. It is not possible to say intra-age variation increases systematically over the life course if comparisons are being made only between two remote time periods, for example, college students and elderly individuals. Thus, it is of interest to note that four of the six longitudinal studies report data

based on at least three age groups. Of the cross-sectional studies reporting increasing variability with age, nine were based on multiple age groups, and of the cross-sectional studies reporting decreasing variability, ten were based on multiple age groups.

These data support the notion of a systematic increase in variability over the life course, although this contention is vastly limited in strength due to two reasons. The first is that these studies are cross-sectional in nature, and thus it is not possible to determine whether increasing diversity is based on

Table 3. Summary of Sample Size, Age Ranges, and Age Groups by Pattern of Variability for Gerontological Studies Reviewed

Sample size	Range of age	# of groups	Age groups	Years	Pattern of variability
Longitudinal studies^a					
N = 118	24-36	4	Mean ages: 14; 30; 40; 54	7	Increasing
N = 92				2	Increasing
N = 85	45-60	2	15-27; 61-86	c	Increasing
N = 25				8	Increasing
N = 59		3	3rd-year students: high school, college, graduate school	3	Increasing
N = 592		4	25-28; 40-49; 50-59; 70-74	5	Decreasing
Cross-sectional studies^d					
N = 75	45-74	6	45-49; 50-54; 55-59; 60-64; 65-69; 70+		Increasing
N = 459	18-89	6	18-29; 30-39; 40-49; 50-59; 60-69; 70+		Increasing
N = 104	5-86	8	5-9; 10-19; 20-29; 30-39; 40-49; 50-59; 60-69; 70-86		Increasing
N = 102	b	2	< 40; ≥ 40		Increasing
N = 54		3	18-25; 40-48; 52-71		Increasing
N = 144	20-70	5	20-25; 35-40; 45-50; 55-60; 65-70		Increasing
N = 24		2	27-38; 59-76		Increasing
N = 36		2	18-34; 66-80		Increasing
N = 40	b	2	Mean age: 20.6; 73.5		Increasing
N = 24	b	2	Mean age: 24; 73		Increasing
N = 48	c	2	c		Increasing
N = 481	21-79	6	21-29; 30-39; 40-49; 50-59; 60-69; 70-79		Increasing
N = 40		2	17-24; 60-75		Increasing
N = 144	18-30	No groups			Increasing
N = 150	Mean age: 28.4	No groups			Increasing
N = 40		2	23-58; 60-82		Increasing
N = 64		2	21-47; 66-84		Increasing
N = 704	60-90	No groups			Increasing
N = 37	b	2	≤ 32; 65+		Increasing
N = 25		2	19-31; 60-72		Increasing
N = 71	20-79	3	20-39; 40-59; 60-79		Increasing
N = 18	60-82	c	c		Increasing
N = 25		4	19-31; 40-55; 70-78; 79-86		Increasing
N = 85	b	2	Mean age: 19.5; 75.1		Increasing
N = 318	55-90	3	55-62; 63-69; 70-90		Increasing
N = 246		2	College, elderly		Increasing
N = 285	67-93	2	67-71; 72-93		Increasing
N = 1,125		3	Median ages: 26; 49; 74		Decreasing
N = 22		2	Young, old (not specified)		Decreasing
N = 30		2	19-29; 63-83		Decreasing
N = 50		2	22-26; 76-94		Decreasing
N = 20		2	23-28; 61-92		Decreasing
N = 912	50-70+	3	50-59; 60-69; 70+		Decreasing
N = 347	20-69	5	20-29; 30-39; 40-49; 50-59; 60-69		Decreasing
N = 196		3	High school, college, elderly		Decreasing
N = 117	30-88	4	30-39; 40-49; 50-59; 60+		Stable
N = 30		2	23-27; 58-82		Stable
c		3	20-28; 34-44; 59-67		Stable
N = 239		2	Mean age: 18.4; 69.3		Stable
N = 63		2	Mean age: 21; 67		Stable
N = 10		2	19-26; 65-71		Stable
N = 119		2	26-45; 60-85		No pattern
N = 60		2	Mean age: 45; 90		No pattern

^aN = 6.

^bNot reported in study.

^cMissing data.

^dN = 43. Five studies, three with increasing patterns of variability with age and two with stable patterns, were omitted due to missing data.

cohort differences or individual differences. More problematic is the fact that in several studies the range of age in the oldest age group is enormous—thus, greater variance in this group could be due to the age heterogeneity of the group itself. It seems to the present authors inappropriate to lump individuals of vastly different ages together: not only does this muddy the picture of patterns of diversity over the life course, but it also potentially masks true age differences. This tendency may be due to a persistent ageist stereotype that presumes all old people are alike, and hence there is no need to distinguish a 65-year-old person from a 90-year-old person. In examining the longitudinal studies in Table 3, it should be noted that while a wide range of ages is followed over time, the time periods are relatively short, thus making it difficult to draw any conclusions about life-course patterns of diversity.

Types of characteristics. — In order to explore whether these trajectories of diversity vary in regard to different kinds of variables, separate analyses were performed for biological, cognitive, personality, and social characteristics. Examples of the variables included in each of these categories are presented in Figure 1.

As shown in Table 4, a trajectory of increasing within-age variation is the predominant pattern across the three categories of characteristics in which meaningful analyses are possible (only two studies reported data for social characteristics). Seventy-two percent of the studies examining biological characteristics, 57% of those examining psychological characteristics, and 79% of the studies examining cognitive characteristics report such a pattern.

Results: Child Development Studies

Report of Variability

Perhaps it is not surprising that empirical research studies in child development, with its strong focus on normative developmental patterns, report dispersion measures less frequent than gerontological studies. Overall, only 24% of these studies report dispersion measures, a proportion that is consistent among the cross-sectional and longitudinal studies. All 14 of these report standard deviations, and 12 of them discuss the reported variability. In addition, eight studies that do not report data on variability do discuss the issue in some part of the article (see Table 5). All but two of the fourteen studies examined age differences in cognitive characteristics, so compari-

sons across types of characteristics are not meaningful in this set of studies.

Patterns of Variability

Direction. — As shown in Table 6, 50% of the child development studies reporting measures of dispersion display a pattern of increasing within-age variation with increasing age. The patterns reported in the remaining 50% are fairly evenly divided over the remaining three categories. This pattern of increase was the dominant one among the cross-sectional

Table 4. Patterns of Variability by Dependent Variables for 54 Gerontological Studies Reviewed

Patterns of variability	Studies by dependent variables				Total
	Biological ^a	Cognitive ^b	Personality characteristics ^c	Social ^d	
Increasing	75%	79%	57%	50%	38
Decreasing	8%	21%	14%	50%	7
Stable	4%	0	0	0	1
No pattern	13%	0	29%	0	8

^a*n* = 24.

^b*n* = 14.

^c*n* = 14.

^d*n* = 2.

Table 5. Reporting of Variability in Developmental Studies Reviewed

Studies	Report measures of variability in data	Discuss variability found in data	Discuss variability in concluding remarks
All ^a	24%	21%	10%
Longitudinal ^b	25%	25%	17%
Cross-sectional ^c	24%	20%	13%

^a*n* = 58.

^b*n* = 12.

^c*n* = 46.

Table 6. Overall Patterns of Variability in Developmental Studies Reviewed

Pattern	All studies ^a	Longitudinal studies ^b	Cross-sectional studies ^c
Increasing	50%	33%	55%
Decreasing	29%	67%	18%
No pattern	21%	0	27%
Stable	0	0	0

^a*n* = 14.

^b*n* = 3.

^c*n* = 11.

Biological	Cognitive	Personality characteristics	Social
Brain atrophy	Memory performance	Social-moral reasoning	Social networks
Enzyme activity	Intellectual performance	Locus of control	Religious participation
Cholesterol level	Memory recall	Marital satisfaction	
Respiratory disturbance		Self-esteem	
Walking gait		Depression	
		Life satisfaction	

Figure 1. Examples of categories of dependent variables reported in gerontological and developmental studies reviewed.

Table 7. Summary of Sample Size, Age Ranges, and Age Groups by Pattern of Variability for Developmental Studies Reviewed

Sample size	Range of age	# of groups	Age groups	Years	Pattern of variability
Longitudinal studies^a					
N = 180		No groups	6–24 months	1.5	Increasing
N = 75		2	6 and 12 months	1	Decreasing
N = 2,130		2	8–10; 11–13	^b	Decreasing
Cross-sectional studies^c					
N = 90	2–8	3	2–3; 4–5; 7–8		Increasing
N = 115	3–10	3	3–5; 6–7; 8–10		Increasing
N = 100	6–7 months	2	6 and 7 months		Increasing
N = 60		2	9–12 months; 15–18 months		Increasing
N = 112	4–10	7	4; 5; 6; 7; 8; 9; 10		Increasing
N = 51		2	5; 10		Increasing
N = 90	3–5	3	3; 4; 5		Decreasing
N = 22	1–2 months	2	1 and 2 months		Decreasing
N = 36		3	5–6; 7–8; 10		No pattern
N = 72	1–3	3	1; 2; 3		No pattern
N = 78	2–6	5	2; 3; 4; 5; 6		No pattern

^aN = 3.

^bMissing data.

^cN = 11.

studies (55%), but no clear pattern was found among the three longitudinal studies reporting dispersion measures. It was possible to calculate Bartlett's test for homogeneity of variance for only four of these studies; none of the results was significant.

An examination was done here also of the age groups that were compared in these studies. As can be seen in Table 7, three out of six of the cross-sectional studies compare three or more age groups, lending some support to the notion of increasing diversity as age increases. The period of time during which subjects were followed in the longitudinal studies is too short, however, to indicate anything about life-course trends in diversity.

Discussion and Conclusion

It appears that it is still the case that empirical data to address the hypothesis of increasing variability with age are quite limited. This review of journal articles from 1982 to 1987 revealed that measures of dispersion are reported in nearly half of the studies surveyed. However, statistics were generally noted in a rather incidental way or else not discussed at all; in none of the studies was the topic of diversity a research question. The results of the present analysis of patterns of variability from those studies that present measures of dispersion indicate that diversity needs to be considered along with normative age patterns: the evidence here supports the notion of increasing diversity with increasing age.

An analysis of gerontological studies in which such measures are reported indicates that in a majority of cases (65%), a pattern of increasing variability with age was found. Our secondary analysis to determine differences in dispersion among age groups of both developmental and gerontological studies that presented the requisite data shows 50% of the latter were statistically significant (none of the developmental studies were, however).

The dominance of the pattern of increasing diversity does not appear to be domain-specific; the same

general finding emerged across physical, personality, and cognitive domains. While we had insufficient data for a comparison of social characteristics, other analyses have indicated that the social domain may tend to be characterized by more diversity than physiological and personality constructs (e.g., Henretta & Campbell, 1976; Maddox & Douglas, 1974; Treas, 1986).

It is interesting that a pattern of increasing variability was more often reported in longitudinal studies than in cross-sectional ones. In longitudinal work, greater attention is typically given to the study of individual differences, which may account for the finding that studies that utilize this research design are much more likely than ones with cross-sectional designs to report data on variability (70% vs 27%). Nevertheless, in the longitudinal studies surveyed here, variability was still treated as an aside. If a tendency toward increasing variability among age peers is a systematic feature of aging, it is a phenomenon that deserves more systematic attention in longitudinal research.

In the studies of child development over the same time period, measures of variability were reported and discussed with less frequency than in the gerontological studies. Increasing variability with increasing age was the modal pattern here also, although it was not as strong for these studies as for the gerontological ones. It is not possible to determine if variability exists across domains for this subset of studies since only two types of variables were examined.

As we noted earlier, the diversity of the aged is widely regarded as an issue that requires scholarly attention in gerontology. This paper documents what appears to be a neglect in research regarding this issue. Our analysis of homogeneity of variance suggests that the need to attend to diversity is required by methodological as well as theoretical concerns. The problem of how to handle data that do not meet this assumption of heteroscedasticity takes a new form if a tendency toward increasing variance is a systematic aspect of aging.

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